WHITE PAPER

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ENGINEERING ENDURANCE

# HARNESSING TECHNOLOGY FOR BETTER HEALTH OUTCOMES

Early Detection And Real-Time Alerting Through IoT and AI

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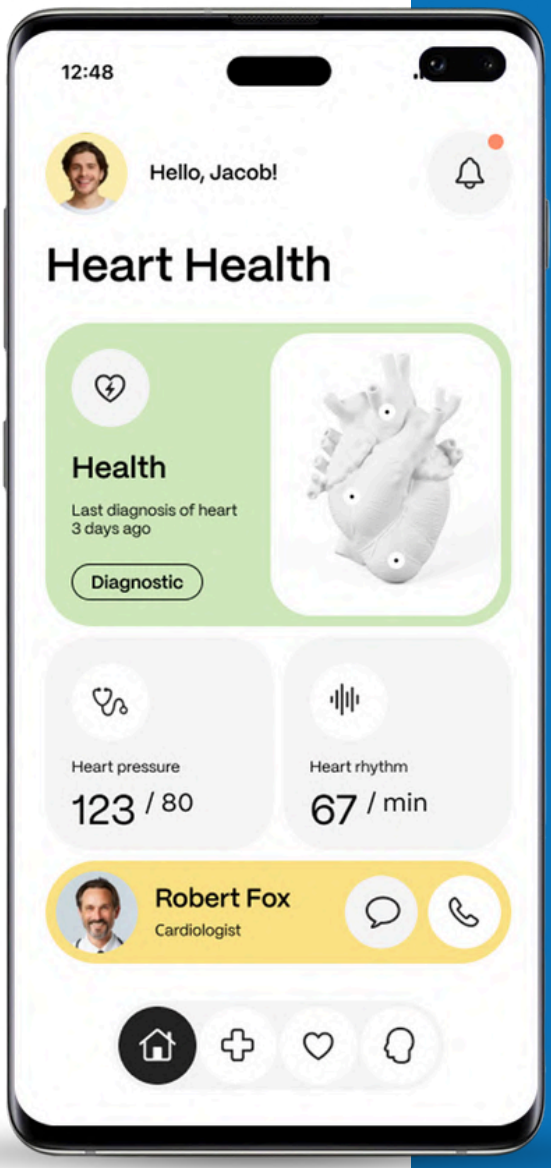
# EXECUTIVE SUMMARY

