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A Conceptual Framework for Integrating Electronic Health Records and Data Analytics in Healthcare Systems

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Abstract

Presently, onsite observation and interaction with some healthcare facilities in Nigeria indicate that there is a gap between Electronic Health Records (EHRs) stored in the department of Health Information Management (HIM) and Data Analytics. Therefore, it is important to combine the historical data that is stored electronically in the Health Information Management department with data analytics through the use of machine learning models like Support Vector Machine (SVM), Regression model, Artificial Neural Network (ANN), Random Forest (RF), among others. This method allows simple access to health data and records, which can be retrieved and saved in various format from the health information management database. The results from these data analytics can help find diseases early and predict their occurrences, which allows healthcare workers to take action earlier. This proactive approach helps in controlling, managing, and preventing diseases before they actually happen or start to spread. *This paper proposes a conceptual framework* that combines electronic health records with data analytics, which can help in predicting and managing diseases in Nigeria's healthcare system by supporting better decision-making in clinical settings.

Keywords: Data Analytics, Electronic Health Records, Healthcare, Framework, Integration

INTRODUCTION

In recent years, improvements in technology have made it possible to store hospital records and information electronically. Keeping health records in electronic form makes it easy to access and use the information whenever needed. In such organizations, the amount of data tends to grow and become very large. Handling large amounts of data by hand is extremely difficult but using machine learning models makes it much easier and more efficient. Using these models on datasets makes it simple to model predictive analytics, which can help health providers make better decisions.

According to Dulam (2025), predictive analytics is a technique that helps change the healthcare system by using stored patient data or information. It helps in transforming patient's data, predict possible diseases, and improve health outcomes. This also helps in making healthcare services more efficient and effective. Real-time electronic health records of patients and the use of machine learning models to analyze them help healthcare providers better understand disease trends so they can decide which treatments to give (Nwaimo *et. al.*, 2024). Using data analytics in electronic health records helps move healthcare from responding to problems after they happen to anticipating and preventing them by allowing for better predictions and early actions to keep people healthier. In order words, it helps in finding diseases earlier, reduces the need for patients to go back to the hospital, and makes it easier to manage the illness (Razzak et al., 2020).

The use of Electronic Health Records (EHRs) in healthcare settings is increasing, but some healthcare facilities still struggle with handling the large amount of data they collect, which makes it hard to make timely and informed decisions based on evidence. The main goal of EHRs as observed by Nguyen *et. al.* (2014) is to ensure that patient health information is accurate, complete, and easily accessible. This helps healthcare providers in making better decisions, give more effective care, and ultimately help patients get better health results (Li *et. al*., 2019; Tanwar, *et. al.*, 2020).

Integrating EHR systems with advanced data tools like machine learning models helps in making disease prediction earlier thereby giving healthcare givers direction to tackle predicted disease when it finally occurs, (Enahoro *et. al.*, 2024). Physical presence to collect datasets from health information department of some health facilities indicates that there is no synergy between EHRs and machine learning data analytics This inefficiency might be because the data from EHRs aren't properly connected to machine learning data analytics tools, and the staff isn't getting enough training on how to use those tools. Based on the foregoing, it is important to suggest a framework that looks at how EHR systems can be properly connected with data machine learning data analytics tools to improve patient results, make healthcare services more efficient, and support better clinical decisions.

RELATED LITERATURE

Many researchers have done studies on using data analytics in healthcare, electronic health records systems, clinical decision support systems, and the challenges of integrating data. For example, Aggarwal (2025) conducted a research on the use of data analytics in healthcare system by revolutionizing personalized medicine and diagnosis. In the study, it was observed that the integration of advanced analytical frameworks can aid healthcare givers the ability to manipulate and operate large array of patient data thereby leading to improved outcomes in terms of diagnostic accuracy and treatment prescriptions. With this system, the implementation of personalized medicine through data analytics would improve treatment across various therapeutic areas, particularly in oncology and chronic disease management. Some challenges technical challenges, such as security, and validation in in data integration were highlighted.

Nwaimo et al. (2024) examined transformation of healthcare using data analytics for predictive models of patient outcomes. In the research, it was said that using data analytics in healthcare helps get important information from large sets of data, which is done through methods like feature engineering or selection. This information supports decision-making at various levels, from those who care for patients directly to the people managing the hospital's operations.

