

Expert System for Diagnosing Gout and Cholesterol Using Forward Chaining Method

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Abstract — This study aims to address challenges in gout and cholesterol diagnostic services at Puskesmas Elly Oyu, South Jayapura, which faces significant working time and patient limitations. With only 4 medical personnel, this study proposes the use of forward chaining methods in expert systems to improve the quality of diagnosis at an affordable cost. This method allows combining factors and evidence with appropriate levels of confidence, managing uncertainty in medical diagnoses. Observations and projections show an increase in the number of patients, and with forward chaining methods, diagnosis becomes more accurate, providing a solid basis for effective intervention planning, especially in the elderly group. Furthermore, this study designed a website-based system to detect early symptoms of early childhood delay in the disease. This approach aims to ease awareness of the importance of 4 healthy 5 perfect and prevent delays in diagnosis. Waterfall development and structured design methods are used to build systems with structured stages of analysis, design, coding, and testing. Using the blackbox test method, the sustainability of the system's functionality is emphasized without regard to the details of the internal implementation. This development is expected to provide an efficient, accurate, and affordable solution in diagnosing gout and cholesterol at the Elly Oyu Health Center.

Keywords: Expert_System, Forward_Chaining, Uric_Acid and Cholesterol

I. INTRODUCTION

In this modern era, technology has developed very quickly allowing humans to carry out various activities more easily. Technology can now do anything that humans can't imagine[1].

In this section, we will discuss problems that often occur at the Elly Oyu Health Center Jl. Ardiapura Raya, South Jayapura District, Jayapura City, Papua. Puskesmas service hours start from 07.00 to 10.30 This puskesmas serves people in the South Jayapura area and its surroundings. One of the services provided by the Elly Uyo Health Center is the disease diagnosis service. One of the services available at the Elly Uyo Health Center is gout and cholesterol at the Elly Health Center UYO serves about 50 to 100 patients a day for 6 working days. Elly Uyo Health Center is usually done by doctors by asking the symptoms experienced by patients. Based on the results of an interview with dr. Yunita SKEP. M.S., in 2023 patients diagnosed with gout and cholesterol at the age of 20-44 years are 32 men, 101 women, adults 55-69 years, 75 men and 113 women, and a total of 663 patients from January to December 2023. For 2024, there are 82 20-44 years old, 82 for women, 123 for women, and 100 for adults 55-69 years old, 100 for 249 women, for a total of 554 patients in January. Based on the results of *observations* made at the Elly Uyo Health Center, the number of patients in one week ranges from 25 – 40 for 1 week patients with gout and cholesterol. This is due to the general public's ignorance of gout and cholesterol which is a lack of awareness of early symptoms. With many patients and limited working time owned by Tenga Medis, it consists of 4 medical personnel, 2

doctors and 2 *assistants* Therefore, a more efficient diagnostic method is needed and can be done at a cost that is not so large.

Method *forward chaining* is a decision or inference of new information based on the facts of the diagnosis of gout and cholesterol. Method *forward chaining* Allows expert systems to combine various factors and evidence with appropriate levels of confidence, so that diagnosis results can be more accurate and reliable, methods *forward chaining* help manage the uncertainty often associated with medical diagnoses, which can stem from a variety of factors such as differences in *Clinical data* or available evidence[2][3]. Thus, in the context of gout and cholesterol, where many factors can contribute to the use of methods *forward chaining* It can strengthen the quality of diagnosis and help design more effective interventions to treat gout and cholesterol in the elderly.

Thus, in the context of gout and cholesterol disease, where many factors can *be conducted*, the use of *forward chaining* methods can strengthen the quality of diagnosis and help design effective interventions to treat gout and cholesterol. Based on these problems, a website-based system will be developed to detect early symptoms of early age delay. The measures are intended to ease awareness of the importance of 4 healthy 5 perfect as well as prevent delays since then. The development method used in this research uses the waterfall development method with stages of system requirements analysis, system design, coding and testing while for the design method that uses *structured design*. The test method used uses the *blackbox test method*.

II. RESEARCH METHODS

2.1 Research Flow

The data analysis of this study contains current systems, functionality needs, and non-functionality needs. Analysis using the waterfall method which is at the design stage until management is carried out in stages, and data analysis aims to make readers understand and understand directly.

