Expert System for Diagnosis Skin Disease in Infants With Case-Based Reasoning Method

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Abstract— **Skin is the most vital for children under five years of age (infants) who are susceptible to the disease. The absence of a dermatologist or expert who can diagnose skin disease and offers the solution results in a long process of healing or cause a fatal condition to the patient. Overcoming of it, it is built an expert system that aims to diagnose skin disease in infants and to provide prevention and treatment solutions. This expert system is constructed by using Case-Based Reasoning (CBR), which calculates the similarity to select the cases that are most relevant or appropriate. This study uses the PHP programming language and MySQL as the database server. This expert system makes it easy to diagnose the disease. It can adapt easily and quickly because the knowledge is constructed from cases. As well, It's able to produce solutions for prevention and treatment based on symptoms experienced by the patient in accordance with the rules.**

Keywords-CBR; Expert System; Infants; Similarity; Skin.

I. INTRODUCTION

Information technology is growing rapidly. Communication that is connected to the internet using the world wide web (www) enables the exchange of information from one place to another quickly and helps the human in almost all fields of life, including in the health sector. Skin health needs to be considered because the skin is a vital part, considering the children under five years (infants) are susceptible to disease. When a skin health problem occurs, parents that do not understand health will trust more to doctors. The disadvantages of this condition are a limitation of working hours while many patients have to queue for treatment.

In this case, parents need an expert who can easily diagnose skin diseases at any time in order to make prevention early. Therefore, it's needed a tool for diagnosing skin diseases in infants as experts do it (expert system). Expert systems are systems that contain certain knowledge so everyone can use it to solve various specific problems [1].

This expert system uses the Case-Based Reasoning or CBR method. The basic idea of CBR is to solve a new problem by using available answers from previous problems [2]. The CBR method is easier to be implemented because CBR knowledge representation is made in the cases form so the process only looks for cases similar to the previous case to solve the problems.

II. METHODS

System development methods describe the sequences of work carried out in research. The steps taken are

A. Preliminary Study

1) Interview
The interview is done by asking directly to experts. The Expert in this system is Dr. Nurwestu R, M.Kes, SPKK.

2) Literature Study
Search for literature is conducted to obtain information and theories about Case-Based Reasoning.

B. System Development

The system development method used in this study was SDLC (Systems Development Life Cycle) with the waterfall model. There are five stages in this development system [3].

1) Analysis
The analysis is the activity of learning or understanding an object or problem to find flaws, strengths, and solutions. The system to be built is "An Online Expert System to Diagnose Skin Diseases in infants with the Case Base Reasoning Method" based on symptoms experienced by patients. The system will display a diagnosis of skin diseases suffered based on the results of similarity values obtained from the symptoms entered by the patient.

a) System Requirements Analysis
The process of diagnosing skin disease in infants is begun with the determination of symptoms based on patient complaints. the symptoms displayed have been stored in the case database. If symptoms are found, the patient can process the similarity calculation for each disease data that matches the symptoms selected by the patient. However, if the symptoms are not found on the basis of the case, these symptoms will be saved as potential new symptoms that will be validated by the experts.

Furthermore, the system will do retrieve process where the system will produce a value that determines whether there are similarities or not between the new cases and the cases on the basis (calculating similarity). If there are similarities between new cases and past cases, the system will do reuse process [4].

Reuse is the process to carry out search results of cases that are similar to new cases. After finding out which cases are similar to the new case, the solution will be issued to the user. If no similarity is found, the symptoms of the new case disease will be validated by the expert. The validation process can only be done by experts. In this system, the expert will conduct a revision based on valid data held by experts so the new case will be processed by the system to retaining.

In the retaining process, the system will use a new solution as part of a new case. If the expert has stated the new case as a valid case, then the new case is stored on the basis of the case.

b) Functional Requirements Analysis
Functional requirements are facilities needed and activities are carried out by the system in general. Facilities needed in this system are:

- Facility of login and authentication.
- Registration facility.
- Edit Profile facility.
- Consultation process.
- The process of criticism and suggestions
- The process of managing content and news, managing patient data, managing system user accounts.
- There are base case acquisition facilities and consultation data facilities.
- There are facilities for managing symptom data, disease data, and solution data.
- Data manipulation, which is adding, changing, or deleting data on the system.
- There is a case search process that assists experts in diagnosing skin diseases based on the patient's symptoms.