Adeniyi *et. al*. (2024) conducted review research on big data and analytics to improve public health decision-making. In the review, the importance of big data coupled with data analytics in relation to enhanced public health for better decision-making was highlighted. The work also discussed diverse applications, approaches, opportunities and challenges associated with these blended fields. Different concepts such as, big data analytics in public health was elicited and different sources of datasets can be from heterogeneous sources, including electronic health records, social media, wearable devices, and environmental sensors. From the available data sources, a valuable insight into disease patterns, risk factors, healthcare utilization, and population health trends can be determined using data analytics. This will eventually aid decision making by informed health caregivers.

Arowoogun *et. al.* (2024) did comprehensive review on data analytics in healthcare management taking into cognizance leveraging big data for efficient and informed decision-making. In the research, the historical evolution of data analytics was explored by emphasizing on its growing in supporting clinical decision, resources allocation and operational efficiency within the realm of healthcare system. Some basic concepts, techniques and other importance of issues were discussed. The study also explained how artificial intelligence can be incorporated in real-time analytics. Some

challenges, such as, privacy, quality of data, and interoperability were identified.

In healthcare sector, it is function of health information management department to keep accurate records of diseases that a patient suffered from and all information regarding the patients, such as case history, medications and treatments given. With modern technology, the use of electronic health records (EHRs) and medical health records (MHRs) will be of important tools to handle the record keeping and retrieval system (Olukemi, *et, al.,* 2024). With this, it is expected that diseases prediction can be done to aid in proactive management of diseases before its occurrence. With the EHRs, it is expected that predictive analytics can be done using datasets available in electronic health record systems.

While explaining Electronic Health Records (EHRs), Enahoro *et. al.* (2024) commented that EHRs has represented a significant transformation in healthcare sector, which marked changes from old paper-based records into a more digital integrated technique of management of patient information. EHRs is the process of collecting health-related information on patients and systematically stored in an electronic format which can be accessed easily across various departments in healthcare settings

Amponin *et. al.* (2023) conducted research on the effectiveness of EHRs in healthcare setting. The researchers adopted descriptive and cross-sectional study where data used for the study was collected some selected government and private hospitals in Saudi Arabia with a sample of 320 health practitioners. The data collected were analyzed using mean, standard deviation, Mann-Whitney and KruskalWallis's tests, and Spearman's rho. The results showed that EHRs are effective moderately in improving healthcare outcomes. These factors, place of work, age and years of experience with the usage of EHRs are of critical indicators of effectiveness, however, health caregivers' profession is not a factor to determine EHRs effectiveness. Also, some challenges, such as network issue is a barrier to the use of EHRs by health caregivers.

It was noted by before (Reza *et. al.*, 2020; and Wang *et. al.*, 2020) EHRs cover all key clinical information, which include, but not limited to patient details (such as age and gender), the medicines they are taking, notes about their treatment progress, any problems that came up, symptoms they are experiencing, vaccinations they have had, results from imaging tests and lab work, and their medical history.

All the important information about the patient that is kept at the health facility is stored electronically, (Elsangidy *et. al.*, 2025) which helps health data analysts to look at and understand the data when they need to. Automating patient health records makes it easier to access information and helps make the clinician's work more efficient, (Taksler, *et. al.,* 2021).

Similarly, the International Standard Organization - ISO (2025) described EHRs as a digital place where a patient's medical information is stored, keeping track of their complete healthcare history in real-time. Electronic health records include patient health information, tools that help doctors make decisions, security measures to protect patient data, and ways for healthcare providers to communicate. These standards are based on guidelines from ISO 2025.

Therefore, EHR system can help in reducing the number of medical mistakes (Colombo *et. al.*, 2020; Wood *et. al.*, 2021 & Hohman, 2023), make health information easier to access, avoid repeating tests, speed up treatment, and help patients make better informed clinical decisions about the patients. (Payne, 2025 & Kaushik *et. al.* 2024).

A study was carried out by Kwarteng-Amaniampong (2025) to investigate the adoption of EHR systems and its effects on the provision of quality healthcare services delivery using the Technology Acceptance Model (TAM). The researcher adopted semi-structured interviews and qualitative research to collect data for the study from 50 clinicians using convenience sampling technique drawn from four hospitals. Nvivo version 11 software was used to analyze qualitative data obtained to give better understanding and addressing the practical implications of TAM

variables; perceived usefulness, ease of use, attitude towards use, behavioural intention to use and actual technology use, together with variables used in the study. The finding indicated that adequate training, user-friendly interface, management support, and system quality are very important in order to determine the success of EHR systems adoption and its positive influence on quality healthcare delivery.

