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A systematic review of the applications of artificial intelligence in autoimmune diseases

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Abstract-

The purpose of this study is to present an overview of how artificial intelligence (AI) might be utilized to solve health problems caused by autoimmune illnesses. More than 80 kinds of autoimmune disorders impact a wide array of areas of the body. Diagnosis may sometimes be challenging since these symptoms might mimic those of other more prevalent diseases. Autoimmune system diseases are characterized by either unusually low or excessive immune system activities [1]. When the immune system becomes too active, the body fights and destroys its tissues. Immune deficiency disorders weaken the body's capacity to combat intruders and make infection vulnerable. The immune system may produce antibodies in reaction to an unexpected cause, which targets their tissues rather than combat infection. In general, autoimmune disorders are treated by decreasing immune system activation [1]. In the last decade, the treatment plan for self-immune illnesses has changed significantly, leading mainly from precision medicine to precise health and from precise efforts in the healthcare system [1,2]. To comprehend and apply these methods pragmatically, the motivations, gaps, and limits of precision medicine need to be understood. The importance of earning the confidence of the people and patients cannot be overstated, but it is important to recognize that innovations like artificial intelligence still necessitate context, which can only be made available by human intervention, or what is known as augmented machine learning.

Keywords*: Artificial Intelligence, Autoimmune diseases, Biomarkers, machine learning, genetics, genomes*

I. INTRODUCTION

Autoimmune disorders are severe, complex ailments that affect multiple organ systems. Machine learning (ML), a subset of the larger subject of artificial intelligence, helps in identifying patterns from medical data and use these methods to identify health outcomes, allowing for more accurate clinical decision-making [2]. The purpose of this paper was to review the application of artificial intelligence techniques to solve clinical issues in autoimmune illness. The genetic predisposition, environmental variables, and dysregulation of immune systems have three components in understanding the role in autoimmune disease diagnosis [2]. Due to the variability of autoimmune disease development and development, diagnosis and prognosis are uncertain. Genetic susceptibility to autoimmunity is produced by abnormalities in genes that lead to the loss of self-tolerance. Autoimmune illness occurs as a result of additional deregulation of the immune system, including the innate and adaptive immune responses. It may be caused by microbial or external antigens, as well as cytokine dysregulation [3]. Furthermore, hyperactivation of T and B cells, as well as changes in the frequency and nature of their response, may occur, further disrupting the immunological system's homeostasis and causing further damage. Autoimmune disease prevalence is hard to quantify; various research varies in disease representation and there is no comprehensive list. It is estimated that the prevalence rate for all autoimmune illnesses is between 4.5 and 9.4 percent, depending on the specific condition.

II. PROBLEM STATEMENT

The main problem that this paper will try to solve is to review how artificial intelligence plays a critical role in detecting and diagnosing autoimmune diseases. Autoimmune diseases are characterized by a wide range of complex symptoms, making them notoriously difficult to diagnose. Modern diagnostic procedures are frequently intrusive, unpleasant, and subject to subjective evaluation. Furthermore, the underlying processes of many illnesses are not well known. A patient's immune cell repertoire can be profiled by genetic sequencing, which can be done in patients with autoimmune illnesses [4]. The ability to compare these repertoires to those of healthy individuals has enormous promise for enhancing our knowledge of the immune system. These datasets, on the other hand, pose an analytical difficulty because they contain a large number of highly varied genomes for every patient, with as low as 1 percent of sequences appearing in more than one individual in each dataset.

III. LITERATURE REVIEW

A. Artificial intelligence.

With artificial intelligence, machines, particularly computer systems, are used to simulate human cognitive processes. Computer algorithms, speech recognition, biometrics, and motion detection are just a few of the applications of artificial intelligence that exist. As the buzz surrounding artificial intelligence has grown, providers have been rushing to highlight how their goods and services make use of artificial intelligence [4]. This term "AI" is often used about a single application of AI, like machine learning, which is not always true. For machine learning algorithms to be written and trained, a groundwork of sophisticated hardware

and software is required. Though no one computer program is associated with artificial intelligence, some of the most often used ones include Python, R, and Java. AI systems generally operate by taking in huge quantities of labeled training data, evaluating the information on associations and trends, and making forecasts of future actions using these patterns [5]. By evaluating millions of instances, a chatbot that is given instances of text conversations may learn to create realistic interactions with humans, or an image recognition program can be trained to compare and contrast features in pictures by analyzing millions of examples. Artificial intelligence development is centered on three cognition: learning, reasoning, and self-correction. Collecting data and developing protocols for how to convert it into usable knowledge are the primary objectives of this area of artificial intelligence (AI). These instructions, which are referred to as algorithms, are used to give computer equipment step-by-step commands on how to accomplish a certain operation [5].