2) Design

The design phase is carried out to design a system that is ready to be implemented. At this stage, system designs will be made such as Data Flow Diagram (DFD) and Entity Relationship Diagram (ERD).

   a) *DFD*

- DFD level 0/Context diagram

  Context DFD is a system design that is described as a whole. The context diagram of this expert system described by Fig. 1.
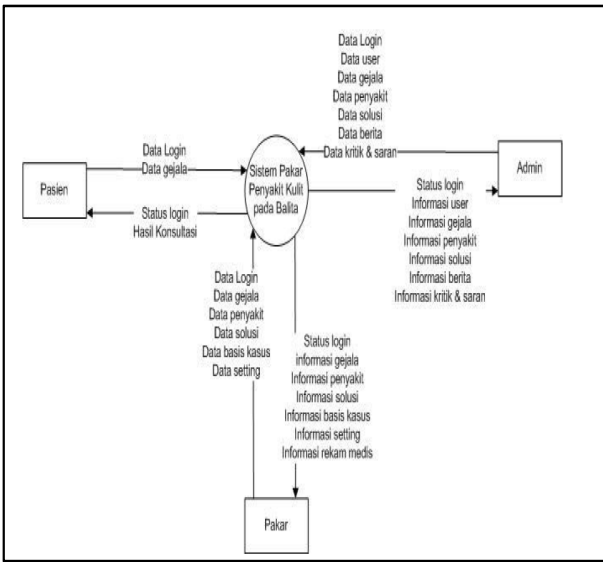

Figure 1**.** DFD Level 0 / Context Diagram

- DFD level 1

  DFD level 1 describes processes in more detail than context diagrams. The processes are divided into five parts, namely the login process, supporting data management, source case management, management of the knowledge base and diagnosis. All of the parts described in Fig. 2.

   b) *ERD*

Entity Relationship Diagram (ERD) represents a relationship between entities in a system [5]. The ERD of this expert system is described in Fig. 3.
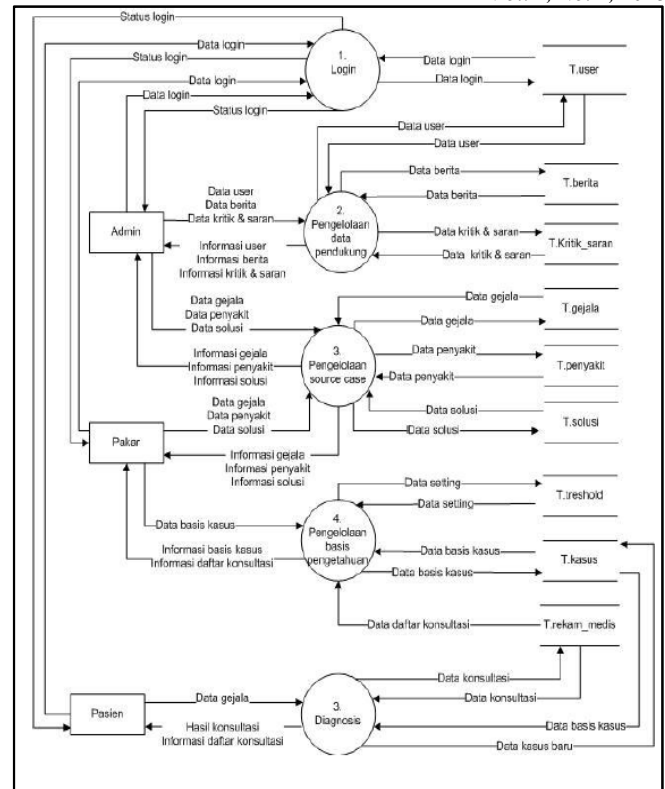

