Mapana – Journal of Sciences
2024, Vol. 23, No. 3, 133-163
ISSN 0975-3303|https://doi.org/10.12723/mjs.70.8

Review paper on Artificial intelligence assisted diagnosis for blood cancer using machine learning

Jain Joseph*, Sherimon P C†, Vinu Sherimon‡

Abstract

This Paper guides a review platform which allows to evaluate Artificial intelligence assisted diagnosis for blood cancer using machine learning. Advanced medical and technology-based research has fuelled the adoption of latest technologies for the sake of advancement in medical science application and overall improvement in detection, diagnosis, prevention and treatment of diseases. AI technology is being used widely in medicine, economy and daily life; in medicine, artificial intelligence is used for mainly treatment, diagnosis and prediction of disease prognosis. This review effectively highlights the wide-ranging applications of AI in medicine, with a specific focus on its contribution to treatment, diagnosis, prognosis and prediction.

Keywords: Artificial intelligence, Blood cancer, Machine learning, Deep learning, AI, Clinical decision making, Lab automation, Medicine 5.0 Technology

Introduction

In the current era of technology advancement, every industry is adopting the latest technologies and digital aids for improving

* Lincoln University College Malaysia, Marian Research Centre, Marian College Kuttikanam (Autonomous), Kerala, India; jjoseph@lincoln.edu.my, Orcid id - 0009-0004-3007-3021

† Arab Open University, Muscat, Sultanate of Oman; jjoseph@lincoln.edu.my

‡ University of Technology and Applied Sciences, Muscat, Sultanate of Oman; jjoseph@lincoln.edu.my

performance and reducing manual errors. Although, historically technology adoption was slow in the medical field, nowadays, advanced medical and technology-based research has fuelled the adoption of latest technologies for the sake of advancement in medical science application and overall improvement in detection, diagnosis, prevention and treatment of diseases. In this regard, it is noteworthy that artificial intelligence (AI) has now considered as the principal technology, being used in different fields, including computer vision, robotics and natural language processing. It has also been revealed that a range of organizations have actively developed in health insurance software development. Thus, it is certain that progress of AI would interfere with the healthcare sector significant, with the need for continuous improvement. At the same time, the combination of XR and AI is providing promising benefits related to biotechnology application, while also enabling the digital interaction with physical environment in a diverse manner. Besides the wide application of AI in medical field, the combination of AI and big data is also providing convenient and effective medical services for the patients. Although AI technology is being used widely in medicine, economy and daily life; in medicine, artificial intelligence is used for mainly treatment, diagnosis and prediction of disease prognosis. It is understood from the existing research and practical knowledge that AI has mainly two key branches in the field of medical science, which involve "a virtual brand and a physical brand". The virtual brand of AI is involving "clinical assistant diagnosis and treatment and drug research and development"; while the physical brand involves "surgical and nursing robots". Recent research has shown that in the context of molecular biology, AI can provide promising benefits in diagnosis of blood cancer.

Aim

This review is commendably thorough, reflecting a successful integration of interdisciplinary perspectives, bridging the gap between medical science and technology.

Empirical Study

Early cancer detection and artificial intelligence (AI) are two rapidly growing technologies that have a lot in common, according to Hunter

2020. According to national registry data from the United Kingdom, there is a significant association between cancer stage and 1-year cancer mortality. For certain subtypes, the correlation grew with stage, whereas for others, it showed gradual reductions. In the five-year time frame, the survival rate for blood cancer is close to 70%. Artificial intelligence (AI) and early cancer detection are the two main fields with rapid growth and significant points of increase. When used to treat blood cancer, machine learning can improve treatment accuracy, save time, and offer a quick, inexpensive, and safe service. ML techniques are among the tools and applications that specialists in labs and clinics can employ. According to national registry data from the UK, there is a significant association between cancer stage and 1-year cancer mortality, with progressive declines in for several subtypes and an increase in outcome with stage. To increase early detection rates to 75% by 2028, which requires innovation and is possible with the application of machine learning, the National Health Service (NHS) long-term plan was launched. Many institutions, like the World Health Organization, which ranks first globally, emphasize the need of early detection. Several studies have shown that screening can decrease cancer mortality and aid in early cancer identification, however even in disease groups where screening programs are well-established.

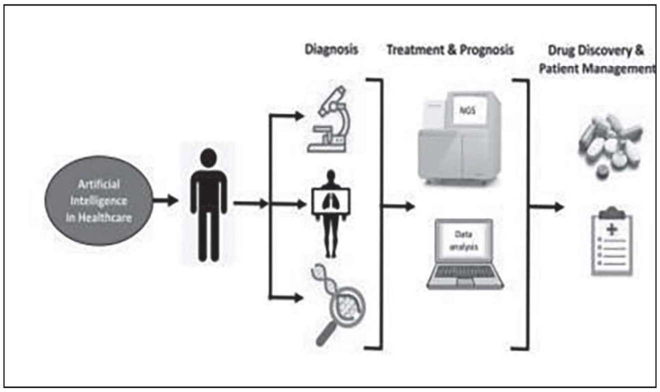

Fig. 1 AI in HealthCare
(Source: https://www.sciencedirect.com/science/article/)

The implementation of artificial intelligence technology in the sphere of health has led to high degrees of transformation processes, according to KAZANCI 2019. The term "artificial intelligence" was initially coined by John McCarthy to refer to the field of study that focuses on developing intelligent computer programs and intelligent machines. Later, it broadened its use and began to be employed in the medical field as well. The digitization of medical records and the use of genetic tools in clinical practice have generated an unprecedented amount of data. A branch of Deep Learning known as ML seeks to computationally extract significant knowledge from intricate data structures. Machine learning is increasingly being used in hematological contexts. However, physicians and researchers frequently lack familiarity with fundamental ideas. In order to assess and evaluate machine learning's impact in diagnosing blood cancer critically, readers will receive tools from this review. The definition of common terms comes first, followed by a discussion of hematology examples. There are provided guidelines for creating and assessing machine-learning studies. There are always limitations while proposing advancement in a particular area so in machine learning approaches. Many areas of health care have changed as a result of the digitalization of data. It is resulting in a positive way as it helps to bring modernization and developed technologies. Machine learning is a much more sophisticated way to identify the correlations in cancer. Countless amounts of electronic data are produced during each interaction with a patient. The information included in the medical records consists of summarizing the patient's interaction, vital signs, lab findings, pathology information, and imaging. Recently, multi-omics data from the likes of genomics, proteomics, and metabolomics have been included in patient-generated health data, a level of data complexity never before seen. More than one professional develops a working hypothesis and puts it into practice based on their education, experience, and intuition. However, the perceptions and prejudices of the human mind are constrained. Machine learning technology provides a wider space for methods and processing of data in meaningful ways that go beyond what the human brain can comprehend. Computer programs that emulate and imitate human intellect, such as problem-solving and learning, are known as artificial intelligence. A component of artificial intelligence called machine learning which involves the automatic identification of patterns in data. Totally human-guided versus fully machine-guided models would score low and high on the machine-learning spectrum which Beam and Kohane refer to as a continuum for either approach's models.

