AI-Powered Intelligent Drug Interaction and Safety Analysis System

R. Hanush Shandilya[1], D. Prasanth[2]

[1]*Assistant Professor, Department of IT & Cognitive Systems, Sri Krishna Arts and Science College, Coimbatore, Tamil Nadu, India*
[2]*Assistant Professor, Department of IT & Cognitive Systems, Sri Krishna Arts and Science College, Coimbatore, Tamil Nadu, India*

---***---

Abstract-*Medication safety is a significant concern in modern healthcare, particularly for patients who take multiple medicines to manage chronic or acute medical conditions. Inappropriate drug combinations, existing health conditions, and insufficient awareness of medicine-related risks may lead to adverse drug reactions and reduced treatment effectiveness. Although several online drug information systems provide basic clinical details, most do not generate personalized recommendations based on an individual's medical profile. This paper presents an AI-Powered Medicine Safety Checker that combines semantic analysis with real-time drug information to evaluate medication safety. The proposed system retrieves verified clinical data from the OpenFDA and RxNav APIs and analyzes patient-specific information, including age, gender, pregnancy status, existing diseases, and prescribed medicines. A Sentence Transformer model is used to understand the contextual meaning of medical information, enabling the system to identify potential risks beyond traditional keyword matching. Based on the combined analysis of patient conditions, contraindications, and drug interactions, the system classifies medicines into Safe, Caution, or Unsafe categories. The application is implemented using Python and Streamlit, providing an interactive interface and downloadable safety reports. The proposed framework offers a practical and accessible decision-support solution that assists users in making informed medication-related decisions while promoting safer medicine usage.*

Keywords-Artificial Intelligence, Medication Safety, Drug Interaction, Semantic Analysis, Sentence Transformers, OpenFDA API, RxNav API, Clinical Decision Support.

I. INTRODUCTION

Medication safety has become an essential component of quality healthcare due to the increasing use of multiple medicines for treating chronic and acute diseases. Patients suffering from conditions such as diabetes, hypertension, cardiovascular disorders, or kidney disease often require more than one medication, increasing the possibility of adverse drug reactions and harmful drug interactions. In addition, many individuals purchase over-the-counter medicines or use information available on the internet without consulting healthcare professionals, which further increases the risk of inappropriate medication use.

Several online drug information platforms provide details regarding indications, dosage, contraindications, and side effects. While these resources are useful, they generally provide generic information and require users to interpret the clinical relevance themselves. They rarely consider patient-specific factors such as existing medical conditions, pregnancy status, age, or concurrent medications before presenting recommendations. Consequently, users may find it difficult to determine whether a particular medicine is appropriate for their individual health profile.

Recent advances in Artificial Intelligence (AI) and Natural Language Processing (NLP) have enabled healthcare applications to analyze medical information more intelligently. Transformer-based language models can understand the contextual meaning of clinical text rather than relying only on exact keyword matching. This capability makes them suitable for interpreting complex medical descriptions, identifying hidden relationships between diseases and medicines, and supporting clinical decision-making.

This research proposes an **AI-Powered Medicine Safety Checker** that integrates semantic analysis with real-time medical information obtained from trusted healthcare APIs. The system collects patient information through a web interface and retrieves drug-related data from OpenFDA and RxNav. A Sentence Transformer model performs semantic analysis to evaluate medicine suitability based on patient conditions and available clinical evidence. The framework also detects potential drug–drug interactions before generating a personalized recommendation.

Based on the overall assessment, each medicine is classified into one of three categories: **Safe**, **Caution**, or **Unsafe**. The application also generates a downloadable report summarizing the identified risks and recommendations. By combining semantic understanding with continuously updated medical information, the proposed system provides a practical decision-support tool that improves medication safety and assists both healthcare professionals and the general public.

The remainder of this paper is organized as follows. Section II reviews related studies on medication safety and AI-based healthcare systems. Section III defines the research problem and objectives. Section IV presents the proposed methodology, followed by the system architecture and implementation in Section V. Section VI discusses the experimental results, and the final section concludes the paper with future research directions.

II. RELATED WORK

Recent advancements in Artificial Intelligence have significantly improved medication safety and clinical decision-support systems. Traditional drug information systems mainly provide dosage instructions, contraindications, and side effects using static databases, requiring users to interpret the information manually. These systems often lack personalized recommendations based on patient-specific medical conditions.