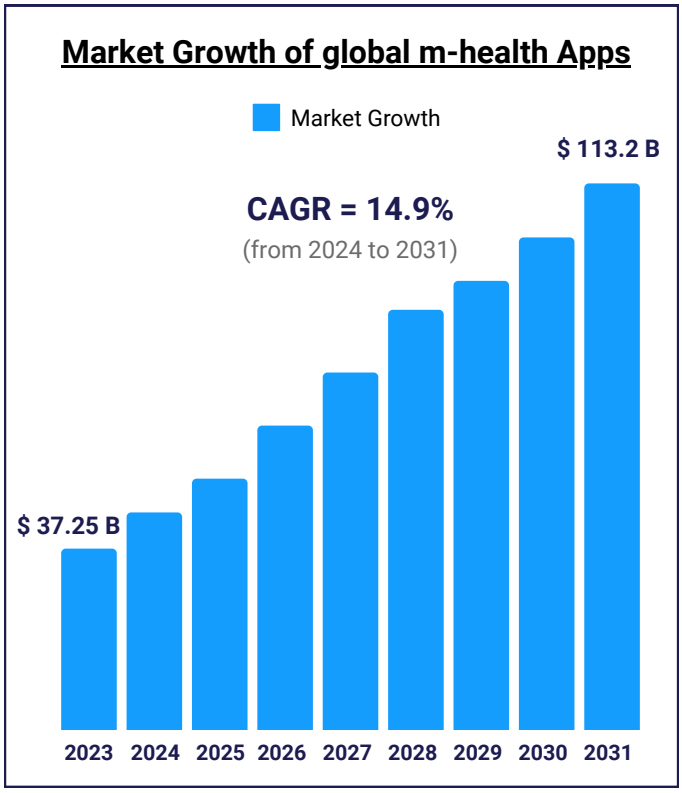


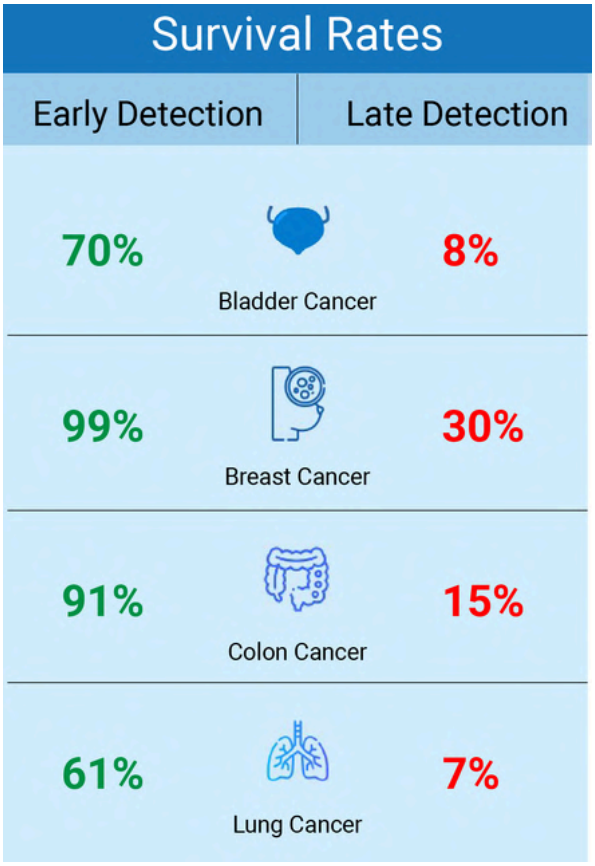

Early diagnosis of preventable diseases can be life-altering. Detecting early onset symptoms of conditions like Alzheimer's, Parkinson's, Cancer, etc. can help mitigate serious health risks. Disruptive technological advancements like the Internet of Things (IoT) and Artificial Intelligence (AI), specifically Machine Learning (ML) and Deep Learning (DL) models can notify users of early signs of diseases. This empowers them to get medical attention preemptively and address conditions promptly before they aggravate.

With this white paper, we aim to address the current scenario of technology and software solutions and their role in early detection, alerting, and prevention of diseases. Furthermore, this study critically examines challenges like data security and privacy concerns inherent in utilizing software solutions and algorithms. By exploring the ethical and regulatory implications of utilizing such technologies in healthcare settings, we aspire to foster a nuanced understanding of the challenges and opportunities associated with integrating disruptive technologies into disease prevention efforts.

# INTRODUCTION

With advancements and improvements in technology, the healthcare sector's technology adoption rate has been skyrocketing. Technology integration in healthcare encompasses a range of tools, including diagnostic imaging, AI-enhanced live-view monitors for guided surgeries, and real-time monitoring and alerting devices. It also includes patient care and data management platforms. These technologies have proven to be valuable for individuals, healthcare institutions, and hospitals alike. In recent years, there has also been a hike in the number of healthcare applications designed specifically for mobile devices and everyday wearable gadgets like smartwatches and smartbands.




The World Health Organization (WHO) reports that millions of preventable deaths occur each year due to late detection. Studies have shown that early detection of life-threatening diseases like cancer can significantly improve survival rates. Unfortunately, approximately 50% of cancer is diagnosed at an advanced stage[1] thereby significantly cutting down on chances of survival. This could be avoided by early detection and recording of symptoms aiding the physician, in arriving at an accurate and timely diagnosis.

# REAL-TIME ALERTING AND EARLY DETECTION & REPORTING OF SYMPTOMS

An early detection and recording of symptoms is crucial for timely diagnosis and intervention. From the admission of a patient, data should be continuously collected and recorded in the patient's EMR (electronic medical record). A patient's EMR includes the patient's primary details, treatment history, vitals, medical imaging data, etc. The consulting physician is then presented with this complete set of information enabling them to make an accurate diagnosis. This EMR data could be coupled with ML models to detect symptoms and/or predict mortality risk.

