Chapter 13
Recent Studies and Research on Sickle Cell Disease: Statistical Analysis and Machine Learning Approach

Bikesh Kumar Singh
National Institute of Technology, Raipur, India

Hardik Thakkar
National Institute of Technology, Raipur, India

ABSTRACT

Machine learning techniques have been successfully applied in various domains of healthcare such as medical imaging, bio-signal processing, pathological data analysis, etc. This chapter discusses the recent studies on sickle cell disease (SCD) based on risk stratification system, predicting the severity of disease, prediction of dosage requirement, prediction of clinical complications of the disease, etc. The blood attributes of SCD patients, which are obtained by high performance liquid chromatography (HPLC) test or complete blood count (CBC) test have been used by many researchers for improving clinical outcomes and therapeutic intervention in SCD. Statistical significance analysis has been reported to determine the correlation and association of pathological attributes with clinical symptoms. Machine learning techniques have been employed for risk stratification and dosage prediction. This chapter summarizes these techniques and suggests research gaps and future challenges.

INTRODUCTION

Footprint of sickle cell disease (SCD) can be found across all groups of population in the world. In India, it has its presence majorly in the state of Chhattisgarh, Orissa, Madhya Pradesh, Andhra Pradesh, Kerala, Jharkhand, Maharashtra, Gujarat, Karnataka, Tamil Nadu. As per the information released by sickle cell institute, Raipur in its handbook (L. V. K. S. Bhaskar et al., 2014), one out of every ten people is affected by sickle cell disease/trait in Chhattisgarh. SCD is a genetic disease, it is because of abnormalities in

DOI: 10.4018/978-1-7998-2120-5.ch013
Recent Studies and Research on Sickle Cell Disease

RBC which affects quality of life and life expectancy of patients. SCD has various clinical outcomes like childhood mortality, sever crises etc. (Sebastiani, Ramoni, Nolan, Baldwin, & Steinberg, 2005).

Sickle cell disease is a type of disorder which affects the hemoglobin present is the red blood cell. People having sickle cell disease (SCD) has atypical hemoglobin called sickle hemoglobin (HbS), this affected hemoglobin, changes the shape of red blood cell. Body of sickle cell disease patient produces sickled (crescent) shaped red blood cells (Okpala, 2004). Unlike normal red blood cells abnormal red blood cell are less flexible, because of this, it breaks downs quickly than usual (Poillon, Kim, & Castro, 1998) and this causes anemia. Sickle shaped cell also stuck in blood vessels and blocks the blood flow. This results in extreme pain or crises as well as it may can damage some vital organs. The major cause of deformation of the shape of red blood cell is defective hemoglobin, i.e. hemoglobin S (HbS). HbS is one of the variants of β globin gene. A protein abnormality in red blood cell has been found in SCD patients.

Most of the hospitals and healthcare sectors in India employ manual approach for analyzing patients input for SCD. Manual exploration is time consuming, subjected to observational errors, inter-and intra-observer variability’s and stressful for patients. Further, the efficacy of such an approach is entirely dependent on clinician’s experience and expertise. This imposes a serious hitch especially in rural areas where expert clinicians may not be available. Hence, development of an intelligent diagnosis system is needed to assist clinicians for predicting the appropriate dosage of HU, monitoring its effectiveness/treatment response in individuals suffering from SCD and suggest a specific treatment plan for the same. The advances in medical information systems is playing a key role in medicine and biology. Artificial intelligence and machine learning approaches have found numerous applications in medicine including huge medical data analysis, assisting medical professionals in disease diagnosis, utilizing patient symptoms and characteristics for effective treatment planning, reducing inter- and intra-observational errors etc.

Treatment for SCD are Bone marrow transplant and blood transfusion. However, medication through hydroxyurea produces fetal hemoglobin (HbF) and reduces the need of blood transfusions. Hydroxyurea is a chemotherapeutic drug; hence it increases the risk of infections (Bikesh Kumar Singh et al., 2018), so it is required to determine accurate amount of dosage. A recent research proposed a technique for accurately predicting the hydroxyurea dosage based on Artificial Neural Network (ANN) and Machine Learning (ML) (Khalaf et al., 2017). The first study which reported to use artificial intelligence techniques for predicting patient’s response of medication is reported in (Valafar et al., 2000). Application of technology plays an important role in medical societies. In past few years different medical information systems have been developed. These developments improved the utilization of technology in medical applications. Powerful systems, Artificial Intelligence techniques have been developed. Which provides decision support tools for clinicians. Machine Learning (ML) is a powerful technique in the field of scientific research that enables computers to learn from data (Emmanuelchide, Charle, & Uchenna, 2011).

BACKGROUND AND MAIN FOCUS

Main focus of this section is to discusses about the background and recent works on statistical significance on the data of blood attributes of sickle cell disease patients for predicting the severity and complications. Also, it discusses the recent works on application of artificial intelligence on blood attributes and morphology of microscopic images of blood cells.

An extensive literature survey and with the best of the knowledge by the investigator, It was observed that the first study which reported use of artificial intelligence techniques for predicting the effect of
Related Content

FPGA on Cyber-Physical Systems for the Implementation of Internet of Things
Rajit Nair, Preeti Nair and Vidya Kant Dwivedi (2020). FPGA Algorithms and Applications for the Internet of Things (pp. 82-96).
[www.igi-global.com/chapter/fpga-on-cyber-physical-systems-for-the-implementation-of-internet-of-things/257556?camid=4v1a](www.igi-global.com/chapter/fpga-on-cyber-physical-systems-for-the-implementation-of-internet-of-things/257556?camid=4v1a)

Functional Form, Elasticity and Lexical Richness: Estimates and Implications
[www.igi-global.com/chapter/functional-form-elasticity-lexical-richness/60875?camid=4v1a](www.igi-global.com/chapter/functional-form-elasticity-lexical-richness/60875?camid=4v1a)

Approaches for Measurement System Analysis Considering Randomness and Fuzziness
[www.igi-global.com/article/approaches-for-measurement-system-analysis-considering-randomness-and-fuzziness/250822?camid=4v1a](www.igi-global.com/article/approaches-for-measurement-system-analysis-considering-randomness-and-fuzziness/250822?camid=4v1a)

Effective Fuzzy Ontology Based Distributed Document Using Non-Dominated Ranked Genetic Algorithm
[www.igi-global.com/article/effective-fuzzy-ontology-based-distributed/60656?camid=4v1a](www.igi-global.com/article/effective-fuzzy-ontology-based-distributed/60656?camid=4v1a)