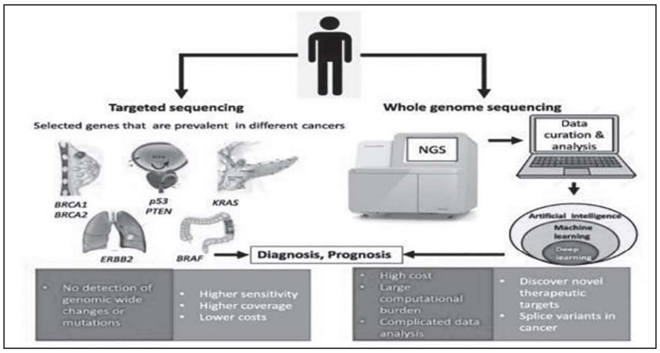

Fig. 2. Use of AI & ML to detect Blood Cancer (Source: https://www.sciencedirect.com/science/article/pii/2X)

According to Li 2021, machine learning in detecting blood cancer is one of the promising technologies in the modern world. Blood cancer is mainly caused by the transformations in the DNA in the cells of the blood. This allows the cells to act unnaturally and most of the time these changes cannot be linked or identified easily. AI can analyze complex datasets in terms of cancer. AI can oversee the uses of chemotherapy medicines and recognize the tolerance of those drugs. Artificial intelligence can advise doctors to choose the appropriate treatment and decisions, can help to mitigate unimportant surgeries and change the plans to treat blood cancer. Recent research showed that an algorithm of machine learning can also predict cancer. Machine learning approaches are widely used for blood cancer detection. The processes are categorized into different stages like early processing, aspect extraction, and the process of classification. Some processes also include segmentation to bring a performance improvement. Currently, advanced systems to treat cancer are rapidly growing, and machine learning techniques are receiving more. It is cost-reductive and improves the growth, and accuracy of the diagnostics. Medical picture processing is another important part of the detection of the disease. But the old machines encounter few problems while imaging. To overcome the issues, software-based solutions are being made to receive the accurate counting of the platelets. Effective early diagnosis is critically important for improving the care of people with cancer. Early-stage patients are the only ones who can benefit from many effective treatment methods like surgical resection and organ transplantation. Hence early diagnosis is important for that process which can be expected from the advanced machine learning method.

Through the advancement of diagnostic techniques, one can offer thoughts on potential prospects for blood cancer's early diagnosis. Machine learning algorithms can work with huge numbers of medical information and give a good understanding of spiteful diseases. It allows the processing of data from several diagnostic functions to suggest methods that machine learning is a necessary tool for the upcoming future management of blood cancer. Nonetheless, these methods propose several pitfalls and need a critical framework to ensure the safe use of machine learning. ML is the most suited to deal with the huge amount of data which are complex and powerful methods to understand the disease neatly and overcome it carefully with the correct treatment through the suggestion of machine learning techniques.

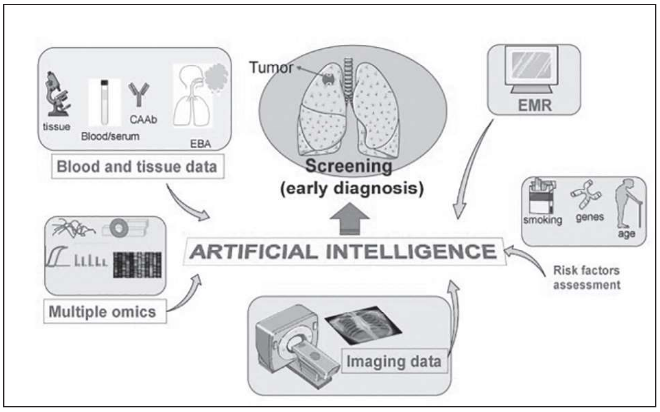

Fig. 3. AI Tools for refining Blood Cancer
"(Source https://www.mdpi.com/2077-0383/9 /12/3860/htm)"

According to G Simon 2019, for working oncologists, there is a knowledge gap due to the exponential growth of cancer information and the rapid pace of advancements, to provide evidence-based cancer care, there is always more to learn about each patient and more information from the literature to take into account. Maintaining current with peer-reviewed research, let alone assimilating it at the point of care, has become unfeasible for humans. Reception delays as a result widen the gap between what is achievable in academic examination organizations and what is practiced in certifiable contexts. Therefore, practicing oncologists need new tools to close this knowledge gap and enable the acceptance of innovative treatments in a proof-based manner. Actually, at that point, more patients will gain from cultural interest in cutting-edge work. The rapid advancements in research serve as a litmus test for how well evidence-based care is received in local settings. The gap between what is possible and what is polished can be closed by looking at methods for creating "artificial intelligence (AI)" systems that can continuously offer patients express choice. All the oncology experts can be designed first to the last consultation with three types of different functions. The three important functions are treatment recommendation options, summarizing the patient history, and some advisory management. This machine-learning algorithm is used to construct a patient's cancer history. Then it suggests the actual therapy that can be approved and also investigates the trial also. Getting counsel that is customized to a particular patient is a major benefit of visiting an expert over conducting literature research. One of its areas of expertise is to evaluate every therapy choice in its knowledge base in order to highlight only those that apply to a patient. To promote its use user's personal opinion, each option in just this case is connected to published research or a consensus guideline that might be examined in real-time within "OEA". This is carried out to guarantee transparency regarding the decision-making process used by "OEA". Following the creation of the ground truth, a retrospective query is run to record each instance during which a patient with lung cancer receives a new treatment for the last two years.

According to Olaniyan *et al.* 2020, the morphological analysis of leukocytes is a topic of major significance since it gives sufficient data for the diagnosis of many hematological diseases, and maladies, such as acute myeloid leukemia. Furthermore, the Leukocytes of different morphological classifications can be counted to be used as a starting point for analyzing the percentage of red blood cells. The following are a handful of the most typical Leukocyte morphological classes. Any abnormality in the ratio of the aforementioned morphological groups may serve as a sign of cancer. Leukocyte classification is crucial to the process of diagnosing these disorders since it is accurate and effective. A pathologist used manual annotation of leukocytes just a few years ago to spot changes in the ratio of various leukocyte kinds. This manual process is inefficient due to the possibility of human error and the significant time commitment. The total processing techniques and the capabilities of the segment automatic system can be discussed with many of the researchers in the last few years.

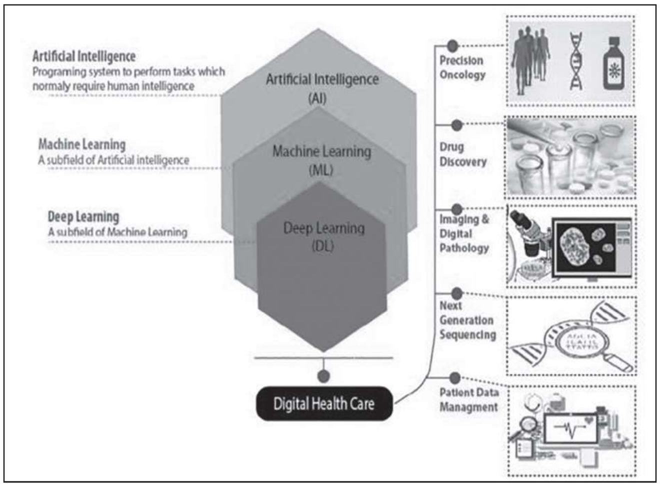

Fig. 4. Implementation of ML in Cancer Diagnosis (Source: https://cancerci.biomedcentral.com/articles/10.1186/s12935-021-01981-1)

For the classification of leukocytes, the author suggests a feature extraction method based on granularity characteristics and Support Vector Machines (SVM) both basophil and eosinophil. A program for automatic recognition, based on a deep learning network that addresses the constraints of the hardware and trustworthy accuracy. Naive utilizes the Bayes classifier for taking segmented pictures from a dataset produced via straightforward Otsu thresholding. The suggested framework presented utilizes a feature approach for extraction based on wavelet, statistical, and texture features. The feature extraction procedure is carried out after the leukocyte segmentation. The writer also planned CNN that takes a segmented copy for training resolutions. The division is approved by the Hue, Fullness, and Value (HSV) shade component of a copy along with splash analysis. Wavelet decomposition is secondhand in the organization of leukocytes to brand early analytical choices for leukemia. The author uses transmission learning by applying a pre-trained rearranged deep neural system. The acquired single-cell blood copy was directly nourished to the classifier deprived of the process of subdivision. The author planned a framework that augments the cataloging compatibilities of the organization. The framework contains cell improvement by Artificial Neural Network (ANN). Recently, the division of leukocytes based on color and lighting variations has been planned. Along with active delineations, arithmetic, and morphological processes are used for correct segmentation.