Figure 2. DFD Level 1

3) Implementation

   a) *Case Base Implementation*

The case base is made to guide the results of the system diagnoses. Users only need to enter the symptoms that are felt, then the system will process the diagnosis based on the previous case. In the implementation of the base case, the classification of each variable is carried out as a determinant of the solution to skin diseases in infants. The classification is seen in the existing tables, as given below.
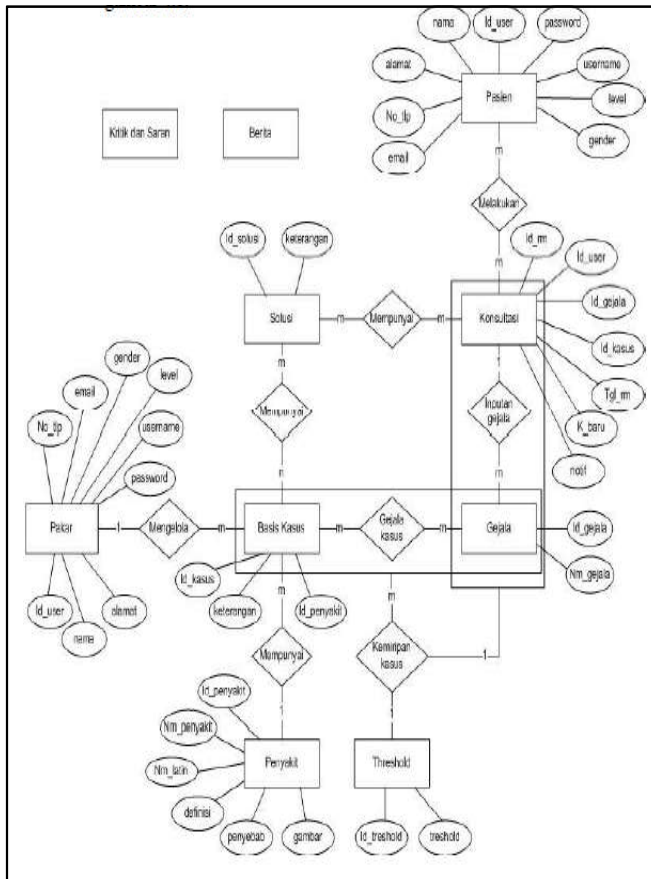
G014	There are small red spots / the size of the base of a needle
G015	There are small grouped spots, filled with liquid
G016	There are fluid-filled blisters/wounds
G017	There are blisters/sores on the lips or the inside of the mouth
G018	There is scab
G019	There are small, flat or prominent spots
G020	There is a reddish lump with the node in the middle
G021	Swelling on the skin
G022	Fussy

Table of solution descriptions

The solutions table (Table 2) is a collection of solutions to cure skin diseases.

TABLE II.   DESCRIPTION OF SOLUTIONS

Code	Information
S001	Clean air circulation
S002	Clean every wound on the skin carefully
S003	Give an ointment or lotion or anti-itching powder
S004	Clean the covered part with warm water or compress it with baby oil/olive oil then dry it
S005	Wash hair and scalp with child-shampoo and warm water, rinse thoroughly, repeat tomorrow if there are still crust
S006	Wash all clothes, towels and bed sheets that are used with hot water and dry them under the sun
S007	Wash the infected area with antiseptic soap. You can also cover boils with bandages
S008	It is recommended not to bathe to prevent irritation and keep dry skin
S009	Use mild powder, ointment or protective cream to prevent irritation and protect the rash
S010	Use special oil or cream for toddlers to soften the scab
S011	Avoid contact with the patient's skin and use towels or clothing with sufferers
S012	Avoid excessive use of water
S013	Avoid excessive air humidity
S014	Rest regularly
S015	Don't scratch and keep your fingernails short
S016	Don't install diapers too hard
S017	Don't kiss other people until the wound heals
S018	Do not touch the eyes so that the virus does not infect the eye

Figure 3. ERD

Table of symptoms description

The symptom table (Table 1) contains skin symptoms that indicate a tendency for skin disease.