B. The need for artificial intelligence

In the absence of interpretive tools, combined clinical and genomic data have little value. When faced with a large amount of data, artificial intelligence methods have the potential to uncover clinically significant patterns, thereby meeting an existing demand [6]. With the capacity to classify patients based on this information, it is possible to improve their whole care, from risk assessment through diagnosis, early and continuing therapy to tracking response to therapy and prognosis [7].

Fig I; Dominant variables for AI in healthcare.

C. AI and autoimmune disease

To provide information on the present state of the use of artificial intelligence techniques to autoimmune illness to enhance patient treatment, this comprehensive review has been conducted to gather information. According to the researchers' best knowledge, this is the first study to be conducted on this subject [7]. There are many techniques, data, and applications discussed in this study. There are also problems surrounding this fascinating multidisciplinary approach and potential prospects discussed in this review as well.

D. Application of AI in Autoimmune diseases

The applications for artificial intelligence in autoimmune diseases may be categorized into six key subjects: identification of patients, risk assessment, diagnosis, categorization of subtypes of illnesses, progression of disease and outcomes, and monitoring [8].

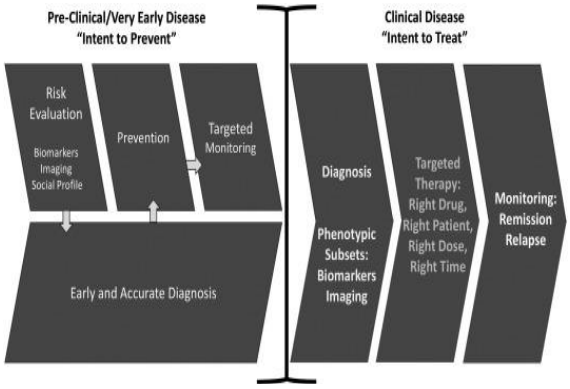

Fig ii: Precision medicine diagnosis and components

1. Identification of patients

Autoimmune illness studies use machine learning techniques and speech recognition to identify people with autoimmune disorders from electronic medical data [9]. Such techniques are developed to accommodate International Classification of Diseases billing codes, which have human errors ranging between 17.1 and 76.9 percent as a result of inconsistency in the language used [9,10]. With the use of language modeling, electronic health records were able to identify comorbidities linked with both alopecia and vitiligo. This revealed that both illnesses were affected by autoimmune diseases.

2. Identifying and assessing autoimmune disease risk

Autoimmune disorders have always been associated with the predictions of illness risk and the discovery of new risk variables via feature selection. GWAS and exome data (nine studies) are used in the majority of the research, as are single SNPs inside HLA areas or pre-selected genes, and biomarkers are used in the majority of the studies as well [10]. In just one research, medical studies were included, while in others, clinical and genetic data were used in conjunction. Logistic regression, support vector machine, and random forest are some of the most often used models in data analysis.

3. Diagnosis

The most common use of artificial intelligence is a patient diagnosis where the process is utilized across all autoimmune disorders [11]. The objective of the autoimmune investigations is to distinguish patients from control subjects. Approaches of diagnostic classification include individuals with several other autoimmune illnesses as controls, to distinguish between overlapped disorders or similar symptoms or phenotypes, such as celiac stratification and irritating bowel syndrome, or the categorization of numerous autoimmune diseases [11]. Studies explicitly targeted ML for early diagnosis of the later onset degenerative diseases like MS and RA. Random forests and support vector machines are the two algorithms that are most often used in practice [11].

4. Classifying disease subtypes

AI is used to categorize disease subgroups and research. These researches use three kinds of uncontrolled clustering: hierarchic clustering to detect new subgroups of autoimmune illness; consensus clustering to detect high, low, and mixed RA inflammatory responses; and agglomerate hierarchical clustering to genetic signature cluster MS [11]. The research makes use of support vector machines, a widely used supervised technique in particular, and also the random forest. There are large variations in the kinds of data utilized. In addition, MRI and genetic information (including RNA sequencing and gene expression) are among the sources [12].

5. Disease progression and outcome

Immunodeficiency illness research focuses on the course and outcomes of the disease. Disease progression, treatment response, and survival prognosis are among the other factors taken into consideration. Other models are geared at improving picture segmentation to assist in the prediction of the prognostic factors [12,13]. The next most often encountered topic in model building is disease progression and outcomes. Random forest, support vector machines, and neural networks have been the most frequently used models throughout the study. The vast bulk of the data utilized was clinical, with just a few studies including 'omic information.'

