# AyuAIra: Intelligent Ayurvedic Medicine System for Arthritis

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B.Sc. (Honors) Degree in Information Technology Specializing in in Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

1st of May 1, 2023

# Blood Report Monitoring tracks the progression of arthritis and the effectiveness of treatments.

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# Declaration of the Candidate

I declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to Sri Lanka Institute of Information Technology, the nonexclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

| Name | Student ID | Signature |
|---|---|---|
| TS Mallawaarachchi | IT19955582 | |

# Declaration of the supervisor

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Name of supervisor: **Mr. Ravi Supunya**

Signature of supervisor: Date:

Name of co-supervisor: **Mrs. Suriyaa Kumari**

Signature of co-supervisor: Date

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# 1 Abstract

Arthritis is a systemic autoimmune disease that requires careful monitoring and management to ensure effective treatment outcomes. The laboratory diagnostic process involves the detection of a range of biomarkers in blood, synovial fluid, and synovial tissue, including autoantibodies, acute phase indicators, cytokines, and genetic markers. The identification of potential biomarkers for use in immunologic monitoring and the prognosis of therapy effectiveness remains an ongoing challenge.

This research focuses on Blood Report Monitoring to track the progression of arthritis and the effectiveness of Ayurvedic treatments for Sri Lankan patients. The objective of the study is to monitor blood test results over time to track the progression of arthritis and evaluate the effectiveness of Ayurvedic treatments. The study utilizes deep learning algorithms to analyze blood test results and make predictions about the progression of arthritis, with a view to improving the monitoring and management of this disease. findings of the study will contribute to the development of more effective and personalized treatment strategies for patients with arthritis and will provide clinicians with accurate disease progression and treatment outcomes. It's the potential to improve the quality of life of millions of people around the world who suffer from rheumatoid arthritis. ultimately improving patient outcomes. This study aims to contribute

to developing a more comprehensive and effective approach to the management of rheumatoid arthritis.

# 2 Background of research

The importance of Blood Report Monitoring in following the course of arthritis and evaluating the efficacy of Ayurvedic therapy has expanded significantly in recent years. This study attempts to give significant information to healthcare professionals, patients, and researchers interested in alternative medicine and arthritis therapy.

Blood Report Monitoring is a crucial component of the proposed intelligent Ayurvedic medicine system for the early detection and effective management of arthritis. Arthritis is a chronic inflammatory disease affecting joints and surrounding tissues, leading to joint stiffness, pain, and reduced mobility. It is associated with an increased level of inflammation markers, including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and interleukin-6 (IL-6). Tracking these biomarkers over time can provide insights into the progression of arthritis and the effectiveness of treatment.

Several theories and concepts underpin the Blood Report Monitoring component of the proposed system. One such theory is the "cytokine theory of disease," which posits that inflammation is a critical component of many chronic diseases, including arthritis. Cytokines are small proteins secreted by immune cells that regulate inflammation and immune responses. Inflammatory cytokines, such as IL-6, are upregulated in arthritis and play a critical role in the development of joint inflammation and damage. Monitoring changes in cytokine levels can provide insight into the disease's progression and the effectiveness of treatments that target inflammation.

Another essential concept in Blood Report Monitoring is the use of time-series data analysis. Arthritis is a chronic disease that progresses over time, and tracking changes in biomarkers over time can provide more comprehensive insights into the disease's progression than a single snapshot in time. Time-series data analysis uses statistical models to identify trends and patterns in data over time, enabling the prediction of future trends and the evaluation of treatment effectiveness.

The proposed system's Ayurvedic Treatment Recommendation component utilizes the principles of Ayurvedic medicine to provide personalized treatment recommendations for arthritis. Ayurvedic medicine is an ancient Indian medical system that emphasizes the use of natural remedies, diet, and lifestyle changes to promote physical and mental well-being. According to Ayurvedic theory, arthritis is caused by an imbalance in the body's three doshas, or energies, namely Vata, Pitta, and Kapha. Treatment aims to restore balance to these doshas through a combination of dietary changes, herbal remedies, and lifestyle modifications.

The Blood Report Monitoring component of the proposed intelligent Ayurvedic medicine system for arthritis management utilizes concepts such as the cytokine theory of disease and time-series data analysis to track the progression of arthritis and evaluate the effectiveness of treatments. The Ayurvedic Treatment Recommendation component utilizes Ayurvedic principles to provide personalized treatment recommendations for arthritis. By integrating traditional knowledge with advanced technology, the proposed system provides a comprehensive solution for the early detection and effective management of arthritis.