TABLE I.   SYMPTOMPS DESCRIPTION

Code	Information
G001	Fever
G002	Itchy
G003	Reddish and swollen gums
G004	Reddish skin
G005	Dry skin
G006	Oily skin
G007	Crusty or yellow scaly skin
G008	The skin looks like peeling orange skin
G009	Cry when the skin is covered with pads is touched
G010	Having a sleep disorder
G011	Having eating disorders
G012	Pain
G013	There are small, runny bubbles

S019	Maintain children's personal hygiene, especially when sweating
S020	Maintain children's hygiene and playing environment
S021	Don't squeeze boils
S022	Do not clean the crust with the nail to prevent injury and the risk of infection
S023	Do not move the affected body part to reduce swelling
S024	Compress with hot water to reduce pain
S025	Cold compresses can reduce discomfort
S026	Take a bath regularly with antiseptic soap and clean water
S027	Cold food and drinks can reduce discomfort
S028	Rub baby oil or coconut oil on the crusty scalp, massage gently, leave overnight. Comb with a soft brush while lifting the loose crust
S029	Avoid oily foods and drink water every day
S030	Do not use clothes too thick and must absorb sweat
S031	Cloth diapers are washed away from soap and detergent remnants
S032	Choose soft, high absorbency diapers and products that don't contain fragrance and alcohol
S033	Separate the eating and drinking equipment that has been used, and wash it clean after use
S034	Occasionally let the child not wear diapers
S035	Always wash hands after touching/handling lesions
S036	If the rash does not disappear within 3 days, immediately consult a doctor
S037	If necessary, give medication according to the doctor's prescription
S038	Consult your doctor if after 3 months it doesn't improve
S039	Clean antibiotics have been used according to your doctor's prescription

K3	G002, G005, G004, G012, G015, G010, G001	S008, S015, S013, S025, S019, S037
K4	G006, G007, G004	S028, S005, S022, S038
K5	G002, G001, G012, G019, G016, G018	S014, S015, S003, S019, S039
K6	G017, G003, G001, G012, G011, G022	S027, S033, S0017, S018, S035
K7	G002, G016, G001, G018	S006, S010, S011, S035, S026, S015, S039
K8	G002, G013, G004, G014, G016	S006, S026, S003
K9	G002, G001, G012, G020	S007, S020, S021, S024, S026, S029
K10	G004, G012, G021, G008, G016, G001	S002, S023, S025

4) Testing

This system testing is done by the Black Box Testing method. This method focuses on the functional requirements of the system. Black Box testing method generally looks for errors in function, interface, data structures, external databases and performance errors. The Black Box Testing method tests the overall ability of expert system applications to diagnose skin diseases in infants, then it can be known whether the system is running well or not.

5) Maintenance

Maintenance is the last step in the system development method. At this stage, system maintenance is carried out by doing corrective maintenance which is repairs to errors that occur in the system.

III. RESULT

The case base is a knowledge containing a set of cases based on expert knowledge in diagnosing previous cases. The case base is made to guide the results of diagnoses. Users simply enter the symptoms that are felt, so the system will process the diagnosis based on the previous case.

If there is a new case, the system must test the level of similarity of the case with the cases that already exist on a case basis. Next, the threshold value will be determined. The threshold value is the minimum value of similarity used to determine the similarity of the previous case with the new case.

b) Base Case Table

Base case table (Table 3) is formed based on the relationship between symptoms and solutions.

TABLE III.   BASE TABLE OF CASE

Case Code	Symptoms	Solutions
K1	G002, G022, G004, G009	S016, S012, S034, S031, S032, S004, S009, S036
K2	G002, G004, G013, G014	S026, S019, S001, S003, S030

There is no provision about the threshold value but may not exceed 1 and less than 0. The value specified as a decimal number. In the system, the threshold value is determined by (θ) = 0.6. Then it will check the existing cases in the case base table by calculating the level of similarity.

Here are some examples of cases:

A. New case with similarity value = 1

Symptoms: itchy (G002), reddish skin (G004), there is a small, bubbly watery bubble (G013), there are small red spots / as big as the base of a needle (G014).

