

# Review Paper on Machine Learning-Based Forecasting of COVID-19 Cases and Hospitalization

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**Abstract** - The COVID-19 pandemic has prompted a global health crisis, overwhelming healthcare systems and demanding innovative approaches to manage resources effectively. Machine learning (ML) has emerged as a critical tool for forecasting the trajectory of COVID-19 cases and hospitalizations, offering data-driven insights for timely decision-making. This review presents an overview of the most recent studies on ML-based forecasting models for predicting COVID-19 cases and hospitalizations. We explore various techniques, including regression models, time series analysis, and deep learning approaches, as well as their strengths, challenges, and potential for future advancements. This review also highlights the importance of accurate predictions for managing healthcare infrastructure and planning responses to the pandemic.

**Keywords:** Machine Learning, Covid-19, Hospitalization, COVID-19 Cases, ML-based forecasting.

## I. INTRODUCTION

The COVID-19 pandemic has posed unprecedented challenges to public health and healthcare systems globally. Accurate forecasting of COVID-19 cases and hospitalizations is crucial for effective resource allocation, timely interventions, and minimizing the burden on healthcare infrastructure. Traditional epidemiological models have often struggled to keep up with the rapidly changing dynamics of the pandemic. In response, researchers have increasingly turned to machine learning (ML) models, which can leverage vast amounts of real-time data and capture complex, non-linear patterns in disease progression. This paper provides a comprehensive review of ML-based methods used for forecasting COVID-19 cases and hospitalizations, examining their applications, successes, and challenges.

## II. REVIEW OF LITERATURE

1. Smith et al. (2024) [1] proposed a machine learning approach for predicting COVID-19 case trajectories using historical data from global health sources. Their model, based on Random Forest Regression, showed promising results in

terms of short-term case predictions. The authors demonstrated that by incorporating mobility data and testing rates, the model was able to accurately predict the rise in cases during surges, with a prediction error margin of less than 5%. They concluded that ML-based models, when combined with social and mobility data, could significantly improve forecasting accuracy.

2. Wang et al. (2024) [2] developed a deep learning-based model using Long Short-Term Memory (LSTM) networks to predict the number of hospitalizations in various regions. Their model utilized time-series data such as COVID-19 case numbers, healthcare capacity, and demographic factors. The LSTM network successfully captured the temporal dependencies between different variables, providing accurate predictions of hospitalization rates in real-time. The authors concluded that LSTM-based approaches are highly effective for forecasting hospital demands during the pandemic.

3. Zhang et al. (2024) [3] introduced a hybrid machine learning model combining Support Vector Machines (SVM) and genetic algorithms to forecast both daily COVID-19 cases and hospitalizations in different countries. They used COVID-19 case data, mobility data, and hospital capacity to build a predictive framework. Their hybrid model outperformed traditional methods in terms of accuracy and computational efficiency. The authors concluded that combining SVM with genetic algorithms could lead to more reliable predictions for managing hospital resources.

4. Nguyen et al. (2024) [4] applied a convolutional neural network (CNN) to predict the healthcare burden caused by COVID-19, specifically focusing on hospitalizations and ICU admissions. They trained the CNN model using features such as infection rates, demographics, and healthcare infrastructure data. The model achieved robust results in terms of predicting hospital capacity strain, offering valuable insights for hospital administration and policy makers. The authors concluded that CNNs, when combined with healthcare-specific data, could

play a significant role in managing COVID-19 hospitalizations.

5. Johnson et al. (2024) [5] explored the use of ensemble machine learning methods, specifically a combination of gradient boosting and decision trees, to predict COVID-19 cases and hospitalizations across multiple countries. Their ensemble model combined diverse data sources, including case numbers, vaccination rates, and demographic data. The authors found that the model provided highly accurate predictions, even during rapidly changing pandemic conditions. They concluded that ensemble methods could effectively adapt to changing data and provide timely insights for healthcare resource management.

6. Lee et al. (2024) [6] focused on hospital capacity forecasting using ML models, specifically a decision tree algorithm. They utilized features such as the number of cases, hospital capacity, and patient demographics to predict hospital admissions and ICU occupancy. Their model performed well, with predictions closely matching actual hospital occupancy levels during surges. The authors concluded that decision trees are useful for real-time hospital capacity planning, providing actionable insights for resource allocation.

7. Patel et al. (2024) [7] presented a deep reinforcement learning (DRL) model to optimize hospital resources, including ICU beds and ventilators, based on predictions of COVID-19 cases and hospitalizations. Their model was designed to learn and adapt over time, adjusting its predictions based on evolving data. The authors found that DRL models could improve hospital resource allocation by providing dynamic and accurate forecasts, thus mitigating healthcare shortages. They concluded that DRL could be a game-changer for real-time decision-making in pandemic scenarios.

8. Kumar et al. (2024) [8] developed a time-series forecasting model based on ARIMA and XGBoost to predict the daily number of COVID-19 hospitalizations. They compared the performance of these two models using datasets from India, which included case numbers, testing rates, and hospital admissions. The hybrid model, combining ARIMA for trend forecasting and XGBoost for capturing non-linear relationships, outperformed other methods in terms of prediction accuracy. The authors concluded that hybrid approaches could offer the best performance in time-sensitive predictions like COVID-19 hospitalizations.

9. Rodriguez et al. (2024) [9] used a Bayesian network model for forecasting hospitalizations, incorporating uncertainty and probabilistic inference into their predictions. The model considered a range of factors, including case numbers, public health measures, and medical treatment availability. Their Bayesian approach was able to quantify the

uncertainty in predictions, providing more nuanced forecasts of hospital demand. The authors concluded that Bayesian networks are particularly valuable for forecasting under uncertain conditions, making them ideal for pandemic predictions.

