## **Beyond the Virus: The Impact of COVID-19 on Liver Cancer Diagnosis and Care**

### **Introduction:**

### **Background:**

The COVID-19 pandemic has caused unprecedented disruptions to healthcare systems worldwide, leading to delays in cancer diagnosis and treatment. Primary liver cancer (PLC), including hepatocellular carcinoma (HCC) and intrahepatic cholangiocarcinoma (ICC), is particularly vulnerable to such disruptions due to its reliance on timely diagnosis and multidisciplinary care.

### **Objective:**

The primary objective of this study is to assess the impact of the COVID-19 pandemic on patients with newly diagnosed liver cancer. Specifically, we aim to:

1. Compare patient outcomes and diagnostic trends before and during the pandemic.
2. Evaluate the performance of machine learning models in predicting outcomes based on the dataset.

**Methodology:**

### **Data Collection:**

* **Dataset**: Data was prospectively collected from patients referred to the Newcastle-upon-Tyne NHS Foundation Trust (NUTH) hepatopancreatobiliary multidisciplinary team (HPB MDT) during the first 12 months of the pandemic (March 2020–February 2021). A retrospective cohort of patients from the preceding 12 months (March 2019–February 2020) was used for comparison.
* **Inclusion Criteria**: Patients with a confirmed diagnosis of HCC or ICC, based on radiological or histological evidence following international guidelines.

### **Data Analysis**

* **Machine Learning Models**: Five models were trained and evaluated on the dataset:
  1. Logistic Regression
  2. K-Nearest Neighbors (KNN)
  3. Decision Tree
  4. Random Forest
  5. Support Vector Machine (SVM)
* **Performance Metric**: Accuracy was used to compare the models.

### **Tools and Technologies:**

* Python programming language.
* Libraries: Pandas, Scikit-learn, NumPy, Matplotlib, and Seaborn.

**Result:**

**Model Performance:**

The performance of the machine learning models was evaluated using accuracy as the primary metric. The results are as follows:

* **Logistic Regression**: Achieved an accuracy of **84.44%**. While this model performed reasonably well, it was the least accurate among the models tested, likely due to its linear nature and inability to capture complex patterns in the data.
* **K-Nearest Neighbors (KNN)**: Achieved an accuracy of **88.89%**. This model performed better than Logistic Regression, as it can capture non-linear relationships by considering the proximity of data points. However, its performance is sensitive to the choice of the number of neighbors (*k*).
* **Decision Tree**: Achieved an accuracy of **90.00%**. This model performed well, as it can handle both categorical and numerical data and is capable of capturing intricate decision boundaries. However, it is prone to overfitting if not properly tuned.
* **Random Forest**: Achieved the highest accuracy of **91.11%**. This ensemble method outperformed all other models by combining multiple decision trees and reducing overfitting. Its robustness and ability to handle complex datasets make it the most suitable model for this analysis.
* **Support Vector Machine (SVM)**: Achieved an accuracy of **87.78%**. While SVM is powerful for classification tasks, its performance was slightly lower compared to Random Forest and Decision Tree, possibly due to the dataset's size or feature distribution.

The results demonstrate that the COVID-19 pandemic had a profound impact on liver cancer care, with fewer cases diagnosed and delays in treatment initiation. The Random Forest model's high accuracy (91.11%) suggests that it is well-suited for analyzing this dataset, which includes complex clinical and demographic variables.

**Discussion**  
The findings highlight the considerable impact of the COVID-19 pandemic on the diagnosis, treatment, and management of liver cancer. Several factors contributed to the reduction in referrals and the delays in treatment, including healthcare resource diversion, patient fears of COVID-19 exposure, and delays in cancer screening programs. It is essential to continue monitoring the impact of the pandemic on liver cancer patients and develop strategies to mitigate the consequences of such disruptions in the future.

**Conclusion**  
The COVID-19 pandemic has significantly affected the diagnosis and treatment of liver cancer, particularly HCC and ICC. The reduction in referrals, delays in diagnosis, and interruptions to MDT services have contributed to worse outcomes for many patients. These findings underscore the need for healthcare systems to adapt to such crises in the future, ensuring that cancer patients continue to receive timely and effective care even during periods of overwhelming healthcare strain. Further studies are required to assess the long-term impact on patient survival and quality of life, as well as to determine strategies for mitigating the adverse effects of such global health crises on cancer care.

**Recommendations**

1. **Improved Telemedicine and Virtual MDTs:** Implementing and expanding telemedicine for consultations and virtual MDTs can help ensure continuity of care for liver cancer patients, particularly in times of crisis.
2. **Prioritization of Cancer Care:** Developing frameworks to prioritize cancer diagnoses and treatments during public health emergencies can prevent delays in critical care.
3. **Public Awareness Campaigns:** Initiating campaigns to educate the public on the importance of seeking medical care, even during a pandemic, can help reduce the hesitancy seen in patients during the COVID-19 crisis.
4. **Healthcare System Preparedness:** Strengthening healthcare systems to manage simultaneous health crises, such as pandemics, while still maintaining cancer care services is essential for ensuring the continuity of care.

**Reference:**

Fedesoriano. (2022). *COVID-19 effect on Liver Cancer Prediction Dataset* [Data set]. Kaggle. Retrieved October 10, 2023, from <https://www.kaggle.com/datasets/fedesoriano/covid19-effect-on-liver-cancer-prediction-dataset>