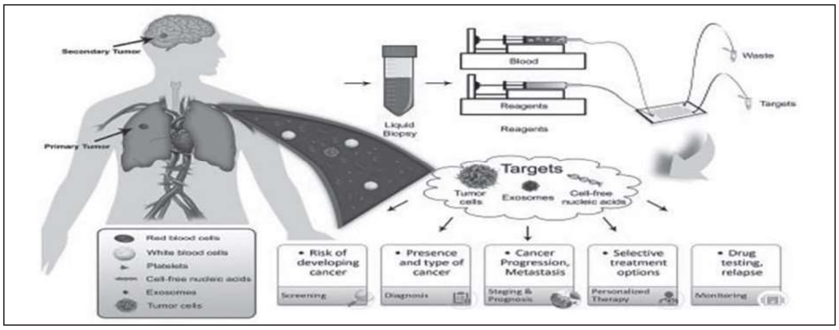

Fig. 5. Blood Cancer detection regarding Attributes "https://www.sciencedirect.com/science/article/abs/pii/S0003267018300783"

According to Borkowski 2019, the term artificial intelligence (AI), originally used in 1956, refers to the area of computer science where robots are taught to gain knowledge by experience. The 1956 Dartmouth College publication popularized the phrase. The discipline of AI is fast expanding and potentially shaving an impact on many facets of people's lives including the medical area. A February 2019 study highlights the growing significance of AI, the directive that established the American AI initiative and allocated financing and resources for developing AI. According to the executive order, the prospective effects of AI in the realm of health care, include usefulness in disease diagnosis. Federal agencies were told to spend money on AI research and development to support quick advances in AI technology that could have a broad influence in prominently detecting blood cancer. Of course, there are a few challenges to overcome before such applications may be applied. The separation and purification of exosomes from patient samples provide several quality control challenges. It is still difficult to routinely extract a pure and quantifiable quantity of exosomes from patient sera or plasma. Recent developments in nanotechnology, however, are anticipated to solve all technological problems. Though its use in ultrasonic medicine is still in its infancy, artificial intelligence (AI) technology has attracted a lot of attention in the medical field. Intelligence ultrasound image detection and categorization can be done using deep learning, the primary AI method. The current state of AI applications in ultrasound imaging, particularly those for thyroid, breast, and liver disorders seems promising. The combination of AI and ultrasound imaging has the potential to improve the precision and specificity of ultrasound diagnosis while lowering the rate of misdiagnoses.

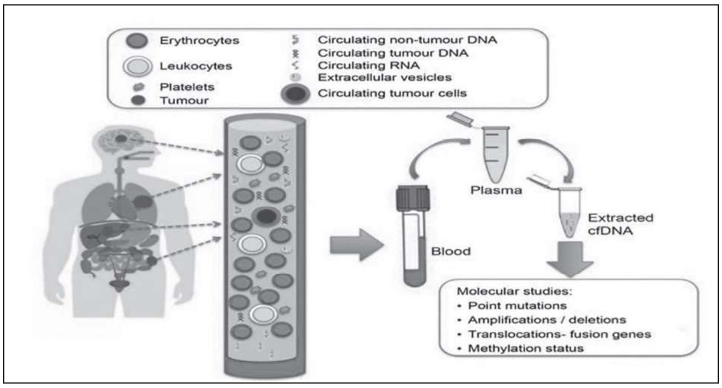

Fig. 6. Blood Cancer Detection Cycle (Source: https://link.springer.com/article/10.1007/s12094-019-02211-x)

According to Quazi 2022, developed on the basis of a person's genetic makeup, lifestyle, gene expression, and environment, precision medicine is quickly expanding. By identifying the traits that lead people to a specific disease and describing the main biochemical processes that cause the ailment, researchers can utilize it to personalize prevention and treatment. The transformation of healthcare from a universally applicable medical practice to a data-driven and individualized one, allowing for more cost-effective spending and better patient outcomes, is one of the most exciting and hopeful advances in modern medicine. It has assisted with a variety of inflammatory-related disorders, including cancer, cardiovascular disease, HIV, and many more. Precision medicine has advanced healthcare services by enabling early risk forecasting of disease through ensuring that information and customization of more new therapies, leaving behind the conventional symptom-driven treatment strategy. It is vital to thoroughly study total patient data as well as general elements to observe and differentiate between sick and generally healthy persons to identify the optimal path toward pharmacogenomics. This will advance our knowledge of the biological markers that can point to changes in one's health. Artificial intelligence with precision and genomic medicine has the potential to advance patient care. Patients are using genetic medicine technology if having unusual therapy responses or special healthcare needs. AI enhances physician decision-making by providing insights through sophisticated computing and inference, allowing the system to reason and learn. Although it has been difficult to use healthcare data in therapeutic decision-making due to the complexity of interpersonal disorders, technology improvements have assisted in removing some of the obstacles. To give high decision support and apply tailored health effects, it is crucial to make the most of EHRs by integrating various datasets and recognizing specific patterns of patients' disease progression. This has a larger chance of improving favorable clinical outcomes. Although the significance of clinical data mining cannot be emphasized, there are still significant problems with substantial data management. Over time, biotechnology has made significant advancements. Datasets are becoming more heterogeneous and their volume is expanding at a rapid rate, while computers are getting faster and smaller. Through these achievements, artificial intelligence (AI) can identify several technical developments that are required to handle challenging problems in nearly every field of research, medicine, and life. Artificial intelligence is one of the many branches of computer science technology that allows computers to do a wide range of jobs including medical treatments that would ordinarily require human brains.

According to Sharma 2021, Machine Learning is already considered a precise, versatile, and strong method in blood cancer diagnostic evaluation. It is certainly better for medical applications, particularly those which rely on compound proteomic, and genomic calculation. As a result, machine learning is widely used in the diagnosis process and the detection part of cancer. Currently, it is also used to predict and prognosticate. This technology is not a very new approach to cancer. AI can quickly recognize how the cells of cancer become impervious to the medicine of anti-cancer that can improve the growth of drugs and can adjust it too. It also can aid in planning radiation-based treatments automatically. It has a strong ability and free learning power that can replicate the thought methods of the human brain. Machine learning can immensely process the present mode of anticancer solutions research. It can assist in developing anticancer drugs. A researcher called Wang has made a model based on machine learning and data screening to predict the sensitivity of the drugs. AI can easily access how the cells of cancer become impervious to medicines of cancer by properly analyzing the data on cancer that helps to improve the development and adjust the use of drugs accordingly.

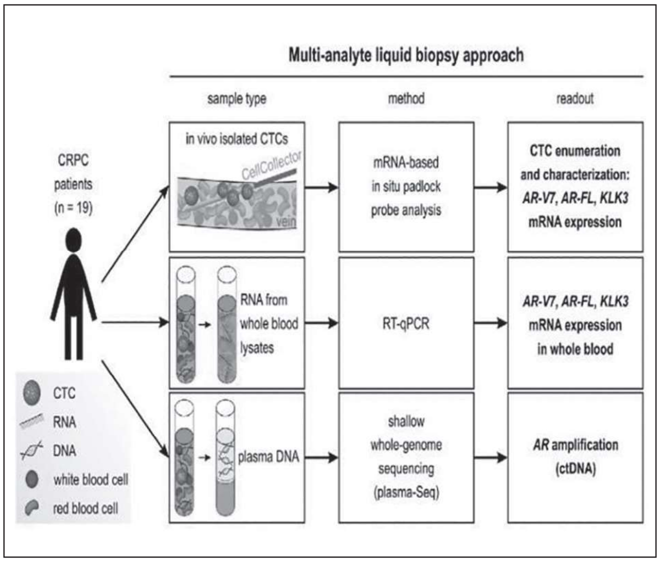

Fig.7. Multi-AnalyteLiquidBiopsyApproach(Source:"https://www.researchgate.net/figure/Overview-of-our-multi-analyte-liquid-biopsy-approach-which-combines-enumerationand_fig1_343592023")

This paper is a description of a variety of medical datasets and resources that can be utilized to diagnose dementia using machine learning techniques. This shows how different machine-learning techniques can be helpful in the early identification of numerous diseases and explains how machine learning and deep learning can be used for medical data that has been electronically saved. How machine learning can be applied in cross-disciplinary study domains has recently advanced. This chapter's primary goal is to elaborate on the use of machine learning in the healthcare industry. In the past, there have been significant advancements in the ways that machine learning might be used in numerous fields of study and industry. In this chapter, the use of machine learning technologies in the healthcare industry is discussed. Several industrial innovations that employ machine learning are also sketched. DL models are being developed for innovative cancer detection in addition to the traditional blood cancer screening and diagnosis procedures. Extracellular vesicles released into the circulation by cancer cells, known as cancer cell exomes, are emerging as critical cancer diagnostic and prognostic biomarkers.

