

Improving Clinical Laboratories Operations Using Machine Learning

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This research explores the use of machine learning (ML) to **predict diseases** based on hemogram (blood test) data at Tallaght University Hospital. By analyzing historical blood test results, the study aims to identify **patterns** that can improve diagnostic **accuracy**, **optimize** laboratory processes, and **reduce waste** caused by errors such as discarded samples.

INTRODUCTION

Clinical laboratories play a crucial role in healthcare by providing vital diagnostic information for patient care. However, inefficiencies such as **overordering**, **unnecessary test repeats**, and **operational delays** can impact both service quality and patient outcomes. This project explores the potential of machine learning (ML) to identify patterns within historical blood test data, aiming to **optimize** laboratory operations at **Tallaght University Hospital**. By leveraging ML models, the study seeks to streamline processes, reduce errors, and ensure more efficient use of resources, ultimately enhancing patient care and supporting clinicians in their decision-making. Furthermore, **fairness metrics** will be applied to ensure that the developed models are unbiased and equitable in their predictions.

ASSISTANCE IN DIAGNOSING

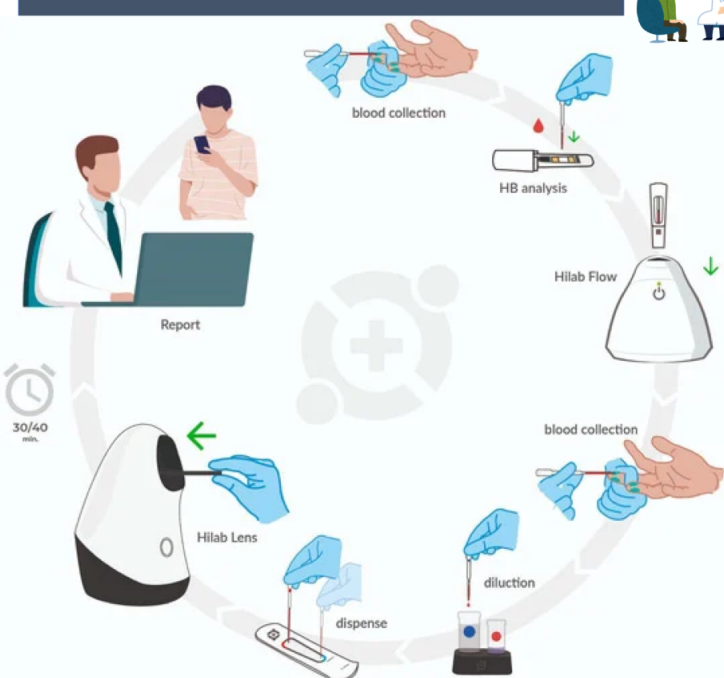


Fig. 1. Shows the process of the blood analysis process.

A study by Alqurashi et al. (2024) emphasizes the potential of artificial intelligence (AI) tools in enhancing laboratory practices, particularly in **hematology**. The review covers various machine learning applications in **diagnosing** benign and malignant hematological diseases, using CBC and other laboratory test results.