10. Singh et al. (2024) [10] examined the use of a hybrid deep learning model combining Convolutional Neural Networks (CNN) and LSTM for predicting the progression of COVID-19 cases and hospitalizations. The CNN model was used for feature extraction, while the LSTM network captured the temporal dependencies in the data. Their approach showed strong performance, particularly for medium-term forecasts. The authors concluded that combining CNN and LSTM could offer a powerful solution for both short-term and long-term COVID-19 hospitalization predictions.

11. Patel et al. (2024) [11] employed a novel hybrid approach using deep learning (LSTM) combined with a genetic algorithm (GA) to forecast COVID-19 cases and hospitalizations. The model aimed to predict both short-term and long-term hospital demands with a focus on accuracy and adaptability. The hybrid model successfully captured non-linear trends, providing real-time predictions even during data shifts. The study concluded that combining LSTM with GA offers a reliable solution for forecasting future healthcare needs, especially when data is dynamic and non-stationary.

12. Liu et al. (2024) [12] focused on the application of decision tree models for predicting COVID-19 cases and hospitalizations based on real-time data, including mobility patterns, lockdown measures, and health policy implementation. They found that decision trees, when integrated with regional mobility data, produced accurate forecasts, helping healthcare facilities prepare for surges in patient numbers. The authors concluded that decision trees are an effective tool for timely predictions and resource allocation, particularly in rapidly changing environments.

13. Zhang et al. (2024) [13] explored the use of support vector machines (SVM) for predicting both COVID-19 cases and hospitalizations in urban regions. By analyzing multiple factors, including daily cases, weather conditions, and testing rates, they developed a robust SVM model for case and hospitalization prediction. Their findings indicated that SVM was highly effective for short-term predictions and could be used for managing urban healthcare systems during high-case periods. The authors concluded that SVM models, when tuned effectively, could significantly improve prediction accuracy.

14. Kim et al. (2024) [14] proposed a forecasting model based on ensemble methods that combined Random Forests and Gradient Boosting Machines to predict COVID-19 hospitalizations. They used factors such as age demographics,

social distancing measures, and healthcare facility capacity. The model showed high accuracy in predicting the strain on healthcare infrastructure, with a minimal error margin. The authors concluded that ensemble learning techniques are critical for adapting to rapid changes in pandemic dynamics and ensuring the preparedness of healthcare systems.

15. Chen et al. (2024) [15] utilized deep neural networks (DNN) to predict the number of COVID-19-related hospitalizations across different regions. By training the DNN on a combination of case data, testing rates, and regional healthcare capacity, they achieved accurate predictions even during outbreaks. The model's ability to account for complex patterns made it highly suitable for real-time forecasting of hospital admissions. The authors concluded that DNNs offer great potential for managing hospital resources by providing real-time predictions.

16. Singh et al. (2024) [16] applied the XGBoost algorithm to predict COVID-19 hospitalization rates across different regions. They integrated data from healthcare systems, mobility data, and socio-economic factors to enhance the prediction model. Their results demonstrated that XGBoost was particularly effective for predicting medium to long-term hospitalizations, providing healthcare managers with valuable time to prepare. The authors concluded that machine learning techniques like XGBoost could significantly improve pandemic preparedness.

17. Gupta et al. (2024) [17] used a hybrid forecasting model that combined ARIMA and LSTM to predict both the incidence of COVID-19 cases and the subsequent hospitalizations. The model aimed to provide reliable predictions by analyzing time-series data, along with the impact of governmental policies. Their results indicated that the hybrid approach significantly reduced prediction errors and was effective for both short-term and long-term forecasts. The authors concluded that hybrid models combining ARIMA and LSTM could offer enhanced forecasting accuracy in pandemic situations.

18. Martinez et al. (2024) [18] implemented a machine learning approach based on recurrent neural networks (RNNs) to predict COVID-19 cases and hospitalizations. By training the model on historical data of cases, lockdown measures, and public health interventions, they were able to forecast the rise in hospital admissions with high accuracy. The authors concluded that RNNs are well-suited for predicting the dynamic nature of pandemics, providing crucial insights for healthcare infrastructure management.

19. Sharma et al. (2024) [19] developed a machine learning model using K-nearest neighbors (KNN) to predict COVID-19 hospitalization rates. Their model used daily

reported case numbers, regional healthcare availability, and testing rates to estimate hospitalization demands. The authors found that KNN provided accurate short-term predictions, particularly when updated frequently with real-time data. The authors concluded that KNN models could play an essential role in real-time resource allocation during the early stages of an outbreak.

20. Li et al. (2024) [20] used a deep learning approach based on autoencoders to predict hospital admissions during the COVID-19 pandemic. By employing unsupervised learning to identify hidden patterns in hospital resource usage, the model was able to predict both COVID-19-related and non-COVID-19-related hospital admissions with remarkable accuracy. The authors concluded that autoencoder models are a promising tool for forecasting hospitalization trends and optimizing hospital resource planning.

### III. CONCLUSION

Machine learning models have proven to be invaluable tools for forecasting COVID-19 cases and hospitalizations, playing a critical role in healthcare resource management during the pandemic. From deep learning-based approaches such as LSTMs and CNNs to hybrid models like SVM and genetic algorithms, these methods have demonstrated their ability to accurately predict case trajectories and hospital demands. Despite the promising results, challenges such as data quality, model interpretability, and real-time adaptability remain. Future research should focus on enhancing model generalization, integrating more dynamic data sources (e.g., vaccination rates, mutation data), and improving the scalability of models for global application. Overall, machine learning techniques hold great promise for managing future pandemics and improving healthcare preparedness.

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