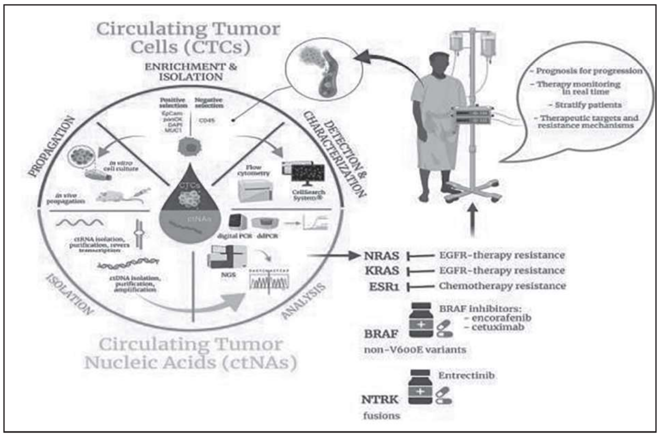

Fig. 8. Blood Cancer Diagnosis
"https://www.frontiersin.org/articles/10.3389/fonc.2022.856575/full"

According to Al-Sowayan 2021, the diagnosis of blood cancer can be aided by application software. However, current developments in artificial intelligence (AI) are tackling issues with the identification, categorization, and monitoring of various blood cancers. Deep learning techniques can be used by AI to do automated analysis on histologic or mammographic tests. Through sophisticated machine learning, a sizable volume of data produced by digitized mammograms or whole-slide images can be interoperated. When compared to human performance, this permits swift examination of each tissue patch on an image, leading to speedier, more sensitive, and more reproducible diagnoses. On the other hand, extracellular vesicles called cancer cell exosomes, which are secreted by cancer cells into the bloodstream, are being investigated as potential cancer biomarkers. Recent research on the miRNA contained in cancer exosomes showed that and other biomolecules can be used to predict the prognosis, potential metastasis. Therefore, potentially, a profile of every cancer subtype, estrogen receptor status, and probable metastatic site can be created using Nano genomics. Deep learning calculations based on artificial intelligence have been used to identify complex instances in clinical images as well. It works to interpret images and enhance clinical judgments, enabling important decisions that are frequently difficult for individuals. The social occasion of various information streams is improved by computer-based intelligence into increasingly integrated indicating frameworks. These include genetics, capturing electronic health records, informal organizations, and radiographic images targeted at pathology. While PCs may be effectively set up to produce outcomes that can be created rapidly, ML can be applied to carefully captured images or MRI datasets. There is a developed algorithm by Hu, that can analyze the digital pictures of the cervix of the women to mitigate the patient's overtreatments. Another tool based on machine learning can reduce the over-treatment of lesions. This tool can identify which are more dangerous and can lead to cancer. This enables the doctors to make the right decisions and proceed with proper treatment.

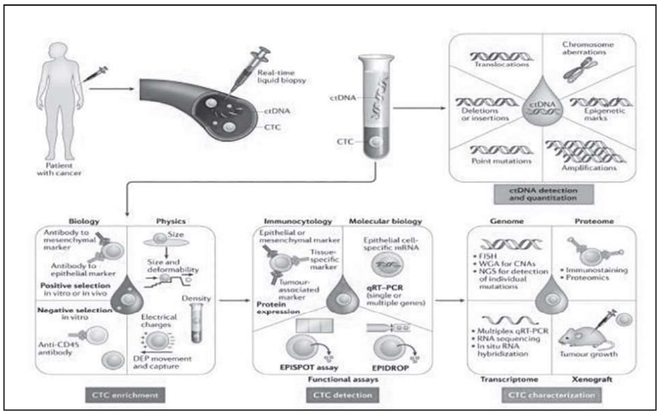

Fig. 9. CTC Process of Blood Cancer Detection

(Source: "https://www.researcher-app.com/paper/2219485")

According to Ibrahim *et al*. 2021, by dissecting illustrations from the blood and bone marrow, it is possible to determine whether there is cancerous growth in the lymphatic system. A group led by Dr. Peter Krawitz from the Department for Genomic Statistics & Informatics at the Teaching Hospital Bonn in Germany previously showed that AI can aid in the identification of such lymphomas and leukemias in the year 2020. The invention improves both the speed and objectivity of the research when compared to traditional methods by making full use of all the abilities of estimation values. Many of the interpretations can be reliable, and many of the features can be visible in many marrow bone cells of the body. This interpretation makes use of light microscopy-observed visual characteristics of bone marrow cells and tissue. Man-made intelligence (AI) and AI have emerged as one of the most cutting-edge innovations, with several applications in many industries, including medicine.

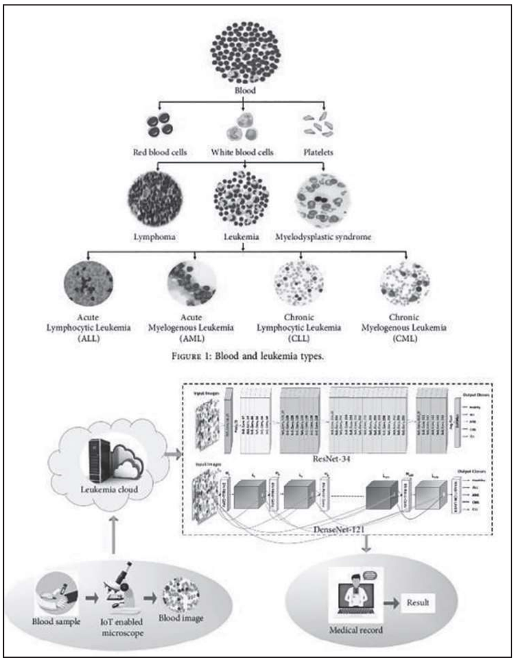

Fig. 10. Blood Cancer Detection Using ML

(Source: https://www.semanticscholar.org/paper/IoMT-BasedAutomated-Detection-and-Classification-Bibi-Sikandar/0f8e25d6581850f1286bbf6a20a07abcfeac2d35)

The most well-known non-transmittable disease at the present moment is malignant growth, which has been blamed for a staggering number of fatalities across the globe. There have been ongoing efforts to increase the fatality and grimness of malignant development. The integration of artificial intelligence into disease research has successfully been accomplished and produced incredibly positive results. The key factor that plays a crucial role in further refining the forecast for malignant growth, includes early detection and precise conclusion using various imaging and sub-atomic techniques. The use of artificial intelligence as a tool in this case has demonstrated that it has increased accuracy in its ability to recognize and determine. Similar to this, the diagnosis and risk assessment of patients with myelodysplastic syndrome depends on the detection of minute cytological alterations in bone marrow cells (MDS). A delayed or inaccurate diagnosis may result from failure to accurately identify and count aberrant cell populations in the aspirate. It takes time and is subject to inter-observer variability to undertake a cytological review of each bone marrow aspirate specimen in a busy reference hematopathology lab. Likewise, smaller community centers frequently don't have enough to interpret the marrow bone aspiration Cytology.

