



# International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*



**Impact Factor: 8.699**

**Volume 15, Issue 3, March 2026**

# **A Machine Learning-Based Patient Adherence Prediction System Using Random Forest Algorithm**

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**ABSTRACT:** Non-adherence to medication is a significant problem in the current healthcare systems. It is particularly evident among patients suffering from chronic diseases. Adherence to medication regimens is critical to the control and management of such diseases. Failure to adhere to medication results in the progression of the disease and higher health care costs. In this paper, an intelligent patient adherence monitoring system has been proposed. The proposed intelligent patient adherence monitoring system can predict the non-adherence to medication by the patient using machine learning algorithms. The proposed intelligent patient adherence monitoring system can use the random forest classifier for predicting non-adherence to medication due to the robustness of the classifier. The proposed intelligent patient adherence monitoring system can use data pre processing techniques such as categorical encoding and feature selection for improving the performance of the classifier. Based on the risk level of non-adherence to medication by the patient, the proposed intelligent patient adherence monitoring system can use automated notification mechanisms such as reminders and alerts. Additionally, rule-based prioritization strategies are incorporated into the system for improving the effectiveness of interventions for high-risk patients. The proposed system also incorporates a visual analytics component for monitoring patient adherence trends as well as risk distribution. The experimental results show that the inclusion of behavioral as well as clinical features improves the accuracy of predictions. The proposed system is efficient and scalable for use in a real-world healthcare environment.

**KEYWORDS:** Medication Adherence, Machine Learning in Healthcare, Random Forest, Risk Prediction, Healthcare Analytics, Predictive Modeling, Patient Monitoring Systems.

## **I. INTRODUCTION**

In addition, the increased growth of digital healthcare technology in patient monitoring and clinical decisions has posed a challenge in healthcare delivery across the world. For example, patients suffering from chronic conditions such as diabetes, hypertension, and cardiovascular disease need medication and monitoring of their condition over time. However, patients do not adhere to their medication plans and schedules, and this has posed a significant challenge in healthcare delivery across the world. As a result, it has become critical to monitor patients who are at risk of non-adherence.

Conventional approaches to monitoring medication non adherence include manual follow-up and survey-based approaches, as well as regular clinical visits by patients. However, these approaches are mostly reactive and do not offer predictive insights. In addition, rule-based systems that use threshold-based approaches such as missed dose counts are not effective in dealing with complex relationships between different factors.

A more effective solution is provided through machine learning methods that analyze historical data related to health care to recognize unknown patterns associated with nonadherence. Ensemble methods like Random Forest classifiers are more appropriate for applications related to healthcare due to their strength and ability to handle diverse data types. They facilitate precise risk assessment through the assessment of multiple factors.

Apart from predictions, timely intervention is also vital to ensure improved patient outcomes. The integration of the prediction model with notification tools helps to facilitate timely monitoring of the patient population.

In this regard, this paper proposes an intelligent Patient Adherence Monitoring and Risk Prediction System based on the application of machine learning classification techniques and automated alerts. The system will utilize the attributes to effectively forecast the risk levels and enable proactive health care decisions.

## II. LITERATURE SURVEY

The increasing use of digital health systems and electronic health records has helped improve the availability of patient data for predictive analytics. Medication non-adherence is also an issue in health systems across the world. Researchers have started to use computer-based methods to predict and manage non-adherence behavior.

Past research studies on non-adherence monitoring have focused on rule-based and statistical methods. These methods use thresholds such as the number of missed appointments and the gap in refilling prescriptions and demographic factors. Even though these systems provided basic monitoring facilities, they were not adaptable and could not handle complex relationships between multiple behavioral and clinical factors.

Subsequently, machine learning algorithms such as Logistic Regression, Naïve Bayes, and Support Vector Machines were introduced for medication adherence prediction. These algorithms were based on structured data from the healthcare domain, such as patient ages, disease types, medication counts, and patient adherence history. Although these algorithms were seen to have higher predictive accuracy than rule-based systems, they were often unable to handle non-linear relationships between features and data interactions.

Recent advancements have been made in machine learning algorithms such as ensemble learning algorithms, particularly Random Forest and Gradient Boosting algorithms, because of their robustness and ability to handle heterogeneous data from the healthcare domain. Ensemble learning algorithms combine multiple decision trees and are seen to have higher predictive accuracy than other algorithms for risk prediction and patient outcome analysis in healthcare classification problems.

In addition to this, some studies have also focused on the use of automatic reminder systems as well as mobile health apps for improving the adherence rates. However, many of these systems have focused only on the periodic reminder mechanism without any use of predictive intelligence for patient stratification.

In this paper, we propose an intelligent framework for patient adherence risk prediction using machine learning as well as automatic notification systems along with a visual analytics mechanism. The proposed approach is quite different from the existing systems as it unifies all the above three components within a single architecture.

## III. PROPOSED SYSTEM

The proposed system is a "Machine Learning-Based Patient Medication Adherence Prediction System" designed to analyze data and predict whether or not the patient is adhering to the prescribed medication and treatment. This is done in order to assist healthcare providers in identifying patients who may not adhere to prescribed treatment and prevent it in its early stages.