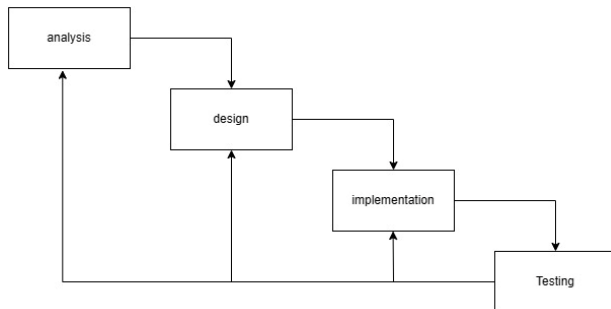


Figure 1. Research Flow[4]

1. System Analysis

At this stage of analysis, it was carried out to determine the need for software to detect symptoms of gout and cholesterol in patients at the Elly Uyo Health Center Jl. Ardipura Raya, Ardipura, South Jayapura District, Jayapura City Papua. By conducting interviews, discussions, *observations*, and *surveys*.

2. System Design

At this design stage, the system is designed to determine *the software* and *hardware* to be used. *Context Diagrams*, *Cascading Diagrams*, *Overview Diagrams*, in addition, *Flowchat database design* can be done using *Entity Relationship Diagrams* (ERDs).

3. Implementation

The implementation of this expert system will use PHP *programming* language to implement the design of the information system built, then use *Mysql* as *database management*.

4. Testing

The system test will be presented to ensure good quality so as to identify and fix *bugs* or problems, which are found during testing testing methods using *blackbox*.

2.2 Uric Acid and Cholesterol

Uric acid is a substance produced by the body when *Purines* Broken down. Purines are compounds found in some foods and are also produced naturally by the body. Cholesterol is a type of fat found in the blood and is an important component of the body's cells and is used to produce certain hormones and vitamins. Both uric acid and cholesterol are important components for

a healthy body, but unbalanced levels of both can lead to serious health problems. Therefore, it is important to maintain a healthy diet, exercise regularly, and undergo regular health check-ups to monitor uric acid and cholesterol levels in the blood[5].

2.3 Forward Chaining

One of the methods of reasoning and functioning as a decision-making machine (*Inference*) with the aim of finding one from *antecedent* or postulate the hypothesis of the rule *IF-THEN*. If there are facts that match the statement (*IF*), then (*Then*) the rule is executed as a new fact and added[6].

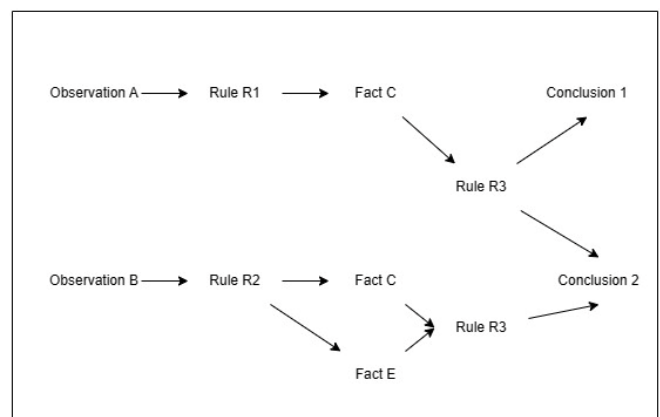


Figure 2. Forward Chaining[7]

2.4 Expert System

One branch of artificial intelligence known as expert systems is "making computers think like humans". When a system passes the tested test, it is considered a powerful artificial intelligence. The term "strong" is used because strong artificial intelligence should be based on a strong logical foundation rather than what is referred to as weak artificial intelligence, i.e. networks. An excellent application of artificial intelligence is an expert system[2][8].

2.5 Context Diagram

A context diagram is a type of diagram in system modeling techniques used to provide a high-level visual picture of how a system interacts with outside entities. It helps in understanding the context in which the system operates without paying attention to its internal details. A context diagram consists primarily of one main entity, the system itself, and the outside entities that interact with that system[9].

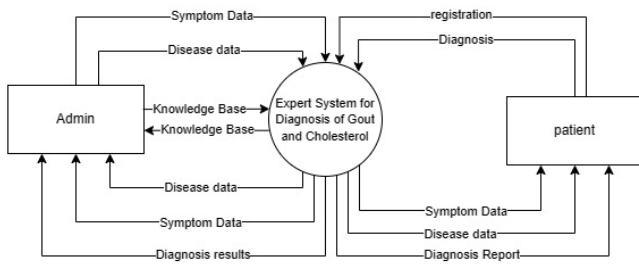


Figure 3. Context Diagram

2.6 Data Flow Diagram (DFD)

A diagram used to show the steps or processes that occur in the system being designed. Using a DFD model, the data flows involved can be easily identified. DFD models typically start with context diagrams, cascading diagrams, level 1 diagrams, and so on up to detailed diagrams. The model is also adapted to the level of complexity of the developed system[10].