According to Sadashiv 2019, Leukemia is the most common type of malignancy among all blood malignancies across all age groups, especially in children. The underlying reasons for this anomalous illness are excessive proliferation and immature growth of blood cells, which can affect red bone marrow, blood cells, and the immune system. Hematologists in cell transplant facilities treat various kinds of leukemia and can make a diagnosis or distinction based on microscopic images. Some varieties of leukemia can be more easily detected on the slide if it is properly dyed. More tools are required to determine the underlying leukemia, however some are more easily diagnosed and distinguished than others. Early detection of Leukemia diagnosis is challenging in the early stages, which has always been a challenge to researchers, physicians, and hematologists. hases as a result of the modest symptoms. Leukemia is a very deadly type of disease which is why it is very important to stop spreading this type of disease. The main goal of it is to develop which can be detected significantly and can be classified using so many types of deep learning techniques with the smear blood images which are found to be provided using a microscope. The Automated detection study offers a framework based on the Internet of Medical Things (IoMT) to improve and offer a quick and secure detection of leukemia. In the proposed IoMT system, clinical devices are connected to network resources with the aid of cloud computing. The technology enables real-time collaboration between patients and medical experts for leukemia testing, diagnosis, and treatment which could spare both patients and doctors time and effort. The machine learning detection study provides a thorough and organized overview of the current state of all reported machine learning (ML)-based leukemia detection and classification models that interpret PBS pictures. The application of ML might produce amazing results in the detection of leukemia from PBS images, according to the average accuracy of the ML methods utilized in leukemia analysis of PBS images. All in all, higher sensitivity and precision were attained in the detection of various leukemia cases using ML approaches, specifically deep learning (DL). In the automated detection study the authors of this work suggest a novel mix of strategies to deal with the trickiest aspects of the detection process and provide in-depth analyses of the biggest drawbacks of the current classification procedures, such as overfitting and the dependability of specific classifications. An expert can identify ALL from peripheral blood smear photos in the end. Optimized support vector machines and artificial neural networks

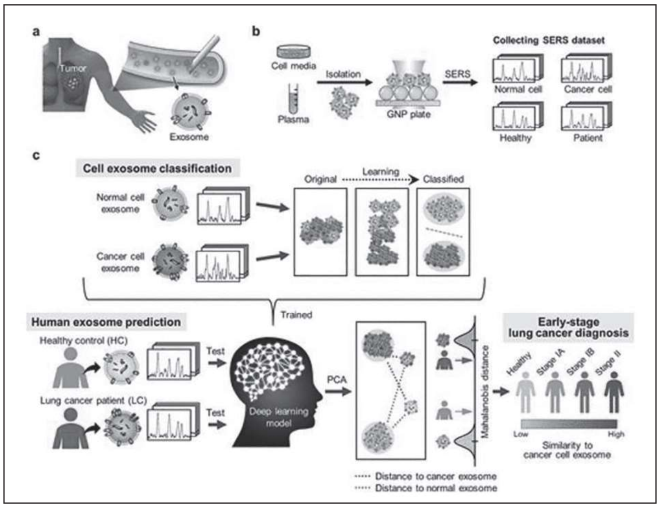

Fig. 11. Use of AI & ML in Detection Procedure "(Source: https://pubs.acs.org/doi/10.1021/acsnano.9b09119)"

According to Salah 2019, The future of medical treatment may be inflicted by tools using artificial intelligence (AI) and enhanced human intelligence (AHI). Due to the expansion of data generated by our systems, medical literature, and healthcare system indices, to use of the power of AI technologies tools will be vital. The clinical practice is now utilizing AHI tools, such as "machine learning (ML)" and "deep learning algorithms". For instance, since 2017, the US FDA has given its approval for numerous AI-based software to be used in medicine. Telemedicine is one of the many options that digital pathology has offered to the science of pathology. Recently, the use of digital pathology has made it possible to automate pathological diagnosis using ML, including deep learning algorithms. There are several applications of machine learning in pathology, such as digitizing slides, labeling in supervised learning cases, initial and ongoing costs, sophisticated equipment, technical know-how, and ethical problems. However, there are several prospects for using AHI tools in pathology. The use of machine learning (ML) in pathology has increased recently. Bejnordi and his coworkers presented algorithms developed as part of a challenge competition to apply deep learning to identify blood cancer using advanced machine learning techniques. Comparing the area under the curve (AUC) of seven of the 32 proposed algorithms to those of 11 pathologists with varied levels of experience, exhibited a much higher AUC. Furthermore, when pathologists did not have time constraints, five algorithms performed similarly to them. This experiment serves as an excellent example of the potential benefits of applying ML and its promise to produce accurate, effective workflow. ML has also been used successfully in the field of pathology in the treatment of malignancies of the lung and brain. A serious hematological disease called leukemia causes mortality and morbidity in people of all ages. New cases were reported worldwide in the year of 2012. 13 Several variables, such as limited access to healthcare and misclassification owing to a lack of competent staff, make leukemia diagnosis difficult. Leukemia was one of the potential diseases that ML may be used to treat. Several publications have examined the various methods of classifying and segmenting various blood cells, including white blood cells.

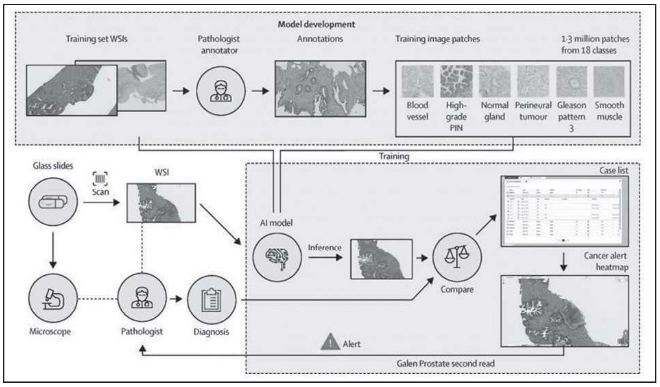

Fig.12. Model Development
(Source: http://jase.tku.edu.tw/articles/jase-202106-24-3-0007)

According to <u>U Kubra</u> 2019, The ability to diagnose various hematological disorders is made possible by the ability to recognize leukocytes, also known as white blood cells, in histological blood tissue images. In this research, one proposed a deep learning-based automatic detection and classification model for the diagnosis of lymphoma malignancy, a hematologic condition. A type of region-based convolutional neural network (CNN) model called faster

R-CNN performs satisfaction on object detection and classification issues. Everyone provides a ResNet50 modified Faster R-CNN model for the identification and classification of leukocyte types, which include lymphocyte, monocyte, basophil, eosinophil, and neutrophil in histological blood tissue pictures, to eliminate the feature extraction process in image-based applications. Furthermore, a revolutionary Faster R-CNN object detection system. In histological blood tissue imaging, leukocyte types are categorized as lymphocyte, monocyte, basophil, eosinophil, and neutrophil. Parallel to this goal, the locations of leukocytes in the image were identified and categorized using a unique Faster R-CNN object identification model that was created by modifying the ResNet50 model. On a unique histology dataset with images of blood tissue, the effectiveness of the suggested model was evaluated. To diagnose lymphoma malignancy, the quantity of lymphocytes in the blood tissue is employed as an evaluation criterion. As a result, this study serves as a model for future clinical studies. The suggested model states that after normalizing the blood tissue pictures, the implicit features are then retrieved using a trainable convolution kernel. Next, to reduce the extracted implicit types of features the highest amount of pooling is used in it. The next step is to create very high-quality region proposals using region proposal networks, which are then employed by faster R-CNN for detection. To classify the different types of leukocytes and estimate the border boxes of the test samples, respectively, the softback classifier and regression layer are used. Experimental findings demonstrate the effective operation and generalizability of the innovative Faster R-CNN for the identification and categorization of leucocyte types. Because the technique has been tried on a real-world histology data set, this model has the potential to be used as a diagnostic tool for clinical investigations.

According to Barhoom, 2018, A Dartmouth conference laid the groundwork for artificial intelligence about 60 years ago (AI). The term was created to describe the application of technology to tasks that ordinarily need “human intelligence”. These include, but are not limited to: utilizing visual perception, making judgments, and comprehending language. After the conference, the AI industry quickly began to grow dramatically. Stanford University’s central project, which got its start in the early 1960s, is one notable example.

Dental provided solutions in the realm of science using heuristic programming. The body of research-based literature on healthcare is currently growing rapidly. To address many of the current healthcare concerns, the prospects given by the development of artificial intelligence (AI) tools like machine learning are alluring. As a result, AI integration is growing across most healthcare specialties, including hematology. This paper aims to review additional measures of AI in "hematopoietic cell transplantation (HCT)". The databases used for the literature search were as follows: Including In-Process and other unindexed citations, Ovid Medline and Google Scholar are both available. Additionally, the abstracts from the European Society for Blood and Bone Marrow Transplantation, the American Society for Blood and Marrow Transplantation, and the American Society of Hematology were studied. According to the literature analysis, the use of AI in the field of HCT has significantly increased over the past ten years and offers potential opportunities for diagnosis and prognosis in HCT populations that target both pre- and post-transplant complications.