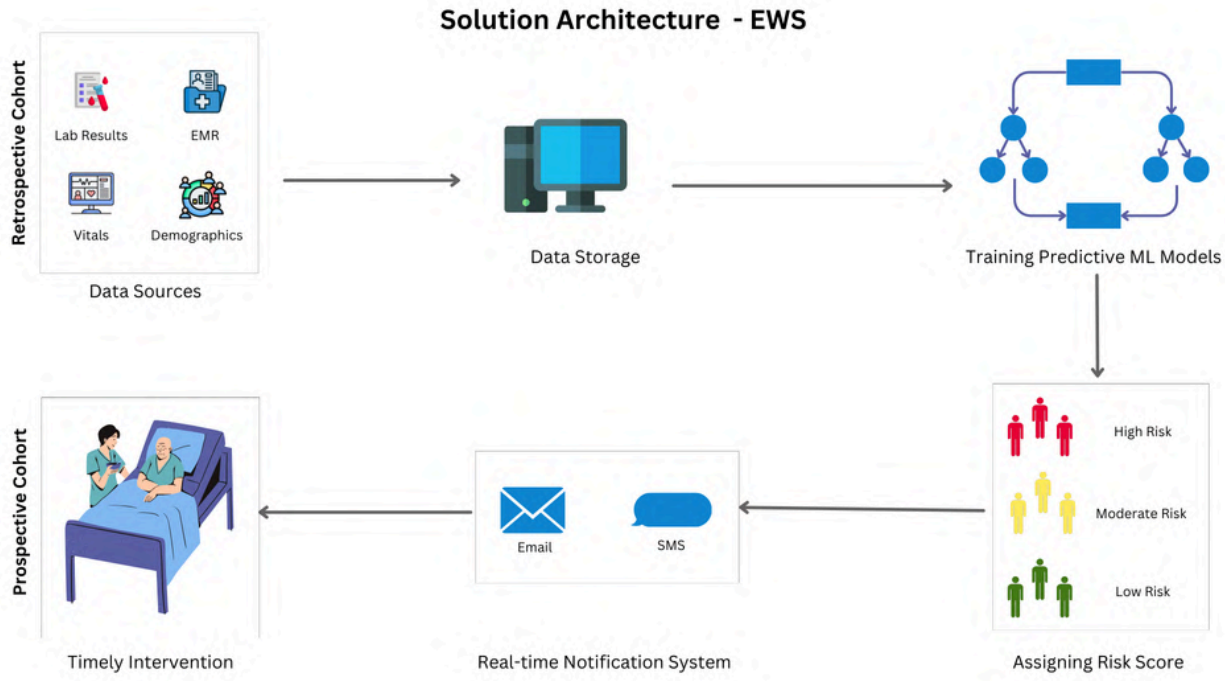
**Personal Data Collection**

**Vitals Taken**

**Blood & Serum Testing**

**Medical Imaging & Analysis**

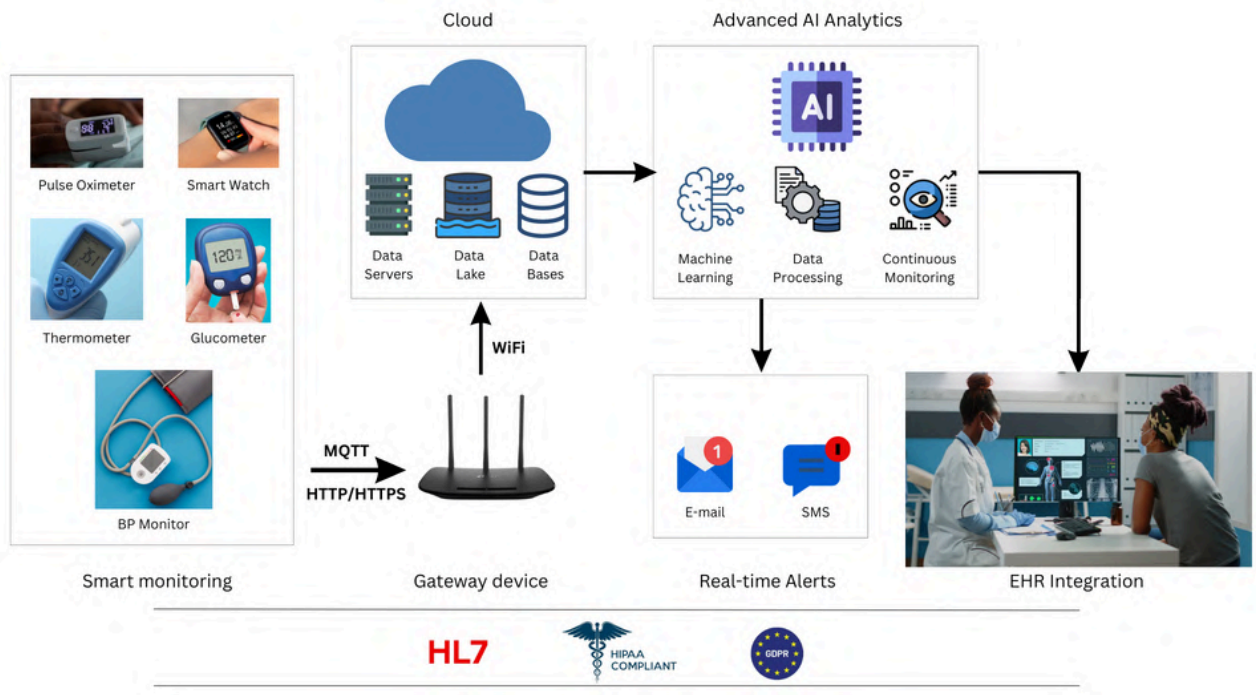
Presently, the solution closest to an early detection system is an Early Warning System (EWS) which is an on-premises, connected system. The system can predict in-patient mortality risk by integrating the patient's Electronic Medical Record (EMR) data. Data including demographics, clinical utilizations, medical history, vitals, lab results, and EMR data is collected from patients within a hospital or a network of hospitals. Collected data is utilized to assess in-patient mortality risk and corresponding risk scores will be assigned to each patient using a combination of EMR data and Machine Learning algorithms. When the risk score exceeds predefined thresholds, the software sends real-time alerts to healthcare providers, allowing for immediate intervention.