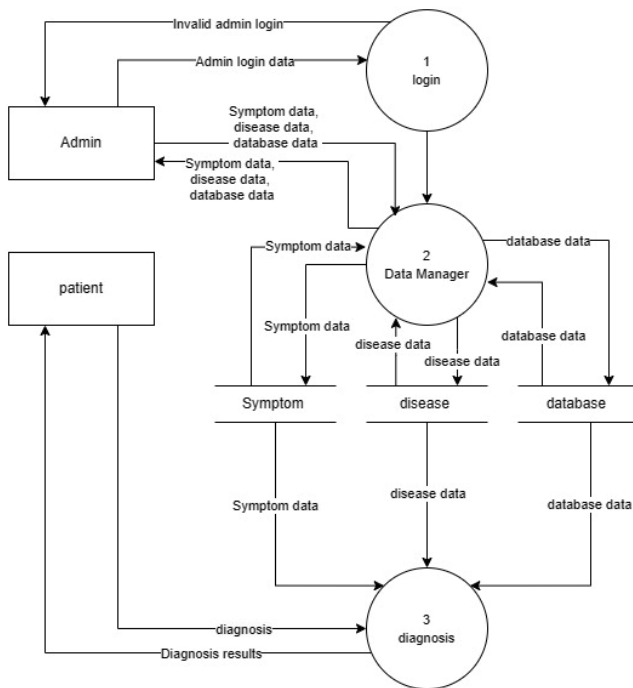


Figure 4. Data Flow Diagram

2.7 Entity Relationship Diagram (ERD)

ERD can be used to describe relationships between entities in a database, facilitate the development of database systems, and can also be used for debugging databases in case of problems with the database[3].

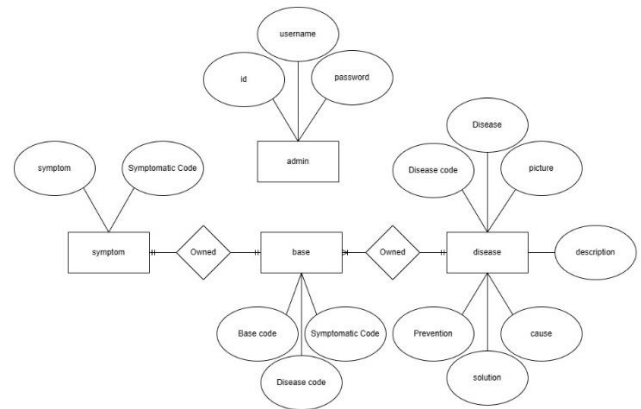


Figure 5. Entity Relationship Diagram

III. RESULTS AND ANALYSIS

3.1 List of Diseases and Symptoms

After the data obtained from experts, it is then mapped based on and symptoms, formulated in table 1.

Table 1. Diseases: Symptoms and Solutions

Disease	Symptom	Solution
Gout	1. Intense joint pain	1. Exercise regularly
	2. Long-term discomfort	2. Doctor's drug consumption
	3. Inflammation and redness	3. Consumption of foods high in vitamin C
	4. Limited range of motion	4. Drink plenty of water
	5. Complaints in the kidneys	5. Avoid foods high in purines
	6. The presence of swollen lumps	6. Avoid stress
	7. There is a lump around the eye (<i>Xanthoma</i>)	
Cholesterol	1. Often feel sleepy	1. Vegetable and fruit consumption
	2. Pain in the shoulders to the neck to the head	2. Increase omega-3 food intake
	3. Experiencing stress	3. Consumption of low-fat foods
	4. Weight gain	4. Exercise regularly
	5. Easily tired	
	6. Chest pain	
	7. Pain in the legs	
	8. Loss of balance	

Table 1. Shows the relationship between the symptoms of the disease and the treatment solution that will be carried out on the results of the diagnosis of gout and cholesterol.

From the data or facts that have been grouped in table 1. Furthermore, the code is made to simplify the diagnosis process. The coding can be seen in table 2.

Table 2. Disease Code

Disease Code	Disease
K01	Gout
K02	Cholesterol

Table 2. is the provision of codes for the type of disease to facilitate the identification process of each diagnosed disease

After coding the disease, then coding the symptoms can be seen in table 3.

Table 3. Symptom Code

Symptom Code	Symptom
G1	Intense joint pain
G2	Long-term discomfort
G3	Inflammation and redness
G4	Limited range of motion
G5	Complaints in the kidneys
G6	The presence of swollen lumps
G7	There is a lump around the eye (xanthoma)
G8	Often feel sleepy
G9	Pain from shoulder to neck to head
G10	Experiencing Stress
G11	Weight Gain
G12	Easily Tired
G13	Chest pain
G14	Pain in the Legs
G15	Loss of balance

Table 3. is a code for the type to facilitate the process of identifying each selected symptom according to the conditions found in uric acid and cholesterol.