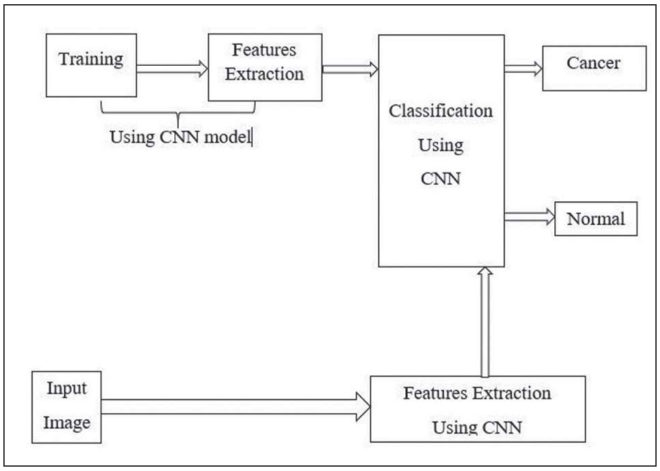

Fig. 13. Architecture of CNN Model (Source: https://aihubprojects.com/blood-cancer-detection-using-cnn-ai-projects/)

There are significant limitations to studies of AI integration in HCT, including the use of few diverse AI tools, inadequately verified algorithms, and lack of generalizability. As one can believe that this will be the practice paradigm of the future, machine learning techniques in HCT are an intense area of study that needs substantial development and extensive support from hematology and HCT associations and organizations worldwide. A decade after the Dartmouth summit, AI integration in medicine began. One of the first medical Applications built on general was mycin, which was used to identify microorganisms causing Infections and select the best antimicrobials and dosages. When compared to choices made using human expertise, this program's agreement rate was 50%. Although the rate of agreement was below ideal, it was nonetheless able to cover all treatable infections and was demonstrated to reduce the use of antimicrobials. This was followed by the creation of numerous other AI tools for medical professionals and also including internists.

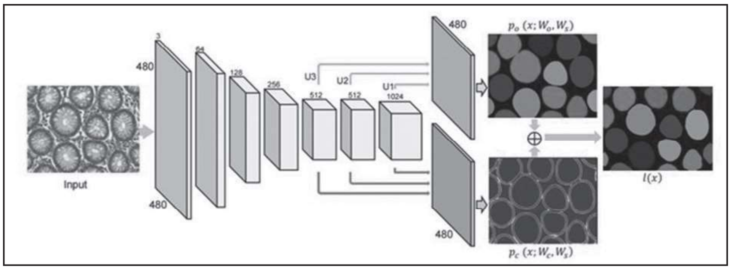

Fig. 14. Diagnosis of Cancer Using Machine Learning "(Source:https://developer.nvidia.com/blog/diagnosing-cancer-with-deep-learning-and-gpus/)"

According to Visaggi *et al*. 2020, the focus of numerous studies and funding has recently been placed on applications relating to efficient computational approaches for the cancer diagnosis and therapy center is now the second-leading cause of mortality worldwide, according to statistics. The most typical form of cancer in men. The World Health Organization said that this cancer caused about 7.3 million deaths in the years of 2012 and 2015 which can increase to 8.5 million. Furthermore, it was projected that there would be 26 million new instances of this type of condition by 2030. While these methods have been studied for a while, their cancer applications have recently begun to emphasize academics in addition to. Cancer can be regarded as the primary disease responsible for many developing countries and peoples' mortality. It's possible that the classification of cancer in medical practice, which is based on Historical and clinical data, produces muddled and insufficient results. Cancer is a terrible condition for anyone. This illness claims the lives of millions of people every year. A critical study topic in medical science right now is neural networks. Choosing the right treatment for cancer patients is crucial for medical professionals. As a result, cancer cells need to be appropriately identified. More investigations have been forced to look at the role associated with computational techniques in general about several works related to cancer due to recent breakthroughs in biological as well as computer science. In recent years, there has been a general increase in the use of various AI techniques for cancer disease diagnosis. The advantages of AI and machine learning techniques are also being focused on more.

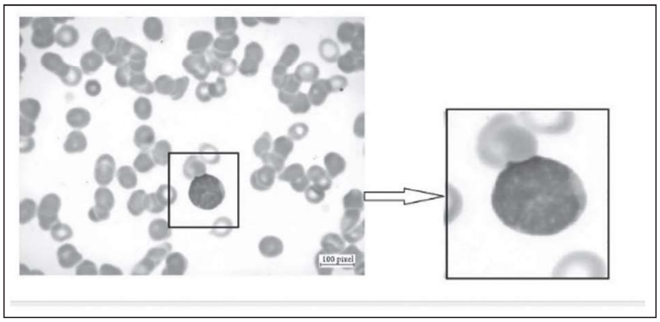

Fig. 15. Blood cells Detection

(Resource: https://www.hindawi.com/journals/sp/2021/9933481/)

According to Deepika Kumar *et al* 2020, 1% of blood cells in the human body are leukocytes, which is mainly made in the bone marrow. Blood cancer develops as a result of the unchecked proliferation of these cells of white blood. The proposed work uses the white blood cancer data set to give a vigorous apparatus for the categorization of "Multiple Myeloma (MM)" and "Acute Lymphoblastic Leukemia", two of the three main forms of cancer. Too many "lymphocytes" are produced by the bone marrow in this particular type of malignancy. However, a separate type of cancer called "multiple myeloma (MM)" causes cells of cancer to build up in the bone marrow rather than liberating them in the bloodstream. They thereby compete with and obstruct the development of healthy cells of blood. In the past, the procedure was manually completed by a knowledge expert throughout a long period. The suggested model uses deep learning methods, namely "CNN (Convolution Neural Network)", to completely eliminate the possibility of mistakes in the human process. The model retrieves the best features from the preprocessed photo after being trained on images of cells. The model is then trained using an optimal

“Dense Convolution Neural Network” framework (here referred to as DCNN), and it is then predicted which results in cell, cancer is existing. The model accurately captured the samples 94 out of 100 times while reproducing all measurements. In comparison to traditional machine learning techniques like “(SVMs) Support Vector Machines”, Random Forests, Naive Bayes, Decision Trees, etc., the complete accurateness was evaluated to be 97.2 percent. According to this study, the “Dense Convolutional Neural Network” model’s performance on the retrieved data set is comparable to that of the well-known Convolutional Neural Network architectures while having many fewer parameters and a shorter time of computation. As a result, the model is a useful tool for identifying the different kinds of cancers in the bone marrow. Selecting the appropriate treatment for blood cancer patients is vital for professional personnel. As a result, it’s important to correctly identify blood cancer cells. As a result, it’s important to correctly identify cancer cells. Recent advances in biological as well as computer science have compelled more studies to examine the role linked with computational methods in all-purpose about many works related to cancer. The use of various AI approaches for cancer illness diagnosis has generally increased in recent years. The benefits of machine learning and artificial intelligence (AI) methods are also receiving greater attention.