Such real-time alerting systems could help in timely intervention by medical professionals thereby mitigating considerable amounts of risk. However, it is significantly limited as it is an on-premise system. It is necessary to employ a fully remote system that supports real-time monitoring of patients. Such a practice is termed Remote Health Monitoring (RHM). In RHM various physiological data, such as blood oxygen level, heart rate, body temperature, and ECG signals, etc. are collected remotely[2]. These data points could be analyzed to identify potential health issues and provide real-time feedback to healthcare providers.

# ENHANCING EARLY WARNING SYSTEMS WITH TECHNOLOGY

With advancements in technology and the eruption of disruptive technologies like AI and IoT, real-time monitoring can now be facilitated remotely enabling early detection of diseases. Wearable devices, cloud integration, and AI/ML data analysis models provide real-time alerts and facilitate the early detection of diseases.




**Collection and Storage of Data:** Real-time data on vitals like heart rate, blood sugar levels, blood pressure, and body temperature are continuously collected by wearable devices. These real-time data streams are ingested using protocols like MQTT, HTTP/HTTPS, and integrated into a centralized cloud platform using a gateway device. Data Lake is used as a central repository to store accounts of historical data and relational & NoSQL databases are utilized for ensuring quick access and retrieval of structured and unstructured data.

**Data Processing, Analysis & AI Model Training:** The incoming data is cleaned, preprocessed, and relevant features are extracted for analysis during the model training process. This normalized data is then used for AI/ML model training. The trained model assists in symptom detection and risk assessment by recognizing complex patterns within the data sets used during training. Pre-trained models can subsequently be applied to specific treatments with improved accuracy through Transfer Learning, which fine-tunes the model for application to particular classes of diseases.

**Integration with EMR and Real-time Alerting:** Users and their concerned healthcare providers are notified of the detected anomalies and early symptoms. Notifications are sent via SMS, email, and push notifications. This preemptive approach can lead to timely intervention, early diagnosis, and disease prevention. The data is seamlessly integrated with existing Electronic Health Records (EHR) or Electronic Medical Reports (EMR) for future reference and a comprehensive view of the patient's medical history. To guarantee the security and confidentiality of sensitive medical data, end-to-end data encryption and role-based access control are ascertained. HIPAA, GDPR, and other healthcare regulatory standards are followed to ensure patient data.

# CHALLENGES

The growing adoption of technology in healthcare also presents its own unique set of challenges. The early detection system relies heavily on patient data available from the patient's EMR and data sets used to train the algorithm. Data privacy, patient anonymity, information security, etc., should be prioritized while utilizing Artificial Intelligence and Machine Learning models. Another significant challenge is the incorrect detection of symptoms, false and frequent alerts, biases in the selection of training data sets, etc.

- **Information Security & Data Privacy:** While using historical treatment data sets to train AI it is important to prioritize patient privacy and anonymity. Hospitals and healthcare institutions often face data security threats like hacking, malware, ransomware, etc.[3] Data encryption and access control should be practiced to maintain information security.

- **Frequent Alerts, False Alerts, and Alert Fatigue:** It was noted from the implementation of CDSS that frequent alerts often lead to dismissal or inaction. Studies estimated that 90% of drug-related alerts are overridden by prescribing physicians,[4] and more than half of alert overrides were due to alerts being deemed irrelevant.[5]

- **Algorithm bias and training data set:** The data set used in training AI and ML algorithms could be irrelevant or different from the actual population on which they'll be giving recommendations. This data drift could be duly addressed by ensuring the data sets diversity and inclusivity. In 2021, the WHO released its first guidance on the ethics and governance of AI in healthcare[6] which indicates that AI systems should be designed to reflect the diversity of socioeconomic and healthcare settings[7].

# CONCLUSION

We've discussed how early detection of symptoms and real-time alerting help in reducing mortality risk and improving the quality of life. The recent healthcare trends show how Artificial Intelligence has been pivotal in improving the healthcare system. Software solutions leveraging machine learning and deep learning algorithms are at the forefront of this improvement. We have also explored the challenges that arise with the use of such solutions primary of which is the data privacy and security concerns. By staying compliant with regulatory standards like HIPAA and HL7 the discussed challenges could be cut down. Technology advancements can thus improve healthcare service delivery significantly without compromising data privacy.

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