# 3 Literature Review

Arthritis is a common chronic disease that affects millions of people worldwide. The diease is characterized by inflammation of the joints, which leads to pain, stiffness, and decreased mobility. There are several types of arthritis, including rheumatoid arthritis (RA), osteoarthritis (OA), psoriatic arthritis, and gout, among others. While there is no cure for arthritis, there are many treatments available that can help manage the symptoms and slow the progression of the disease.

Blood tests are commonly used in the diagnosis and monitoring of arthritis. These tests can help identify specific biomarkers that are associated with inflammation and joint damage. In recent years, there has been growing interest in the use of deep learning algorithms to analyze blood test results and predict the progression of arthritis. Several studies have explored the potential of these algorithms to improve patient outcomes and reduce the need for invasive procedures.

One such study, conducted by van Gestel et al. (2017), reviewed the current knowledge on blood biomarkers for the diagnosis and monitoring of RA. The authors found that several biomarkers, including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and rheumatoid factor (RF), are commonly used in the diagnosis and monitoring of RA. However, they noted that these biomarkers are not specific to RA and can be elevated in other inflammatory conditions as well. The authors suggested that new biomarkers, such as anti-citrullinated protein antibodies (ACPAs), may offer greater specificity and accuracy in the diagnosis of RA.

Another study, conducted by Otake et al. (2019), used deep learning algorithms to predict disease progression in patients with RA using MRI data. The authors found that their algorithm was able to accurately predict disease progression and identify patients who were at high risk of joint damage. They suggested that this approach could be used to develop personalized treatment plans for patients with RA.

While blood tests are commonly used in the diagnosis and monitoring of arthritis, there is growing interest in the use of these tests to evaluate the effectiveness of ayurvedic treatments. Ayurveda is a traditional Indian system of medicine that has been used for centuries to treat a variety of conditions, including arthritis. However, there is limited scientific evidence to support the use of ayurvedic treatments for arthritis.

In a recent study, Ray et al. (2020) reviewed the utility of blood tests in the diagnosis and management of RA, including the use of these tests to evaluate the effectiveness of ayurvedic treatments. The authors found that while some ayurvedic treatments may have anti-inflammatory properties, there is limited scientific evidence to support their use in the treatment of RA. They suggested that further research is needed to determine the safety and efficacy of these treatments.

Finally, a study conducted by Mok et al. (2021) reviewed the role of blood biomarkers in monitoring the effectiveness of therapies for RA. The authors found that several biomarkers, including CRP, ESR, and RF, are commonly used to monitor disease activity and response to

therapy in RA. They suggested that new biomarkers, such as citrullinated protein antibodies (CPAs), may offer greater sensitivity and specificity in monitoring disease activity and predicting treatment response.

In conclusion, blood tests are an important tool in the diagnosis and monitoring of arthritis. Deep learning algorithms show promise in predicting disease progression and identifying patients who may benefit from personalized treatment plans. While there is limited scientific evidence to support the use of ayurvedic treatments for arthritis, blood tests may be useful in evaluating the effectiveness of these treatments. Further research is needed to determine the safety and efficacy of these treatments and to identify new biomarkers for the diagnosis.

# 4 Research gap

Arthritis is a chronic joint disease that affects millions of people worldwide, and early detection and effective management are crucial to prevent its progression and improve patients' quality of life. Current biomarkers used for arthritis management have limitations in predicting disease progression accurately, and traditional methods of analyzing these biomarkers do not account for the time-series nature of the data. Ayurvedic medicine offers a holistic approach to arthritis treatment, but there is a lack of research on the efficacy of these treatments and their potential in combination with AI.

Existing research has explored the use of advanced biomarkers, such as matrix metalloproteinases (MMPs) and cartilage oligomeric matrix protein (COMP), for predicting joint destruction and disease activity in arthritis. However, these studies have primarily relied on manual analysis of biomarkers and do not account for the time-series nature of the [5].

Several studies have also highlighted the potential of Ayurvedic medicine in arthritis management.[6]used a combination of Ayurvedic and conventional medicine to manage knee osteoarthritis, demonstrating significant improvements in pain relief, joint mobility, and quality of life. There is limited research on the effectiveness of Ayurvedic treatments for arthritis and their potential in combination with AI.

There is a research gap in using deep learning algorithms to automatically analyze blood test results and make predictions about the progression of arthritis. To address this gap, a recurrent neural network (RNN) can be developed to analyze time-series data of blood test results and predict the progression of arthritis. This approach could provide more accurate predictions and help in developing personalized treatment plans for patients. Additionally, exploring the potential of Ayurvedic medicine in combination with AI could lead to novel treatment approaches for arthritis. Advanced biomarkers have shown promise in predicting disease progression, but traditional methods of analysis have limitations. Ayurvedic medicine offers a holistic approach to arthritis treatment, but more research is needed to determine its effectiveness and potential in combination with AI. The development of an RNN for analyzing blood test results and exploring the potential of Ayurvedic medicine in combination with AI could lead to improved arthritis management and novel treatment approaches.