REDUCING CLINICAL ERRORS

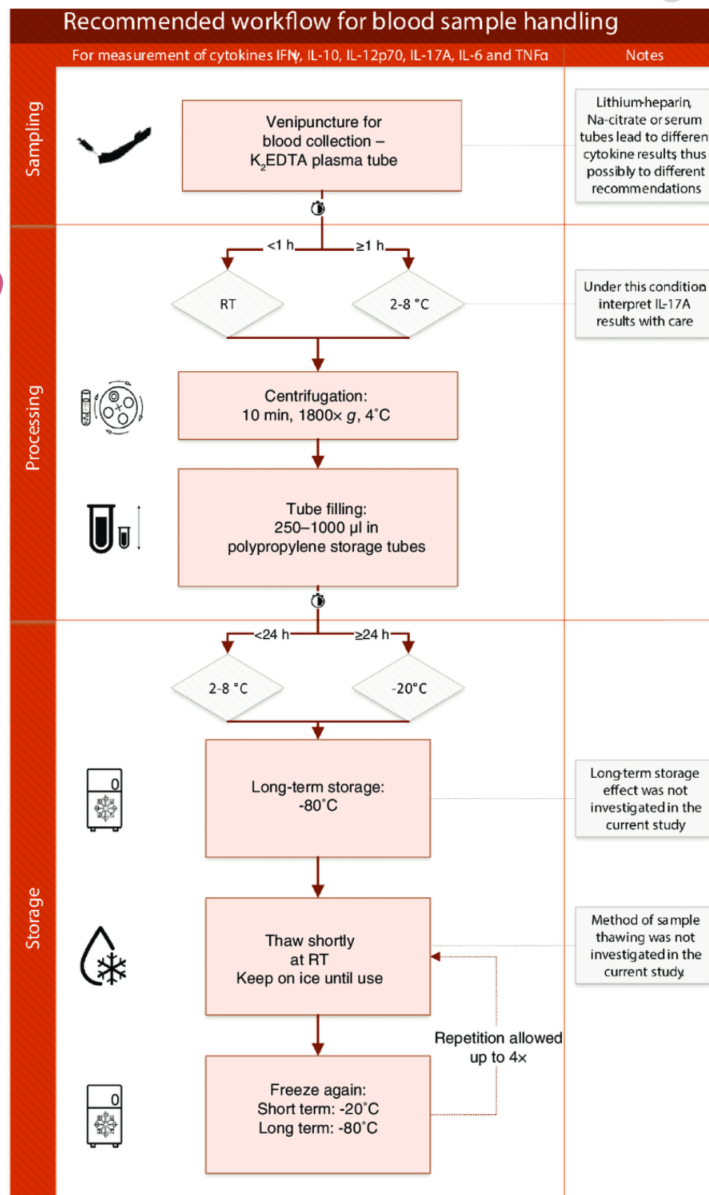


Fig. 2 Shows the recommended workflow for blood sampling and how clinical error might occur otherwise

Clinical errors in blood testing can lead to significant **waste**, particularly when samples are deemed unusable or discarded due to inaccurate or absurd results. These **errors** may arise from improper sample collection, such as **contamination**, **incorrect labeling**, or **improper storage**, which can compromise the integrity of the blood sample. These erroneous results can lead to the unnecessary **repetition** of tests or the discarding of samples, contributing to **inefficiency**, **increased costs**, and **delays** in patient care. Identifying and minimizing these errors is crucial to optimizing laboratory operations and ensuring that resources are used effectively.

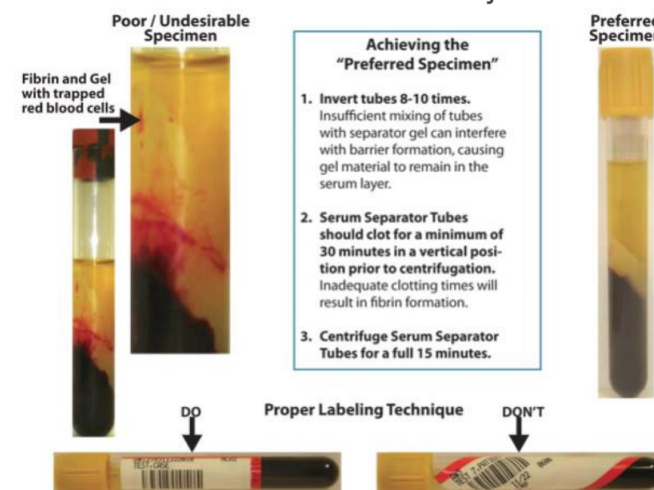


Fig. 3 Shows the difference of labeling and overall quality in two blood samples

RESEARCH METHODOLOGY

This research will apply machine learning (ML) to predict diseases using blood test data, particularly hemogram results, from Tallaght University Hospital. The methodology includes collecting **historical blood test data** and **preprocessing** it to handle missing values, outliers, and errors. Key features like red blood cell count and hemoglobin levels will be selected through feature engineering.

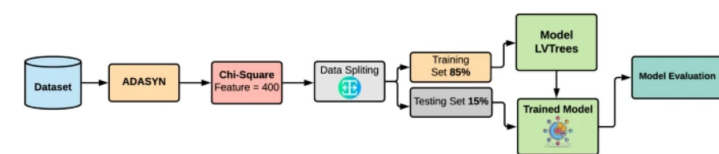


Fig. 3 shows the architecture of the proposed methodology. It consists of feature selection, data resampling, data splitting, model training, model evaluation.

CONCLUSIONS

This research aims to **leverage** machine learning techniques to enhance disease prediction and optimize clinical laboratory operations, specifically focusing on hemogram data from Tallaght University Hospital. By applying advanced ML models, the study seeks to identify patterns in blood test results that could improve diagnostic accuracy, reduce clinical errors, and **minimize unnecessary resource waste**.

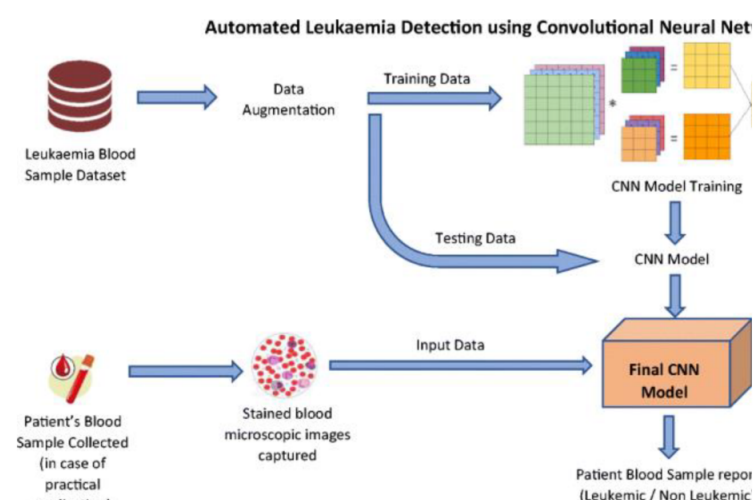


Fig. 4 shows the general flow of the final results of the proposal

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