Transformer-based Natural Language Processing models such as BERT and Sentence Transformers have improved semantic understanding of biomedical text by capturing contextual relationships instead of relying solely on keyword matching. Similarly, OpenFDA and RxNav APIs provide reliable and up-to-date information regarding drug labels, contraindications, adverse reactions, and drug interactions. However, most existing applications focus on only one aspect of medication safety, such as interaction checking or drug information retrieval.

The proposed system integrates semantic analysis with real-time medical APIs to perform patient-specific medication safety evaluation. By combining contextual language understanding, drug interaction detection, and personalized risk assessment, the system provides more informative recommendations than conventional medicine information systems.

III. PROBLEM STATEMENT

Despite the availability of numerous online drug information platforms, patients often face difficulties in determining whether a medicine is safe for their specific health condition. Existing systems mainly provide general drug information and basic interaction details without considering patient-specific factors such as age, pregnancy status, chronic diseases, or concurrent medications. Furthermore, many applications rely on keyword-based searches and static drug databases, which limit their ability to provide accurate and personalized recommendations. Therefore, there is a need for an intelligent medication safety system that combines semantic analysis with real-time medical information to support safer and more informed medication decisions.

IV. OBJECTIVES

The primary objective of this research is to develop an AI-powered medicine safety checker that provides personalized medication recommendations using semantic analysis and real-time drug information.

The specific objectives are:

- To retrieve updated drug information using OpenFDA and RxNav APIs.
- To analyze medicines using Sentence Transformer - based semantic similarity.
- To identify drug–drug interactions and condition-specific contraindications.
- To evaluate medication safety based on patient health conditions.
- To classify medicines as Safe, Caution, or Unsafe.
- To generate an easy-to-understand medication safety report for users.

V. PROPOSED METHODOLOGY

The proposed AI-Powered Medicine Safety Checker follows a modular architecture that combines semantic analysis, real-time medical information retrieval, patient risk evaluation, and drug interaction analysis. The system is designed to provide personalized medication safety recommendations based on individual health conditions rather than general drug information.
Initially, the user enters personal and medical information, including age, gender, pregnancy status, existing diseases, and medicine names through a web-based interface developed using Streamlit. The system validates the entered information and standardizes medicine names before initiating the analysis. After preprocessing, the application retrieves clinical information from the OpenFDA API, including drug indications, contraindications, warnings, adverse reactions, and pregnancy safety information. Simultaneously, the RxNav API is used to identify potential drug–drug interactions among the prescribed medicines.

To improve the interpretation of medical information, the proposed framework employs a Sentence Transformer model. Unlike conventional keyword-based systems, semantic analysis enables the application to understand the contextual meaning of clinical text and identify relationships between medicines and patient conditions. This approach improves the accuracy of medication safety assessment, particularly when different medical terms describe similar concepts.

The Patient Risk Evaluation Module analyzes whether each medicine is suitable for the user's health profile. The system considers common medical conditions such as diabetes, hypertension, kidney disease, liver disorders, cardiovascular diseases, and pregnancy before generating recommendations.

The outputs from semantic analysis, patient risk evaluation, drug interaction detection, and FDA safety warnings are combined in the Decision Engine. Based on the integrated analysis, the system classifies medicines into one of three categories:

- **Safe** – No significant risks detected.
- **Caution** – Medicine may require medical supervision.
- **Unsafe**–Serious contraindications or harmful interactions detected.

Finally, the application displays the analysis results through an interactive dashboard and generates a downloadable PDF report containing medicine details, identified risks, interaction information, and personalized recommendations.

VI. SYSTEM ARCHITECTURE

The proposed system consists of seven interconnected modules that work together to evaluate medication safety. The architecture begins with the User Input Module, where patient information and medicine details are collected. The Input Processing Module validates the entered data and standardizes medicine names before forwarding them for further analysis.

The Drug Information Retrieval Module communicates with OpenFDA and RxNav APIs to obtain real-time clinical information and interaction details. The retrieved data is then processed by the Semantic Analysis Module using Sentence Transformer embeddings. The Patient Risk Evaluation Module examines whether the medicines are suitable based on the patient's medical conditions. Finally, the Decision Engine integrates all findings and produces the final recommendation, which is presented through the Streamlit web interface along with a downloadable PDF report.

VII. IMPLEMENTATION

The proposed application was implemented using Python due to its extensive support for artificial intelligence and web application development. Streamlit was used to develop the user interface because it enables rapid deployment of interactive healthcare applications. The Sentence Transformer model was integrated to perform semantic similarity analysis between patient conditions and clinical drug information.

