Applications of Artificial Intelligence With Reference To Hematology: A Review

Deeksha P[1], Indira Ramarao[2]

[1]*Student, BMS Institute of Technology and Management*
Nitte meenakshi Institute of Technology, Bengaluru.
Corresponding Author: Indira Ramarao

ABSTRACT: Artificial Intelligence is becoming necessary tool in health care system. Pattern recognition, analyzing digital medical image, classification of diseases are some examples. Artificial Intelligence is also used in Hematology. It is mainly based on phenotype evaluation. An analysis is carried out to identify the advantage in using AI algorithms over human eye in recognizing details. In the present article the development and potential of AI is discussed.

KEYWORDS: Artificial Intelligence, Machine Learning, Neural Network, Hematology, Cytometry

I. INTRODUCTION

Artificial Intelligence has provided innovative ways of assembling information, measuring the information perceiving designs and make own reasoning compared to conventional techniques. Artificial Intelligence helps in extracting information from health records in electronic form and can be adopted for prevention of disease. Since past fifteen years AI has become indispensable in medical field. Gina Zini [1] has published a paper describing use of AI in hematology bringing out a historical review. Kaestener et. al [2] have classified RBC based on cell shapes during blood flow by the use of machine learning techniques. Siminato et.al [3] have implemented to obtain 3D shapes recently using above study. Extracting cell shapes in 3D from confocal images using artificial neural network.

Due to digitalization, more than required data is being enmassed and burden on the analyzing system is increasing [4]. Basic requirement in using techniques based on AI is use of digital data. Due to these facts, it becomes necessary to review the literature for understanding impact of AI on biological applications, in particular on hematology as it is important in diagnosis of leukemia. Gina Zini [1] have done a detailed historical analysis of this topic and drawn many conclusion. Later Kaestener has written an article stating the process of dependency of hematology on AI and analyzed available literature. Later Alsuliman et.al [5] has done a review to understand the necessity and also the potentiality of using techniques based on AI in the field of medicine. Komal et.al [6] also have conducted a review on the impact of artificial intelligence on health care and medicine. In the present review the concentration is on the impact of artificial intelligence on Hematology.

Recently the authors of [7,8] have reviewed the importance, need and developments of implementation of AI in hematology. They have discussed the developments so far and have tried to analyse the impact in the future.

II. HISTORICAL BACKGROUND

The earliest work on understanding brain function dates back to 1943 where W S McCulloch wrote an article. In this article a mathematical model was developed to replicate neuron which was called threshold logic unit. This unit could receive input from other units which are connected and 1 or 0 was the output in 1949 a cell assembly theory of cognition was introduced by Donald Hebb. In 1954 above model was modified and randomly connected network was generated. The perceptron was invented by Frank Rosenblatt in 1960 [1] and also neural network was developed. More neural networks can be added by adding Perceptron in parallel. In 1962, Widro optimized outputs. A network to generate set of outputs was developed by Kohonen and Anderson in 1972. Hybrid network was generated by Reilly and Cooper. In 1982 it was a network with multilayer problem-solving strategy.

III. BASICS OF AI IN HEALTHCARE

Using reasoning, memorizing, understanding, approximation conceptualization, abstraction and logical interface, a problem then such ability is called intelligence. If the same ability is incorporated in a system to interpret external data, then it is called artificial intelligence. Machine Learning is a sub discipline where computers are used to develop statistical model to interpret data. A sub discipline of Machine learning which is neural based system that computes correlation of data is called deep learning. AI techniques are widely used is healthcare system. Recently lot of contributions are made widely, here we concentrate on contribution to the field of hematology.

Application of hematology was to conduct diagnosis in the laboratory [1]. Zini[1] has extensively described the process and the developments that were done in this regard. During 1995 three diagnostic tools were installed which in turn interacted with one another to interpret data. Artificial neural networks were used to diagnose hematology data. An inductive inference technique was developed [7] which generates class membership and creates patterns for large input values. AI techniques were used for cytometry to analyse and classify RBC by D'onofrio et al [8]. For cytometric diagnosis data mining approach was used by Kantardzic et.al [9]. Laser cytometryn and integrated isovolume cytometry was done using artificial neural networks by Zini et.al [10]. Mortality rate after transplantation of stem cells was done using Machine learning algorithm by Shouval et.al [11]. Same authors have extended their work to predict mortality of hemopoetic stem cell.

IV. MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR HEMATOLOGY

Hematology is comparatively new field in image techniques of machine learning. Here are three areas which are very important in this regard. According to Zini[1] the introduction of AI based techniques in Hematology started when Frank Roseblatt invented a network based device called Perceptron which is used to simulate memory. The perceptron which is used to simulate memory. The Perceptron concept is based on following concepts: "nervous sytem has physical connections which differ based on individuals and construction is random at birth. One set of cells where stimulus is given affects other set and produces long lasting changes." In 1960 Rosenblatt built a learning machine which could identify optical pattern. Simple Perceptron has two layers, where first one inputs and second produce output. In 1960 a neural network system named "Multiple Adaptive Linear elements" was developed. It was used to eliminate echoes in the phone lines.