6. Monitoring

Diverse studies of an autoimmune disease such as type 1 diabetes (T1D) employ machine learning to monitor and manage predicted blood glucose levels, identify or predict hypoglycaemic incidents, and support decision-making through the use of case-based rationale or predictive analytics, among other things [13]. Clinician-generated data was utilized in the bulk of the models. Movement monitoring approaches for multiple sclerosis (MS) and rheumatoid arthritis (RA) were created utilizing activity measures. It is most common to use support vector regression.

E. Applications of AI in rheumatology imaging

The aim to create and use AI in diagnostic devices is stated in most papers following the same pattern [14]. In certain cases, automation is preferable to visual scoring since it is less costly and time-intensive, and requires less thorough training and/or specialized examiner abilities. Its objective is particularly important in clinical studies in which minor alterations or therapeutic strategies are anticipated to be properly identified. Additionally, automation may result in more precise measures than visual scoring, since a computer algorithm is more constant and less overwhelmed by extraneous photographic images [14,15]. Nevertheless, in certain cases, an automated quantified alternative to visual scoring but a single evaluation since the modalities of imaging is inherently quantifiable for instance CT densitometry or in compositional MRI [16]. The same would be true when an automated approach quantifies characteristics that are difficult or even impossible to evaluate manually due to the sheer volume of visual input or drawbacks in the visual perception, such as problems recognizing small changes in absolute intensity.

IV. FUTURE OF RESEARCH

In this review, it can be shown that the future uses mainly of AI features in autoimmune diseases is getting a lot of attention. The United States is always a benchmark when it comes to the adoption of AI in health and other sectors. Artificial intelligence applications in autoimmune disorders are scarce, although this is quickly increasing in the U.S. Radiologists and rheumatologists in the United States were until recently interpreters of rheumatological clinical pictures. Their ease of storing and transmitting data alone made these images digital. Neural networks have, nevertheless, recently begun to exceed human visual interpretation in extremely specialized tasks [17]. But AI is not likely to replace human beings since it is far more difficult to generalize computer image interpretation than in extremely specialized fields of expertise. A more probable possibility is the creation of a hybrid system that incorporates both machine and intelligent systems [17]. As people are less able to analyze huge quantities of data sets, AI will significantly minimize dimensionality or patterns which are not evident to the human eye and brain. This is particularly true if picture data are coupled with other medical data to produce even more data analytics not just using human power [17,18]. Making predictions of AI is enticing, but challenging because, given the numerous setbacks that AI has encountered throughout its evolution, the time scale at which advancements occur is extremely difficult to predict. Since AI overestimations are lurking, we must be cautious and conscious of the disadvantages and limits of AI and in-depth education.

V. ECONOMIC BENEFITS

Many see AI as a motor of productivity and economic development. It may enhance efficiency and improve the decision-making process considerably by analyzing huge quantities of data. It may also generate new goods, services, markets, and industries, increase consumer demand and provide new sources of income. To improve medical standards and establish companies for medical manufacturers, the continuing use of AI for autoimmune illnesses is commercially feasible for the US. Robotics that use AI skills to diagnose autoimmune disorders are very popular worldwide. The sending of these goods to other nations will be of economic advantage to the United States. AI is creating a new virtual workforce called 'intelligent automation,' able to solve issues and learn by themselves. Third, the economy will also profit from the spread of innovation that will impact many industries and generate new income sources [18]. The beneficial impacts of AI on employment, productivity, and GDP are both direct and indirect. Increased income and jobs in American companies and sectors developing or manufacturing AI technology to anticipate autoimmune illnesses will have a direct impact, which may also create whole new economic activity. Indirect productivity increases in AI sectors are expected to optimize health practices and decision-making, as well as improve their understanding and access to information. Over the following decade, they anticipate considerably more moderate increases.

VI. CONCLUSION

The purpose of this study was to investigate how AI works to detect and diagnose autoimmune disorders. The results from this study reveal that over the past few years, health care has seen enormous developments, such as advanced new technologies like electronic medical records, telehealth, virtual consultations, smartwatches and advanced analysis techniques like artificial intelligence (AI) integrate big data. After many decades of fundamental study, artificial intelligence (AI) has achieved major advances that allow computer systems to perform human interpretation of medical pictures in highly specialized fields. Following this shock wave, which arguably exceeded the effect of the world chess champion's first AI triumph in 1997, some thought maybe warranted on the implications for rheumatology clinic imaging. This narrative review provides a brief introduction of the different AI methods, especially 'machine learning,' and the application of these to rheumatoid imaging, focused on rheumatoid arthritis and systemic sclerosis. This study seeks to provide an understanding of potential prospects of Artificial intelligence in rheumatism by addressing the main constraints of AI and deep learning.

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