Drug-related information was retrieved dynamically using the OpenFDA API, while the RxNav API was used to identify clinically significant drug interactions. The application processes patient information, evaluates medication safety, and presents the final recommendation through an intuitive web dashboard. Additionally, ReportLab was used to generate downloadable PDF reports summarizing the medication safety analysis.

VIII. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed AI-Powered Medicine Safety Checker was evaluated using multiple medicine combinations and patient health profiles to verify its effectiveness in identifying medication risks. The system successfully retrieved real-time drug information from the OpenFDA API and identified clinically significant drug interactions using the RxNav API. Semantic analysis further improved the interpretation of clinical information by recognizing relationships between medicines and patient conditions beyond simple keyword matching.

The application accurately classified medicines into three categories: Safe, Caution, and Unsafe, based on the patient's age, pregnancy status, existing diseases, and prescribed medications. The generated PDF reports provided users with detailed explanations, including contraindications, interaction warnings, and safety recommendations.

The developed system demonstrated consistent performance while processing different medication combinations and produced meaningful recommendations that can support medication safety awareness. Compared with conventional drug information systems, the proposed framework offers personalized evaluation rather than displaying only general drug information.

Input Medicine	Patient Condition	System Output
Paracetamol	Healthy Adult	Safe
Ibuprofen	Kidney Disease	Caution

IX. CONCLUSION AND FUTURE WORK

CONCLUSION

This research presented an **AI-Powered Medicine Safety Checker** that combines semantic analysis with real-time drug information to support medication safety assessment. The proposed system integrates OpenFDA and RxNav APIs with a Sentence Transformer model to evaluate medicines based on patient-specific information such as age, pregnancy status, existing diseases, and prescribed medications. By classifying medicines into **Safe**, **Caution**, and **Unsafe** categories, the system provides personalized recommendations that help users understand potential medication risks. The web-based application developed using Streamlit offers a simple and accessible platform for retrieving medicine information and generating medication safety reports. Overall, the proposed framework demonstrates the potential of Artificial Intelligence in improving medication safety and supporting informed healthcare decisions.

FUTURE WORK

Future enhancements may include integrating Electronic Health Records (EHR), multilingual support, dosage recommendation, mobile application development, and advanced deep learning models to improve the accuracy and usability of the system. Additional features such as voice-based interaction and cloud deployment can further enhance accessibility and support a wider range of healthcare applications.

REFERENCES

1) J. Devlin, M. W. Chang, K. Lee, and K. Toutanova, "BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding," in Proc. NAACL-HLT, Minneapolis, MN, USA, 2019, pp. 4171–4186.

2) N. Reimers and I. Gurevych, "Sentence-BERT: Sentence Embeddings using Siamese BERT-Networks," in Proc. EMNLP-IJCNLP, Hong Kong, China, 2019, pp. 3982–3992.

3) K. Song, X. Tan, T. Qin, J. Lu, and T. Liu, "MPNet: Masked and Permuted Pre-training for Language Understanding," in Advances in Neural Information Processing Systems (NeurIPS), vol. 33, 2020.

4) U.S. Food and Drug Administration, "OpenFDA API Documentation." [Online]. Available: https://open.fda.gov. [Accessed: Jul. 2026].

5) National Library of Medicine, "RxNav API Documentation." [Online].Available: https://lhncbc.nlm.nih.gov/RxNav/. [Accessed: Jul. 2026].

6) S. Rajkomar, J. Dean, and I. Kohane, "Machine Learning in Medicine," New England Journal of Medicine, vol. 380, no. 14, pp. 1347–1358, 2019.

7) G. Sutton, J. Pincock, D. Baumgart, D. Sadowski, C. Fedorak, and K. Kroeker, "An Overview of Clinical Decision Support Systems: Benefits, Risks, and Strategies for Success," NPJ Digital Medicine, vol. 3, no. 17, pp. 1–10, 2020.

8) World Health Organization, "Medication Without Harm –Global Patient Safety Challenge," WHO, Geneva, Switzerland, 2017.

9) A. Esteva, A. Robicquet, B. Ramsundar, et al., "A Guide to Deep Learning in Healthcare," Nature Medicine, vol. 25, no. 1, pp. 24–29, 2019.

10) Python Software Foundation, "Python 3 Documentation." [Online]. Available: https://docs.python.org/3/

11) Streamlit Inc., "Streamlit Documentation." [Online]. Available: https://docs.streamlit.io/

12) J.Brownlee,"Deep Learning for Natural Language Processing," Machine Learning Mastery, 2019.