

# Predicting Covid-19 Patients outcomes Using Electronic Health Records and Deep Learning

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**Abstract** - The ongoing COVID-19 pandemic has underscored the need for effective predictive tools to manage patient outcomes and healthcare resources. Electronic health records (EHRs), containing a wealth of patient information, have become a vital resource for predicting COVID-19 outcomes. Deep learning, a subset of machine learning, has shown significant promise in extracting patterns from complex healthcare data to predict patient severity, mortality, and recovery. This paper provides a comprehensive review of recent research exploring the integration of deep learning models with EHR data to predict COVID-19 outcomes. It evaluates various deep learning architectures such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and transformers, applied to diverse datasets from patient demographics, clinical histories, laboratory results, and even imaging data. The paper also discusses the challenges faced in this area, such as data quality issues, model transparency, and the integration of predictions into clinical workflows. Finally, the paper offers a perspective on the future directions for improving the use of deep learning models in predicting outcomes, emphasizing the importance of interdisciplinary approaches and addressing ethical concerns such as data privacy and informed consent.

**Keywords:** Predicting Covid-19, Covid-19, Patients, Electronic Health Records, Deep Learning.

## I. INTRODUCTION

The COVID-19 pandemic has had far-reaching impacts, placing immense strain on healthcare systems worldwide. One of the critical challenges faced by hospitals and medical professionals is predicting which patients are likely to experience severe symptoms or complications, and subsequently, which require intensive care. While traditional methods of assessing patient prognosis based on clinical guidelines have been invaluable, the sheer scale and complexity of COVID-19 cases have necessitated more advanced approaches. Electronic health records (EHRs),

which store vast amounts of patient information such as lab results, medical histories, and physician notes, present a powerful resource for making predictions. The use of deep learning, with its ability to identify complex, non-linear patterns in large datasets, offers an opportunity to develop predictive models that can forecast patient outcomes with greater accuracy. This paper reviews the most recent literature on the application of deep learning techniques to EHR data, particularly in the context of COVID-19 patient outcome prediction.

## II. REVIEW OF LITERATURE

1. Li et al. (2024) Li et al. (2024) proposed a novel hybrid model combining convolutional neural networks (CNNs) and long short-term memory (LSTM) networks to predict the severity of COVID-19 in patients. Their model leveraged clinical data from EHRs, including demographics, comorbidities, and vital signs, as well as laboratory results. The CNN component of the model was responsible for processing the raw data, while the LSTM network handled sequential data to predict the progression of the disease over time. The authors found that their model significantly outperformed traditional predictive methods in terms of accuracy and interpretability. Specifically, the model was able to predict ICU admissions and mechanical ventilation requirements with an accuracy rate of over 85%. This study demonstrated the efficacy of hybrid deep learning models in utilizing the rich information embedded in EHRs to make real-time predictions for COVID-19 patients.

2. Yang et al. (2024) Yang et al. (2024) focused on applying recurrent neural networks (RNNs) to predict the length of hospital stays and mortality risks among COVID-19 patients. The authors utilized temporal data extracted from EHRs to account for the time-varying nature of a patient's health condition. The RNN model was trained to identify trends and fluctuations in a patient's vitals, lab results, and medical history, making predictions that improved over time as new data was fed into the model. One of the strengths of this study was its ability to offer predictions that evolved

dynamically as new patient data became available, providing real-time insights for healthcare providers. This dynamic nature allowed for more responsive treatment plans, which is essential in managing rapidly progressing conditions like COVID-19. The authors reported that their model achieved a prediction accuracy of approximately 80% for both hospitals stay length and mortality, with potential for improvement as larger datasets become available.

3. Zhou et al. (2024) Zhou et al. (2024) took a multi-modal approach to predicting COVID-19 outcomes by combining clinical EHR data with medical imaging data, such as CT scans. Their deep learning model used a convolutional neural network (CNN) to process the imaging data, while the clinical data was processed by a multi-layer perceptron (MLP) network. By integrating both types of data, the model was able to enhance the prediction of severe outcomes, including ICU admission and the need for mechanical ventilation. The authors argued that combining imaging data with EHRs not only improved predictive accuracy but also provided a more comprehensive view of the patient's condition, allowing for earlier intervention. The study demonstrated that this integrated model performed significantly better than models relying solely on clinical or imaging data alone, highlighting the importance of multi-modal data in predictive healthcare.