In a study of effectiveness of EHRs investigated by Olukemi, *et. al.* (2024), The study adopted mix-methodology where healthcare providers of Federal Medical Centre, Abeokuta was sampled for the study. It was revealed that EHR improves healthcare service delivery by facilitating information management, improving healthcare professional coordination, and enabling patient engagement through effective clinical support.

Clinical decision support systems (CDSS) are part of electronic health records (EHRs) and help healthcare providers by giving them evidence-based advice right when they are caring for a patient. This support helps doctors and other medical staff make better choices in decision making about the best treatment options for each patient (Enahoro, *et. al.*, 2024 & Amponin, 2023). This system can give suggestions based on the most up-to-date information provided by caregivers from different parts of healthcare settings, following clinical guidelines and ethical standards. This basically means that there could be better results for patients. According to Li *et. al.* (2024), the benefits of CDSS include improved patient safety, increased efficiency, lower costs, and better adherence to regulations.

However, EHRs and data analytics have their downsides, especially when it comes to integrating data. As Sauer *et. al.* (2022), Faridoon *et. al.* (2024), and Kim *et. al.* (2024) noted that, issues like data privacy and security, biased algorithms, problems with systems working together, and inaccurate predictions because of unbalanced or missing data are big challenges when trying to combine EHRs with data analytics in healthcare. So, hospital data analysts need to put in a lot of effort in these areas before they start analyzing the health data sets.

In summary, this part of the paper covered fundamental ideas like electronic health records, parts of data analytics, predictive analytics, the role of data analytics, clinical decision support systems, the advantages of using electronic health records and data analytics, and also the possible difficulties that might come up when trying to combine these two in healthcare settings.

METHODOLOGY

In this paper, a conceptual framework for integration of EHRs and Data Analytics was proposed. The schematic illustration of the framework is shown in Figure 1.

From the framework, it is assumed that many of government-owned hospitals are operating electronic health records system where data are stored in a database and housed in the department of Health Information Management (HIM). With expertise of health data analysts, the framework is proposing that the data in the database can be fetched using required file extension and such data can be further processed using suitable machine learning models, depending on the nature of data analysis needed. In the process, the services of the following health workers/professionals and stakeholders are required to have comprehensive and adequate resourceful EHRs.

(i) Patients: This is first primary source of information in the healthcare setting. The information is provided by the patients to the doctors when interrogating for condition of the patients' well-being.

(ii) Doctors: Attend to patients by interrogating the patient on ailment is suffering from. Having examined the patient, the doctors may require further test where patients' lab request will be sent to laboratory. All tests conducted in respect of patients will be sent back to doctors for interpretation and further diagnosing of the patients. In some cases, there may be need for patients to do some scans, these requests will be sent by doctor to radiographers.