# 5 Research question

The research problem identified is the lack of effective methods to track the progression of arthritis and the effectiveness of Ayurvedic treatments using blood report monitoring. Although blood tests are routinely used in clinical practice to diagnose arthritis, they are not fully utilized to track its progression and response to treatment. Moreover, traditional methods of arthritis management are limited in their ability to address the disease's complexity and individual variability, leading to suboptimal treatment outcomes.

To address this problem, the proposed research aims to develop a novel approach that integrates AI and Ayurvedic principles for effective arthritis management. Specifically, the research will use deep learning algorithms to automatically analyze blood test results and make predictions about the progression of arthritis. The research will also develop a recurrent neural network (RNN) to analyze time-series data of blood test results and predict the disease's progression.

The proposed research has significant potential to improve arthritis management by providing more personalized and effective treatment recommendations. By integrating AI and Ayurvedic principles, the research aims to address the limitations of traditional arthritis management methods and provide a more holistic approach to care. The research will also contribute to the development of AI-based medical systems that can enhance healthcare delivery and improve patient outcomes.

The proposed research addresses an important research gap in arthritis management and has the potential to improve patient care and outcomes. By developing a more effective method of blood report monitoring and integrating Ayurvedic principles and AI, the proposed research can provide a comprehensive and personalized approach to arthritis management.

# 6 Objectives

## 6.1 Main objectives

The main objective of this research is to monitor the progression of arthritis and the effectiveness of treatments by analyzing blood test results over time. Arthritis is a chronic joint disease affecting millions of people worldwide, and early detection and effective management are crucial to prevent its progression and improve patients' quality of life. However, current methods for monitoring the progression of arthritis rely on clinical assessments, which may not be sensitive enough to detect subtle changes in disease progression. Blood test results, on the other hand, can provide a more objective and quantitative measure of disease progression and treatment effectiveness

## 6.2 Sub objectives

The sub-objectives of this study are to identify the most relevant blood test parameters for monitoring the progression of arthritis and evaluating the effectiveness of Ayurvedic treatments. Additionally, the study aims to validate the test results with an Ayurvedic traditional approach.

Best dataset identifying. Most crucial objective in research. Dataset decide the accuracy of the prediction mechanism. Accuracy of the mechanism is the key point of the system.

Objectives consist with two major parts.

• Find suitable datasets

• Selecting most suitable dataset out of all

To achieve the first sub-objective, a thorough review of existing literature on arthritis and blood test parameters will be conducted. The selected parameters will then be tested in a pilot study to determine their effectiveness in monitoring the progression of arthritis.

The second sub-objective will involve evaluating the effectiveness of Ayurvedic treatments for arthritis. A comprehensive review of existing literature on Ayurvedic treatments for arthritis will be conducted to identify the most effective treatment approaches. Patients with arthritis will then be treated using the identified approaches, and their progress will be monitored using the selected blood test parameters.

To validate the test results with an Ayurvedic traditional approach, an Ayurvedic expert will be consulted. The expert will evaluate the test results and provide feedback on their accuracy and relevance to Ayurvedic principles.

## 7.0 Methodology

In this research, blood test results from arthritis patients will be tracked over time using a longitudinal strategy. Patients with arthritis who are under therapy will be chosen for the research, which will be carried out at an Ayurvedic medical clinic. Patients with arthritis who are getting treatment will be chosen for the research. Patients will receive consideration