4. Singh et al. (2024) Singh et al. (2024) addressed a critical challenge in EHR-based predictive modeling—missing data. EHR datasets are often incomplete, with gaps in patient histories, test results, or physician notes. This missing data can severely impact the performance of machine learning models. The authors proposed a deep learning-based imputation technique that utilized autoencoders to fill in missing values. The technique was designed to reconstruct incomplete patient records by learning patterns from existing data. After applying this imputation method, the authors tested their prediction model, which showed a marked improvement in accuracy when compared to traditional imputation methods. By mitigating the issue of missing data, this model was able to make more accurate predictions regarding the likelihood of severe COVID-19 outcomes, such as intubation and mortality.

5. Patel et al. (2024) Patel et al. (2024) conducted an extensive review of various machine learning and deep learning techniques used in healthcare applications to predict patient outcomes. They focused on the challenges and opportunities presented by deep learning in the context of COVID-19, emphasizing the potential of deep neural networks (DNNs) in mortality prediction. The study found that models based on DNNs could successfully analyze diverse features from EHRs, such as demographic information, comorbid conditions, and previous treatment histories, to predict the risk of death. One of the primary advantages of using DNNs in this

context is their ability to model highly complex relationships in the data that traditional methods may overlook. The authors concluded that DNNs were among the most powerful techniques for predicting mortality in COVID-19 patients, with accuracy rates surpassing 90% in some cases.

6. Wang et al. (2024) Wang et al. (2024) explored the use of a multi-modal deep learning model that combined structured EHR data with unstructured data, such as physician notes, to predict patient outcomes. By applying natural language processing (NLP) techniques to unstructured data, they were able to extract valuable features that could be used alongside structured clinical data to predict COVID-19 severity and recovery. The study found that incorporating unstructured data significantly enhanced the model's performance, especially in predicting long-term complications and post-acute COVID-19 outcomes. This model demonstrated superior performance compared to models that relied only on structured data, proving that multi-modal models have the potential to offer more comprehensive predictions.

7. Kim et al. (2024) Kim et al. (2024) proposed the use of transformer-based models to predict critical outcomes such as the need for mechanical ventilation and intubation in COVID-19 patients. Unlike traditional RNNs, transformers use attention mechanisms that allow them to focus on the most relevant features in a patient's medical history, laboratory results, and vital signs. This model was trained on a large dataset of COVID-19 patient records and demonstrated superior performance in predicting critical interventions compared to other deep learning architectures. The study highlighted the advantages of transformers in healthcare applications, particularly their ability to handle large, complex datasets with multiple feature types, which is common in EHRs.

8. Nguyen et al. (2024) Nguyen et al. (2024) applied deep reinforcement learning (DRL) to predict patient outcomes dynamically in real-time. Their model continuously updated predictions as new EHR data was added, which allowed healthcare providers to receive up-to-date insights about the patient's condition. This real-time prediction model was designed to anticipate sudden health deterioration, such as a patient progressing from moderate to severe symptoms, thus enabling proactive interventions. The authors emphasized the potential of DRL in clinical settings where real-time decision-making is crucial. They reported that their model was effective in providing accurate predictions with minimal delays, which is essential in managing COVID-19 patients, particularly in high-risk groups.

9. Lee et al. (2024) Lee et al. (2024) examined the integration of genomic data with EHRs for predicting severe COVID-19 outcomes. Their study focused on identifying genetic markers that predispose patients to worse outcomes, such as needing intensive care or experiencing long-term complications. By applying deep learning models to the combined genomic and clinical datasets, they were able to identify specific biomarkers associated with severe COVID-19 progression. This approach demonstrated the potential for precision medicine, where deep learning can help identify at-risk patients based on both genetic and clinical factors, leading to more personalized treatment plans.

10. Martinez et al. (2024) Martinez et al. (2024) proposed a model that incorporated both clinical EHR data and social determinants of health (SDOH) to predict COVID-19 outcomes. The authors argued that SDOH factors, such as socioeconomic status, access to healthcare, and living conditions, significantly impact patient outcomes. Their deep learning model used EHR data alongside SDOH variables to improve the accuracy of predictions regarding hospitalization, disease severity, and recovery. The study found that models that included SDOH were significantly better at predicting outcomes for underserved populations, highlighting the importance of considering these factors in healthcare prediction models.

11. Martinez et al. (2024): Martinez et al. (2024) conducted a study using a convolutional neural network (CNN)-based approach to predict the outcomes of COVID-19 patients by integrating electronic health records (EHRs) with laboratory test results. The authors demonstrated the model's ability to predict patient outcomes such as ICU admission, mechanical ventilation requirements, and mortality with high accuracy. Their study also discussed the importance of using both structured and unstructured data from EHRs, suggesting that multi-source integration significantly improved model performance in comparison to models that relied on structured data alone.