- The proposed system consists of two main parts:
- Patient Adherence Prediction Module
- Healthcare Assistance Chatbot Module

In the "Patient Adherence Prediction Module," various features of patients such as demographic data, medical history, medication routine, lifestyle, and past adherence behavior are processed and analyzed. These features are used to train a supervised learning model. The "Random Forest Classifier" model analyzes all of these features and predicts whether or not the patient is adhering to treatment based on learned behavior and medical patterns.

In the healthcare assistance chatbot module, patients are allowed to interact with the system to get answers to their queries regarding diseases, medications, symptoms, recovery time, and treatment advice. The chatbot uses a pre-defined knowledge base to provide relevant health-related information to patients and helps them understand their health condition and treatment processes.

**Volume 15, Issue 3, March 2026****|DOI: 10.15680/IJRSET.2026.1503141|**

The system is developed using Python programming language and machine learning libraries. The web interface is created using FastAPI to input patient data and obtain prediction results in real time. The chatbot interface is used for interactive communication between patients and the system.

The proposed system is a smart, automated, and efficient way of monitoring patient medication adherence compared to conventional methods of monitoring patient medication adherence.

**IV. SYSTEM DESIGN AND WORKING PRINCIPLES****System Design**

The proposed system is a modular framework that incorporates various machine learning techniques and data analysis in the field of healthcare to provide a predictive model of patient medication adherence. The proposed system analyzes patient-related medical and behavioral information to determine whether a patient is likely to adhere to a prescribed treatment plan. The main aim of this proposed system is to help healthcare providers identify patients who may require special attention to adhere to medication properly.

First, a dataset of patient information such as age, medical history, medication schedule, and patient lifestyle is collected. Then, this collected data is preprocessed to eliminate inconsistencies and missing values in the dataset, and it is converted into a structured format that can be easily fed into a machine learning model. Feature selection and transformation techniques are applied to convert patient information into a numerical format that can be fed into a predictive model.

A Random Forest classifier is used to analyze the data and make predictions regarding patient adherence behavior. The classifier assesses multiple patient characteristics and makes predictions regarding whether a patient is likely to be 'adherent' or 'non-adherent' to medication. The Random Forest classifier is used for this purpose because of its ability to deal with complex data, prevent overfitting, and produce highly accurate predictions using ensemble methods.

In addition to the prediction module, the system also incorporates a healthcare chatbot interface that can assist patients by answering their queries related to diseases, medications, symptoms, and treatment. The chatbot uses a pre-defined data source to provide relevant and informative answers to patients to raise awareness about their health conditions. The predictions and relevant healthcare information are displayed using a web-based interface.

**Working Principles**

This is achieved through a system of sequential workflow, which involves data collection regarding patients. The data is validated and preprocessed to ensure consistency and reliability. The processed data is then input into the trained Random Forest machine learning model, which analyzes the patterns within the data and is able to make a prediction regarding whether the patient is likely to adhere to the medication plan.

Once this prediction has been made, it is presented to the user through the system interface. If it is identified that there is a high risk of non-adherence, this can be addressed through guidance provided to patients through the healthcare chatbot. The system can therefore be used to monitor medication adherence and provide preventive measures to healthcare professionals and patients.

**V. RESULTS AND DISCUSSION**

The system proposed has been evaluated to determine its ability to predict medication adherence among patients through the use of machine learning. For this purpose, the dataset has been divided into training and testing sets. Various attributes of patients, such as age and medication schedule, have been used to train the classifier. It has been determined from the results that various attributes of patients improve the accuracy of medication adherence prediction.

The proposed system has successfully utilized the Random Forest classifier to evaluate various behavioral patterns of patients and determine whether they would adhere to medication or not. It has been determined from the results that the system is stable and reliable for prediction purposes. It is evident from the results that patients who may not adhere to

medication would be easily identified through this system. Preventive measures would be taken to improve treatment results.

A healthcare chatbot has also been included with the system to provide answers to various queries of patients regarding diseases, medication, symptoms of diseases, and treatment duration. It has been determined from the results that patients would be able to understand their health conditions through this system.



Figure 1 The Random Forest model effectively predicted patient medication adherence (79.9% accuracy, 72.5% F1 score) by analyzing patient medical history, medication patterns, and behavioral features.

## VI. CONCLUSION

This research aims to develop an intelligent Patient Adherence Monitoring and Risk Prediction System based on machine learning algorithms to forecast patient non-adherence to medication regimens. The system will utilize a Random Forest classifier to analyze patient data and forecast patient non-adherence to medication regimens. By analyzing patterns in patient data, healthcare practitioners can understand various factors influencing medication adherence.

Moreover, the system will utilize a risk-aware rule-based approach to deal with uncertain cases and identify significant factors influencing patient non-adherence, including medication and medical appointment skipping. The experimental outcomes reveal that the suggested model has high accuracy, precision, and F1-score compared to traditional methods. The system is flexible and can be applied in digital healthcare settings to enhance patient compliance and treatment outcomes.

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