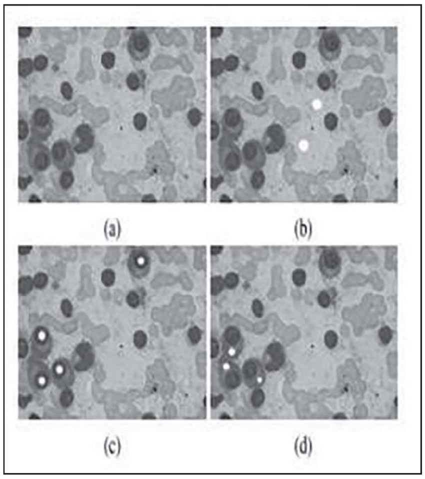

Fig. 16. Sample image of MM datasets
(Resource: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber =9149873)

According to Kadir Sabanci *et al* 2018, blood cancer is very common nowadays. To lower the incidence of blood cancer-related humanity, it is essential to stop the spread of cancerous cells. This necessitates the earliest possible cancer detection. In medicine "MLA (Machine Learning Algorithm)" is used to make diagnoses or forecast how well a treatment will work. Four different "MLA (machine learning algorithms)" were utilized in this study to identify blood cancer early on. The main purpose of this study is to evaluate the outcomes of routine blood analysis using several ML (machine learning) techniques and to ascertain the degree to which these techniques are successful in finding. "K-NN (K-Nearest Neighbor)", "SVM (support vector machines)" conventional "ELM (extreme learning machines)" and "ANN (artificial neural network)" are examples of different methods. The data set was obtained from the unique client identifier library. The variables employed in the data sets include "BMI (body mass index)", age, glucose, "HOMA (homeostasis model assessment)", insulin, leptin, resisting, "chemokine monocyte chemoattractant protein" and adiponectin. Four different kinds of "machine learning algorithms" were used to identify the parameters with the highest accuracy values. The hyper-parameter optimization technique was employed for this. The outcomes were discussed or compared later. "K-NN (K-Nearest Neighbor)", "SVM (Support Vector Machine)", "NB (Naive Bayes)", and Decision-Tree "Machine Learning (ML)" approaches were compared in terms of performance. For this study, a blood cancer dataset was employed. Support Vector Machine approach produced the best result, 97.2 percent. It contains a study in which a hybrid of the "K-Means" and Support Vector Machine algorithms was employed to find blood cancer. An arrangement with a high accuracy rate was carried out as a result of a cross-validation that was completed ten times. The blood cancer data set was utilized in this study. An accuracy of 97.38 percent was attained. The research demonstrates the effectiveness of combining

"Support Vector Machine" and "Artificial Neural Network" approaches. Support Vector Machine and artificial neural network both produced an accuracy of 97.15 percent and 96.72 percent, respectively. These findings show that Support Vector Machine performs better than Artificial Neural Networks in terms of results. Additionally, it was demonstrated that the Support Vector Machine performs better in blood cancer detection. The kernel role affects how well the "Support Vector Machine" performs. This study assessed the effectiveness of several kernel role types. For a quicker and more accurate categorization, the k-nearest Neighbor algorithm was enhanced. The accuracy was 94.11 percent. It all comes down to how different "ML (machine learning)" approaches are used for blood cancer. The study examines the application of a Support Vector Machine, K-nearest neighbor, Decision Tree (DT), and Artificial neural network to the diagnosis of blood cancer. The approaches of the Bayesian Belief Network,

Decision Tree and Machine learning were contrasted in the paper. "Artificial Neural Network" classification was used to find Blood cancer.

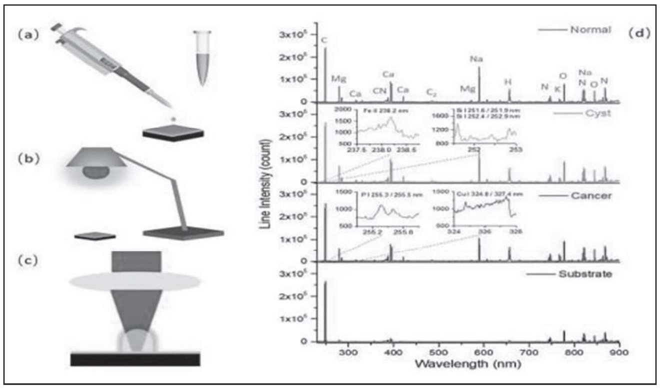

Fig.17. Laboratory Experiments and Analysis

(Resource: https://opg.optica.org/boe/fulltext.cfm?uri=boe-12-5-2559&id =449849)

According to Ibrahim N. Muhsen *et al* 2019, "Artificial Intelligence" and "Machine learning" present prospects to improve pathological diagnosis, particularly with rising trends in the digitalization of microscopic pictures. Leukemia (the human body's blood-forming tissue cancer) diagnosis is time-consuming and difficult in many regions of the world, and there is an increasing trend to use Machine learning approaches for it. The four major kinds of leukemia; "AML (acute myeloid Leukaemia)", "ALL (Acute lymphocytic leukemia)", "CML (chronic Myelogenous leukemia)" and "CLL (chronic lymphocytic leukemia)" were the focus of this study, which sought to describe the research on the use of ML in these diagnoses (chronic

Myelogenous leukemia). A stringent selection criterion, "Boolean logic (BL)" and "MeSH terminology" were used. The manual search of related study references and the top results were included in to search. There was multiple research that discussed, acute lymphocytic leukemia, chronic lymphocytic leukemia, and chronic Myelogenous leukemia, respectively. The common studies used supervised learning to complete classification problems on small, homogenous examples. 74.1 percent of the involved research used machine learning algorithms to identify leukemia at the microscopic level. Ninety-one percent of the investigations were carried out after 2010. The included papers demonstrated the need to advance the discipline of machine learning research, particularly the shift from simply building algorithms to actually using them in clinical settings. This appraisal has produced numerous research using Machine Learning approaches on flow cytometric and microscopic diagnosis for each major leukemia type (chronic Myelogenous leukemia, acute myeloid leukemia, chronic lymphocytic leukemia, and Acute lymphocytic leukemia). Studies involving the finding of leukemia using microscopic pictures were generally more numerous than studies utilizing flow cytometry. The leukemia sub-set with fewest research was chronic Myelogenous leukemia, it can be explained by the need for a genetic analysis in this case. Several precise have been obtainable at conferences devoted to technology, pathology, and hematology. Investigated the use of AI in "multi-parameter flow cytometry (MFC)" for the finding of leukemias and lymphomas Blood cells at the 2018 "American Society of Hematology Congress". A model was created utilizing artificial neural networks and data from 16,384 patients. Using a cross-validation of tenfold, the results were validated. The approach has a classification accuracy of 97.00 percent for distinguishing between normal and malignant cells, but only 74 percent for classifying the sub-sets of the included leukemias and Blood-cell lymphomas.

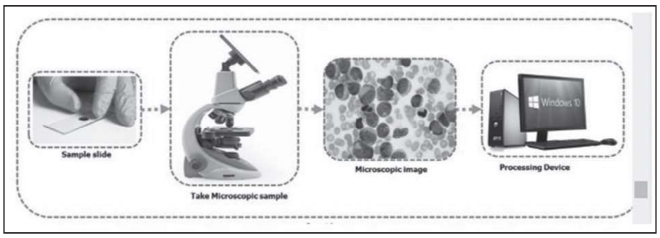

Fig. 18. Microscopic Sample of Input Layer
(Resource: https://reader.elsevier.com/reader/sd)

According to Arash Roshanpour 2021, the diagnosis of many blood-related disorders depends heavily on the picture analysis of blood smears. Early detection of leukemia and the first smear results can result in an accurate diagnosis and prompt treatment. In order to diagnose early-onset leukemia and identify sub-types with the least amount of error and the quickest turnaround possible, blood smear picture analysis using machine learning techniques can be used. The use of novel machine learning algorithms, particularly Deep learning, in CAD systems, "Whole Slide Imaging", and software at haematology laboratories to aid oncologists and pathologists in better-detecting leukemia can be a potential future route for research. Uses of AI in MFC for the diagnosis of Blood cell leukemia and lymphoma at the 2018 American Society of Haematology conference. A model was created utilizing CNN using data from 38,416 patients. The system's accuracy in distinguishing between normal and irregular cells was 75%. However, only 76% of Blood cell leukemia and lymphoma diagnoses were accurate. Therefore, it is advised that the employment of machine learning algorithms for the analysis of blood smear images move from the modeling stage to the implementation stage in the near future.