12. Chen et al. (2024): In their work, Chen et al. (2024) developed a hybrid deep learning model combining CNN and long short-term memory (LSTM) networks for predicting the clinical outcomes of COVID-19 patients. This model leveraged time-series data from EHRs, allowing it to capture temporal dependencies in patient conditions. The authors found that their model outperformed traditional models in terms of prediction accuracy, especially in terms of forecasting patient deterioration over time, thus aiding early intervention efforts.

13. Nguyen et al. (2024): Nguyen et al. (2024) focused on the implementation of deep reinforcement learning (DRL) to

optimize COVID-19 patient treatment protocols. By utilizing EHRs and integrating real-time data, their model provided personalized treatment recommendations based on patient conditions. The study highlighted the potential of DRL for automating decision-making in critical care, emphasizing that real-time learning and adaptation to new data are critical for handling the dynamic nature of the pandemic.

14. Kim et al. (2024): Kim et al. (2024) proposed a deep neural network model for predicting COVID-19 patient outcomes using demographic and clinical data from EHRs. Their approach demonstrated the effectiveness of using deep learning algorithms to predict critical events such as the onset of acute respiratory distress syndrome (ARDS) and the need for intensive care. The model was particularly successful in early identification of high-risk patients, helping healthcare providers allocate resources more efficiently.

15. Sharma et al. (2024): Sharma et al. (2024) utilized deep learning models to predict mortality risk among COVID-19 patients using EHR data. The authors employed a combination of ensemble models and feature selection techniques to improve the model's generalizability. Their findings revealed that specific features, such as comorbidities, age, and oxygen saturation levels, were highly predictive of mortality, underscoring the importance of these factors in outcome prediction.

16. Sarkar et al. (2024): Sarkar et al. (2024) explored the role of electronic health records in predicting COVID-19 severity using unsupervised deep learning algorithms. They focused on clustering methods to identify patterns in EHR data and group patients based on their clinical trajectories. This approach provided valuable insights into the heterogeneity of COVID-19 progression and enabled the identification of distinct patient subgroups that required tailored treatment approaches.

17. Patel et al. (2024): Patel et al. (2024) examined the integration of patient comorbidities and social determinants of health (SDOH) in deep learning models to predict COVID-19 outcomes. Their findings demonstrated that models incorporating SDOH data outperformed those that did not consider these factors, particularly in underserved populations. The study highlighted the need for inclusive healthcare models that account for socioeconomic and environmental variables to improve prediction accuracy.

18. Zhou et al. (2024): Zhou et al. (2024) proposed a transfer learning approach to predict COVID-19 patient outcomes by leveraging pre-trained models on general medical datasets and fine-tuning them on COVID-19-specific EHR data. This method significantly reduced the need for large labeled datasets, making it an ideal solution for healthcare

systems with limited data. The authors found that the transfer learning model could predict adverse outcomes with high sensitivity and specificity.

19. Lopez et al. (2024): Lopez et al. (2024) developed an explainable AI model for COVID-19 outcome prediction that utilized deep learning algorithms to assess EHR data while ensuring model transparency. The model provided clinicians with interpretative insights into why certain outcomes were predicted, such as hospital admission or mortality. This transparency was crucial for building trust in the model among healthcare providers, especially in high-stakes clinical settings.

20. Ravi et al. (2024): Ravi et al. (2024) conducted a large-scale study on the use of deep learning models for predicting long-term COVID-19 complications, such as lung fibrosis and chronic fatigue syndrome, using EHR data. The authors combined CNNs and attention mechanisms to focus on relevant temporal features within patient histories. Their model achieved impressive results in forecasting long-term outcomes, aiding in post-discharge monitoring and patient care.

### III. CONCLUSION

The integration of deep learning techniques with EHR data presents a promising avenue for improving the prediction of COVID-19 patient outcomes. Numerous studies have demonstrated the potential of deep learning models to analyze vast amounts of patient data and make predictions about disease progression, severity, and mortality with high accuracy. However, challenges remain, particularly in terms of data quality, model interpretability, and ethical considerations such as privacy and informed consent. Future research should focus on refining these models, improving data integration techniques, and ensuring that predictions are actionable and align with clinical workflows. Furthermore, the ethical and social implications of using deep learning in healthcare should be addressed to ensure that these technologies benefit all patients equitably. As more diverse datasets become available and technology continues to evolve, deep learning holds the potential to transform the management of COVID-19 and other diseases in the future.

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