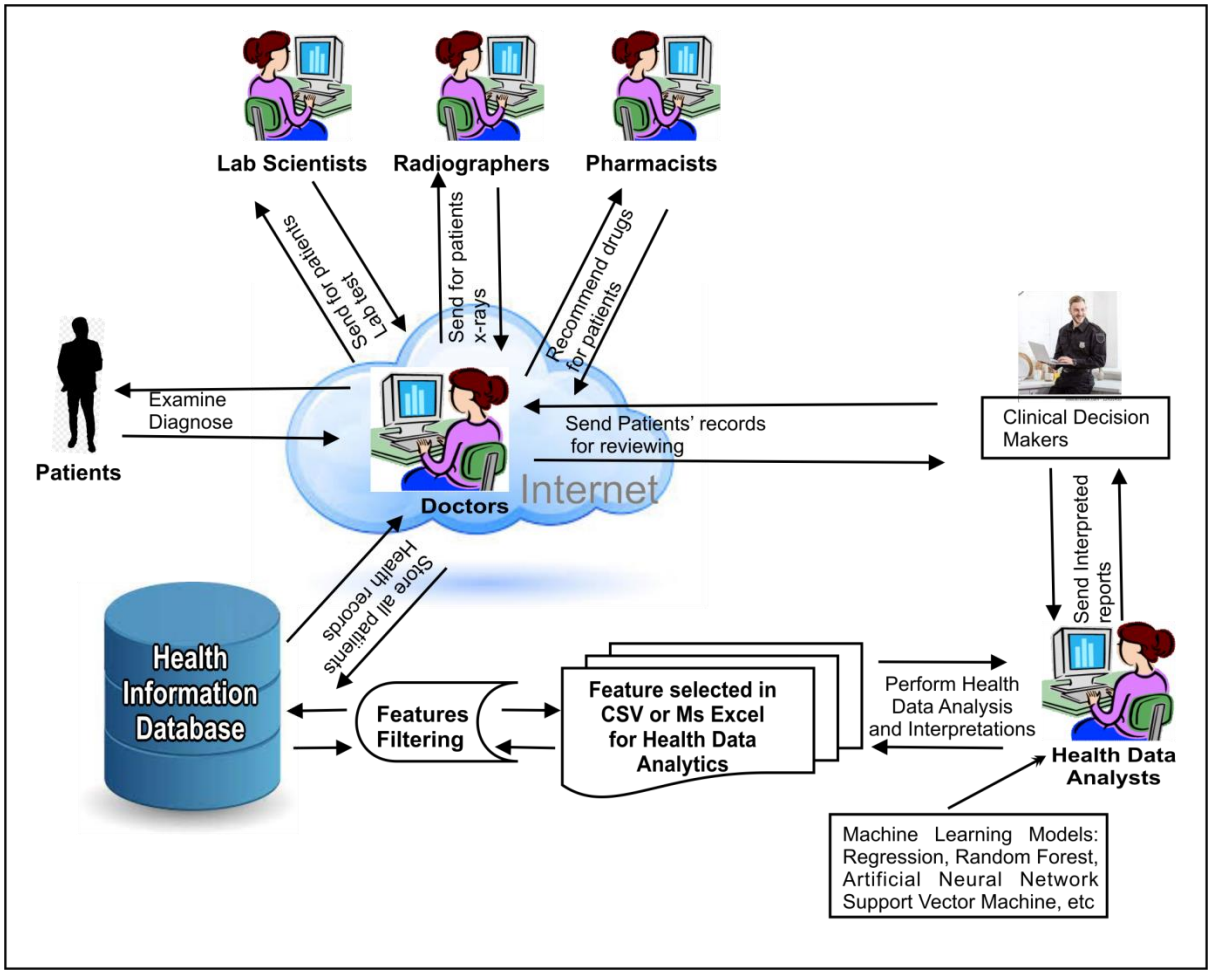

Figure 1: Framework for integration of EHRs and Data Analytics in Healthcare Settings

Also, having conducted the scans, the reports will be sent back to doctors for further interpretations. The doctors in turn recommend or prescribe the drugs for treatment of the diagnosed disease and pharmacists will also dispense by supplying the patients the prescribed drugs. All the patient's records are stored or kept electronically in the health information database at the department of health information management. The patients' records kept in the database can provide useful information on disease early detection, prediction, outbreak and prevention if it is properly harnessed. To achieve these, attention of health data analysts are required who are vast in the knowledge of modern machine learning models.

(iii) Health Data Analysts (HDA): Applies expertise knowledge to conduct feature selection on various variables needed from the health information database, depending on the type of analysis. The extracted datasets generated can be saved in different file format extensions, such as, .sav, .csv, .xlsx, etc. The HDA selects the model or algorithm which is suitable for type of analysis to be conducted, which include, but not limited to, artificial neural network, deep learning, random forest, regression, correlation, support vector machine, etc. The HDA as an expert select the software, such as, Python, R, SPSS, MATLAB, WEKA, Rapid studio, e.t.c. that can effectively and efficiency perform the computation needed on the health datasets. Usually, during modelling datasets are split into training and testing sets and by default majority of software tool assume 70:30 respectively. Though, this ratio can be changed, data analysts should ensure that there is no over fitting while estimating the models. The results obtained at

the end of experiments are interpreted and sent to clinical decision makers for proper action to be taken. The actions to be taken by clinical decision makers after critical look at the reports submitted by HDA can be reactive or proactive in nature.

IV. CONCLUSION

This paper *proposes a conceptual framework* aim to handle disease control, management, and prevention effectively and to achieve this goal, there is a need for trained health data analysts who are skilled in machine learning. The analysts filter various variables from HIM database and use expertise in machine learning modelling to make useful predictions from disease historical datasets which will help in making better clinical decisions. Having information on future diseases outbreak will assist hospital decision makers to find experts for new diseases and get the right medicines ready before the occurrence of the predicted disease. This often leads decision makers to take action early, based on predictions about diseases, instead of waiting until problems occur and then responding.

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