3.2 Inference Mechanism

The inference mechanism in this expert system works using rules that correspond to the forward chaining method, the logic used in this expert system can be seen in.

Table 4. Intake Mechanism

Symptom	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15
Rule	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0

Description: 1= Selected Symptoms 0= Symptoms Not selected.

Table 4. It is how the expert system works in diagnosing diseases in gout and cholesterol, using codes 0 and 1 which means that if symptoms are selected then the value is 1 while if not selected then the value is 0.

3.3 User Interface

The design of an expert system for diagnosing gout and cholesterol is made web-based with PHP programming language tools and Mysql databases[11]. Broadly speaking, this system consists of. User consultation menu, symptom input menu by admin, disease input menu, solution input menu. In consulting users or users need to input symptoms by checklisting symptoms in accordance with the conditions contained in gout and cholesterol that will be searched for diseases, can be seen in figure 4.



Figure 6. Symptom

Figure 4. Show what symptoms will be chosen by the user according to the characteristics of uric acid and cholesterol

The symptoms menu is useful for displaying symptoms found in gout and cholesterol. Users who will diagnose gout and cholesterol can input symptoms by checklisting symptoms that are appropriate for gout and cholesterol conditions. It can be seen in figure 5.



Figure 7. Symptom Selection

Figure 5. Is a selection of symptoms that have been selected by the user in accordance with the characteristics that affect uric acid and cholesterol.

Furthermore, the data that has been inputted will be used to analyze the condition of uric acid and cholesterol in accordance with expert rule, whose diagnosis results can be seen in figure 6.



Figure 8. Symptom Results

From the results of the diagnosis based on the symptoms that have been inputted by the user, the system displays some of the same diseases, based on the rules of the forward chaining method.

3.4 Output Testing Based on Experts

System testing aims to find out the expert system that has been designed can work in accordance with the design objectives

1) Blackbox Testing

Blackbox testing is a software testing method, by observing the results of execution through test data and paying attention to the functionality of the application or software[12]. In table 5, an overview of what has been done in software testing.

Table 5. Blakbox Testings

No	Test Scenarios	Expected results	Status
1	Clear all symptom options	The system cannot read and remains the same menu	Successful/valid
2	Fill in random symptom data that matches the symptoms that appear in gout and cholesterol	Displays the types of diseases that have a chance of diagnosis and is sorted from those with the most symptoms	Successful/valid
3	Have the type of symptoms that are owned by gout and certain cholesterol diseases and these symptoms are owned by other diseases	Will only show one disease according to the rule	Successful/valid

2) Output Testing Based on Experts

After designing and implementing the system, the step that needs to be done is to test the output of the system. Testing is carried out by providing symptoms according to the expert system and then consulted with experts to obtain a percentage of the correctness of symptom values that have been applied to the expert system, with the conclusion of analysis by experts. Table 6, testing was carried out 15 times different cases in the field.

Table 6. Test Results and Cross Check Between Systems and Experts

Case Name	Rule Case	System Results	Expert Results	Ket
Case 1	G1 G2 G3 G4 G5 G6 G7	Urate Asthma	Gout	True
Case 2	G8 G9 G10 G11 G12 G13 G14 G15	Choleterol	Choleterol	True

From the results of cross check between the system and experts, a match value of 15 different cases was obtained so that the percentage of accuracy was 94% from 16 attempts.

VI. CONCLUSION

The results of this study show that the use of forward chaining methods in the expert system can improve the quality of gout and cholesterol diagnoses at the Elly Oyu Health Center, South Jayapura, at an affordable cost. With only 4 medical personnel, the use of this method allows combining factors and evidence with appropriate levels of confidence, thus managing uncertainty in medical diagnosis. Observations and projections show an increase in the number of patients, and with the forward chaining method, diagnoses become more accurate, providing a solid basis for effective intervention planning, especially in the elderly group.

Furthermore, this study designed a website-based system to detect early symptoms of early childhood delay in the disease. This approach aims to ease awareness of the importance of 4 healthy 5 perfect and prevent delays in diagnosis. Waterfall development and structured design methods are used to build systems with structured stages of analysis, design, coding, and testing. Using the blackbox test method, the sustainability of the system's functionality is emphasized without regard to the details of the internal implementation. This development is expected to provide an efficient, accurate, and affordable solution in diagnosing gout and cholesterol at the Elly Oyu Health Center. As such, the study has important implications in improving health services in the region, especially in the face of challenges of limited working time and significant patient numbers.

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