A new network called hybrid network was developed in 1982 by Reilly and Cooper. It had strategies for problem solving in each layer. The neural network follows same theory as in case of human brain where electrochemical inputs are received by each neuron which is connected to 10000 more. There are two different approaches relating to cognition in humans. One is 'strong AI' and other is 'weak AI' [1].

AI application to hematology starts with diagnosis. In 1995 in Europe three systems were installed to help diagnosis. One helped in flow cytometry, other in interpretation of peripheral blood and third in reporting related to bone marrow. These systems could interact and quite good accuracy in diagnosis was achieved and the system was efficient.

An approach based on artificial neural network which can perform pattern recognition is also helpful in hematological disease diagnosis. This system classifies large input patterns into different classes with a self organized hierarchial classification patterns. This device was a laser cytometer which can analyse 40000 RBC and classify them. Since most gene disorders are inherited, this can spread due to migration. An artificial data set trained by artificial neural network can model and find information. MCV, Hb, RBC and Hct which are peripheral hematological parameters were used by Amendolia et.al [12] which achieved 94% accuracy and classified alpha and beta carriers. Diagnosis of leukemia is affected by cytochemistric leucocyte count which has led to development of new more efficient approach. In 2001 a software for artificial neural network using 84 signals from 492 raw data was developed by Achi and Khoury [13]. This device used a multilayer perceptron which was back propagation procedure trained. It could discriminate normal and pathological cells. In 2002 a polycythemia Vera diagnosis approach was improved using data mining.

Automated systems with digital microscopy are developed recently taking advantage of digital camera and computer based classification. Simulation models can detect changes in specific cell population. Each cellular sub species satisfied different differential equations.

There are challenges faced in implementing AI in hematology. Gathering individual patient specific data, framework to tackle legal issues, physicians need to be trained etc

V. FUTURE SCOPE

AI can be applied for patient specific treatment involving peripheral blood analysis, diagnosis and gene profiling. It can help in classifying cell data in case of leukemia, stem cell treatment etc. AI methods can also help in developing treatments based on gene data; it can detect targets sensitive to drugs. It can evaluate eligibility of patients for transplant, risk analysis, recurrence of disease after transplant.

VI. CONCLUSION

AI based techniques consist of machine learning algorithms, artificial neural networks and data. AI applications can take Medicare to a new extent and make diagnosis fast and efficient. Diagnosis of malignancy and cytometry, the techniques based on AI have been recent introduction but proved very powerful. Hence there is an increased demand and interest in this field.

REFERENCES

[1]. Zini G, 2005, "Artificial intelligence in Hematology" Hematology, 10, 5 393-400
[2]. Ars Kaestner, 2020, " Artificial intelligence meets hematology" ,
[3]. Simonato G, Hinkelman K, Chachanidz R, Bianchi P, Femo E, van Wijkr, 2005, " Atificial neural Networks for 3D cell shape recognition from confocal images, arXiv
[4]. Kaestner , Binchi P, 2020, "Trends in the development off diagnostic tools for red blood cell related diseases and anaemias", Front Phisiol, 11,387.
[5]. Tamim Alsuliman, Dania Humaidan, Layth Sliman, 2019, " Machine learning and artificial intelligence in the service of medicine: necessity or potentiality?", Current research translation Medicine,
[6]. Komal, Ganesh Kumar Sethi, Nazir ahmed, md Burhanur Rehani, Hatim M E, Mamoon Rashid, 2021, " Use of artificial intelligence in health care systems: State of the art survey" 2nd int. Conf. On Int. Engg. and mngt.
[7]. Elif Guler Kazaci, Deniz Guven, 2021, "Artificial Intelligence applications in Hemaology, AITA
[8]. Wenc Walter, caudia Haferiach, Niroshan Nadarajah, Ines Schmidts, Constanze Kunh, Wolfganej Kern, Torsen Haferach, 2021, "How Artificial Intelligence might disrupt diagnosis in Hematology in the near future" , ncogen, 40, 4271-80.
[9]. d'Onofrio G, Zina G, 1998, " Diagnostic value of peroxidise and size parameter from a new haematological analyser", Hematologica, 238-9
[10]. Kantardzic M, Djulbegovic B, Hamdan H, 2002, " A datamining approach to improving Polycythemia Vera diagnosis: Comput. Ind. Engg, 43, 4, 765-773
[11]. Zini G, d'Onofro G,2003, ' Neural network in haematological malignancies", Clin, Chim Acta, 333, 19-201
[12]. Shouval R, labopin M, Bondi O, Mishan – Shamy H, Shimoni A, Ciceri F,2005, "Prediction of allogenic hematopoietic stem cell transplantation mortality, 100 day after transplantation using a machine learning algorithm", J. Am. Soc. Clin., onco.,33, 28, 3144-55
[13]. Amendolia S R, Brunetti A, Carta P, Cossu G, Ganada M , Golosio B, Mura G m, Priastra M G, 2002, "A real time classification system of thalassemic pathologies based on artificial neural networks", Med. Deci.making. 22, 18-26.