Conclusion

In conclusion, this study demonstrates the significant potential of artificial intelligence, particularly machine learning algorithms, in the diagnosis of blood cancer. Through the utilization of large datasets and advanced computational techniques, our research has shown promising results in accurately identifying blood cancer subtypes and predicting patient outcomes. The integration of AI into clinical practice offers several advantages, including enhanced diagnostic accuracy, reduced time and cost burdens, and the ability to personalize treatment plans based on individual patient profiles. The development of AI-assisted diagnostic tools holds the promise of improving patient outcomes by facilitating early detection and intervention which include issues related to data quality, interpretability of AI-driven predictions, and concerns regarding patient privacy and ethical considerations. Looking ahead, further research is needed to validate the performance of AI models in diverse patient populations and clinical settings. Efforts should be made to enhance the transparency and interpretability of AI algorithms to foster trust among healthcare providers and patients. While AI-assisted diagnosis for blood cancer shows great promise, continued collaboration between researchers, and industry stakeholders it is essential to realize its full potential in improving patient care and outcomes.

References

[1] Abdulqader, D.M., Abdulazeez, A.M. and Zeebaree, D.Q., 2020. Machine learning supervised algorithms of gene selection: A review. *Machine Learning*, *62*(03), pp.233-244.

[2] Ahmed, N., Yigit, A., Isik, Z. and Alpkocak, A., 2019. Identification of leukemia subtypes from microscopic images using convolutional neural network. *Diagnostics*, *9*(3), p.104.

[3] Akazawa, M. and Hashimoto, K., 2020. Artificial intelligence in ovarian cancer diagnosis. *Anticancer Research*, *40*(8), pp.4795-4800.

[4] Alsalem, M.A., Zaidan, A.A., Zaidan, B.B., Hashim, M., Albahri, O.S., Albahri, A.S., Hadi, A. and Mohammed, K.I., 2018. A systematic review of an automated multiclass detection and classification system for acute Leukaemia in terms of evaluation and benchmarking, open challenges, issues, and methodological aspects. *Journal of medical systems*, *42*(11), pp.1-36.

[5] Bathroom, A.M., 2019. Blood donation prediction using artificial neural network.

[6] Chang, Y.J., Hung, K.C., Wang, L.K., Yu, C.H., Chen, C.K., Tay, H.T., Wang, J.J. and Liu, C.F., 2021. A real-time artificial intelligence-assisted system to predict weaning from the ventilator immediately after lung resection surgery. *International journal of environmental research and public health*, *18*(5), p.2713.

[7] Chaurasiya, S. and Rajak, R., 2022. Comparative Analysis of Machine Learning Algorithms in Breast Cancer Classification.

[8] Eckardt, J.N., Rollig, C., Kramer, M., Stasik, S., Georgi, J.A., Heisig, P., Kroschinsky, F.P., Schetelig, J., Platzbecker, U., Müller-Tidow, C. and Sauer, T., 2021. Prediction of complete remission and survival in acute myeloid leukemia using supervised machine learning. *Blood*, *138*, p.108.

[9] Feltes,B.C.,Chandelier, E.B.,Grisci,B.I.andDorn, M., 2019. Cumida: an extensively curated microarray database for benchmarking and testing of machine learning approaches in cancer research. *Journal of Computational Biology*, *26*(4), pp.376-386.

[10] Feng, Y., Yang, F., Zhou, X., Guo, Y., Tang, F., Ren, F., Guo, J. and Ji, S., 2018. A deep learning approach for targeted contrast-enhanced ultrasound-based prostate cancer detection. *IEEE/ACM Transactions on computational biology and Bioinformatics*, *16*(6), pp.1794-1801.

[11] Goyal, H., Mann, R., Gandhi, Z., Perisetti, A., Ali, A., Aman Ali, K., Sharma, N., Saligram, S., Tharian, B. and Inamdar, S., 2020. Scope of artificial intelligence in screening and diagnosis of colorectal cancer. *Journal of Clinical Medicine*, *9*(10), p.3313.

[12] Ibrahim, I. and Abdulazeez, A., 2021. The role of machine learning algorithms for diagnosing diseases. *Journal of Applied Science and Technology Trends*, *2*(01), pp.10-19.

[13] Joshi, T.N. and Chawan, P.P.M., 2018. Diabetes prediction using machine learning techniques. *Ijera*, *8*(1), pp.9-13.

[14] Koromina, M., Pandi, M.T. and Patrinos, G.P., 2019. Rethinking drug repositioning and development with artificial intelligence, machine learning, and omics. *Omics: a journal of integrative biology*, *23*(11), pp.539-548.

[15] Kosvyra, A., Maramis, C. and Chouvarda, I., 2019. Developing an integrated genomic profile for cancer patients with the use of NGS data. *Emerging Science Journal*, *3*(3), pp.157-167.

[16] Lin, J., Tao, X. and Pan, J., 2022. An artificial intelligence-based system assisted endoscopists to detect early gastric cancer: a case report. *Journal of Digital Health*, pp.25-29.

[17] Liu, R., Zhang, G. and Yang, Z., 2019. Towards rapid prediction of drug-resistant cancer cell phenotypes: single-cell mass spectrometry combined with machine learning. *Chemical Communications*, *55*(5), pp.616-619.

[18] Mitsala, A., Tsalikidis, C., Pitiakoudis, M., Simopoulos, C. and Tsaroucha, A.K., 2021. Artificial intelligence in colorectal cancer screening, diagnosis and treatment. A new era. *Current Oncology*, *28*(3), pp.1581-1607.

[19] Ojha, S., 2022. Recent Advancements in Artificial Intelligence Assisted Monitoring of Heart Abnormalities and Cardiovascular Diseases: A Review.

[20] Olaniyan, O.O., 2019. Stratification of chronic myeloid leukemia cancer dataset into risk groups using four machine learning algorithms with minimal loss function.

[21] POPESCU, F. and ICHIMESCU, C., 2021. Building, training, and validation of an artificial intelligence-assisted Early Warning System for COVID-19 pandemic management. *Romanian Journal of Information Technology and Automatic Control*, *31*(2), pp.7-20.

[22] Rahane, W., Dalvi, H., Magar, Y., Kalane, A. and Jondhale, S., 2018, March. Lung cancer detection using image processing and machine learning healthcare. In *2018 International Conference on Current Trends towards Converging Technologies (ICCTCT)* (pp. 1-5). IEEE.

[23] Rehman, O., Zhuang, H., Muhamed Ali, A., Ibrahim, A. and Li, Z., 2019. Validation of miRNAs as breast cancer biomarkers with a machine learning approach. *Cancers*, *11*(3), p.431.

[24] Shafique, S. and Tehsin, S., 2018. Acute lymphoblastic leukemia detection and classification of its subtypes using pre-trained deep convolutional neural networks. *Technology in cancer research & treatment*, *17*, p.1533033818802789.

[25] Shekar, B.H. and Dagnew, G., 2019, February. Grid search-based hyperparameter tuning and classification of microarray cancer data. In *2019 second international conference on advanced computational and communication paradigms (ICACCP)* (pp. 1-8). IEEE.

[26] Thanh, T.T.P., Vununu, C., Atoev, S., Lee, S.H. and Kwon, K.R., 2018. Leukemia blood cell image classification using convolutional neural network. *International Journal of Computer Theory and Engineering*, *10*(2), pp.54-58.

[27] Visaggi, P., Barberio, B., Ghisa, M., Ribolsi, M., Savarino, V., Fassan, M., Valmasoni, M., Marchi, S., de Bortoli, N. and Savarino, E., 2021. Modern diagnosis of early esophageal cancer: from blood biomarkers to advanced endoscopy and artificial intelligence. *Cancers*, *13*(13), p.3162.

[28] Vougas, K., Sakellaropoulos, T., Kotsinas, A., Foukas, G.R.P., Ntargaras, A., Koinis, F., Polyzos, A., Myrianthopoulos, V., Zhou, H., Narang, S. and Georgoulias, V., 2019. Machine learning and data mining frameworks for predicting drug response in cancer: An overview and a novel in silico screening process based on association rule mining. *Pharmacology & therapeutics*, *203*, p.107395. 9

[29] Wu, J., Zhang, P., Zhang, L., Meng, W., Li, J., Tong, C., Li, Y., Cai, J., Yang, Z., Zhu, J. and Zhao, M., 2020. Rapid and accurate identification of COVID-19 infection through machine learning based on clinically available blood test results. *MedRxiv*.