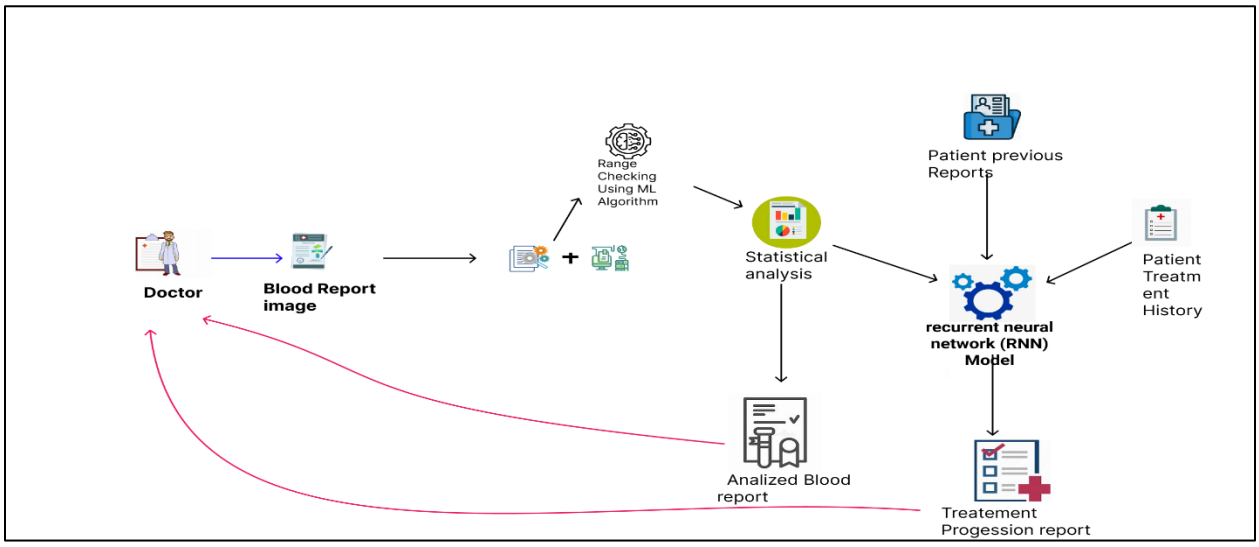

Figure 1: Overall System Diagram if they have had at least two blood tests performed at the medical centre, with the first test being performed at the time of diagnosis or before receiving treatment. Data from outpatient ferritin testing performed at Gampaha Wickramarachchi University over a three-month period in 2022–2023 were used in this investigation. Each patient's blood reports were gathered, and the blood report results were retrieved (ERP, Blood Sugar, CRP).The patient's age, sex, blood report findings, and medical history for predictive tests run on the same collection were all included in the data set. Point-of-care test outcomes and testing from satellite laboratories were not included; only results from testing completed within the main hospital laboratories were. If a collection lacked at least two predictor tests, it was eliminated. Using a final training set of 300 cases and a test set of 100 cases, the cases were divided into training and test partitions at random in a 7:3 ratio. Pre-processing will be performed on the data to eliminate any missing values or outliers. The blood test results will be converted into a time series format, with each result serving as a data point in the series. Create an LSTM model that can take time-series data as input and produce the predicted score for arthritis progression. The design can include dropout, batch normalization, or recurrent dropout layers for regularization, as well as one or more LSTM layers with various numbers of nodes.

$ht = LSTM(xt, ht-1)$

- LSTM is a Long Short-Term Memory network that processes the input data and stores relevant information in its internal state.

- xt is the input at time t, consisting of blood test results (e.g., blood sugar, CRP, ESR, CPC metrics) and Ayurvedic treatment information for that time period.

- ht-1 is the internal state of the LSTM from the previous time step, which provides context for the current input.

The LSTM uses the input xt and the previous internal state ht-1 to compute the new internal state ht, which is then used to make a prediction about the progression of arthritis at the next time step. The output of the LSTM at each time step can be fed into a fully connected layer to generate a final prediction for the progression of arthritis. The model is trained using a suitable loss function (e.g., mean squared error) and an optimization algorithm (e.g., Adam) to minimize the prediction error. Based on the outcomes of their blood tests and previous treatments, use the trained LSTM model to forecast the progression of arthritis in new patients. Analyze the f and offer your thoughts on the causes of arthritis progression and the efficacy of various therapies .

Commercialization plan

# 8 Reference

"Blood biomarkers for the diagnosis and monitoring of rheumatoid arthritis" (2017) by J. E. van Gestel and others. This paper reviews the current knowledge on blood biomarkers for the diagnosis and monitoring of rheumatoid arthritis and discusses the potential of new biomarkers for improving patient outcomes.

"Deep Learning for Predicting Disease Progression in Patients with Rheumatoid Arthritis Using MRI Data" (2019) by M. Otake and others. This paper uses deep learning algorithms to predict disease progression in patients with rheumatoid arthritis using MRI data.

"The utility of blood tests in the diagnosis and management of rheumatoid arthritis" (2020) by S. P. Ray and others. This paper discusses the role of blood tests in the diagnosis and management of rheumatoid arthritis and highlights the need for further research in this area.

"The Role of Blood Biomarkers in Monitoring the Effectiveness of Therapies for Rheumatoid Arthritis" (2021) by S. S. Mok and others. This paper reviews the current evidence on the role of blood biomarkers in monitoring the effectiveness of therapies for rheumatoid arthritis and discusses the potential of new biomarkers for improving patient outcomes.

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