The similarity values can be calculated as follows:
K001 = 2/4 * 100% = 50%
K002 = 4/4 * 100% = 100%
K003 = 2/7 * 100% = 28,5%
K004 = 1/4 * 100% = 25%
K005 = 2/6 * 100% = 33%
K006 = 0/6 * 100% = 0%
K007 = 1/4 * 100% = 25%
K008 = 4/5 * 100% = 80%
K009 = 1/4 * 100% = 25%
K010 = 2/6 * 100% = 33%

From the results above, if a threshold value (θ) = 0.6 is used as a minimum similarity value, then there is one case where the similarity value is above the threshold value, K002. The value of the K002 case is 100%, which means that the similarity of the case entered during the consultation is exactly the same as the case before. So, the conclusion of this case is prickly heat. Diagnosis results for more details can be seen in Figure 4.
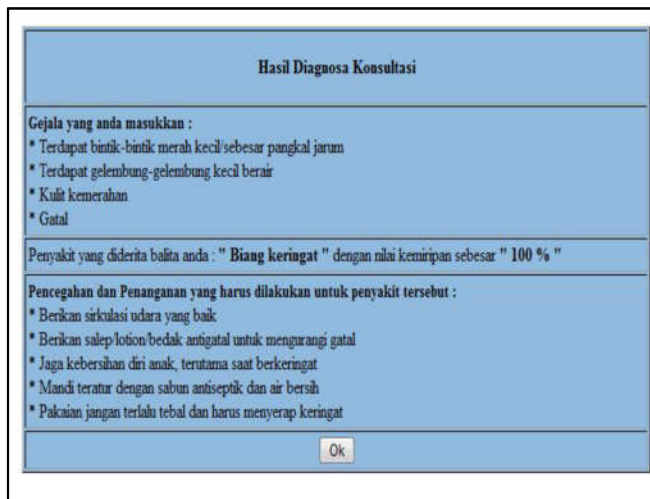

Figure 4. Results of patient consultation diagnosis 3.1

B. New case with similarity value>0,6 (threshold value)

Symptoms: itching (G002), reddish skin (G004), pain (G012), there is a blister/wound filled with liquid (G016). The similarity value can be calculated as follows:
K001 = 2/4 * 100% = 50%

K002 = 2/4 * 100% = 50%
K003 = 4/7 * 100% = 57%
K004 = 1/4 * 100% = 25%
K005 = 3/6 * 100% = 50%
K006 = 1/6 * 100% = 16,7%
K007 = 2/4 * 100% = 50%
K008 = 3/5 * 100% = 60%
K009 = 2/4 * 100% = 50%
K010 = 3/6 * 100% = 50%

From the results above, if a threshold value (θ) = 0.6 is used as a minimum value of similarity, then there is one case where the similarity value is the same as the threshold value, K008. The value of case K008 is 60%, which means that the similarity of cases entered during the consultation is not similar to the cases found on the case base.

This case is considered as a new case because there is no case like this on a case base, but the solution to the K008 case was made a temporary solution for this new case until experts revised and retained this new case. So, the conclusion of this case is scabies. Diagnosis results for more details can be seen in Figure 5.

Figure 5. Results of patient consultation diagnosis 3.2

C. New case with similarity value<0,6 (threshold value)

Symptoms: redness of skin (G004), pain (G012), small grouped spots, filled with fluid (G015). The similarity value can be calculated as follows:
K001 = 1/4 * 100% = 25%
K002 = 1/4 * 100% = 25%
K003 = 3/7 * 100% = 42,8%
K004 = 1/3 * 100% = 33%
K005 = 1/6 * 100% = 16,7%
K006 = 1/6 * 100% = 16,7%
K007 = 0/4 * 100% = 0%
K008 = 2/5 * 100% = 20%
K009 = 1/4 * 100% = 25%

$$K010 = 2/6 * 100\% = 33\%$$

From the results above, if a threshold value (θ) = 0.6 is used as a minimum value of similarity, then there is no single case similar to the case base. Therefore, the inspection data will not enter the new case page. However, patients are still given a solution from the results of the calculation of the largest case, namely the case of K003. So, the conclusion of this case is atopic dermatitis. The diagnosis result for more details can be seen in Figure 6.
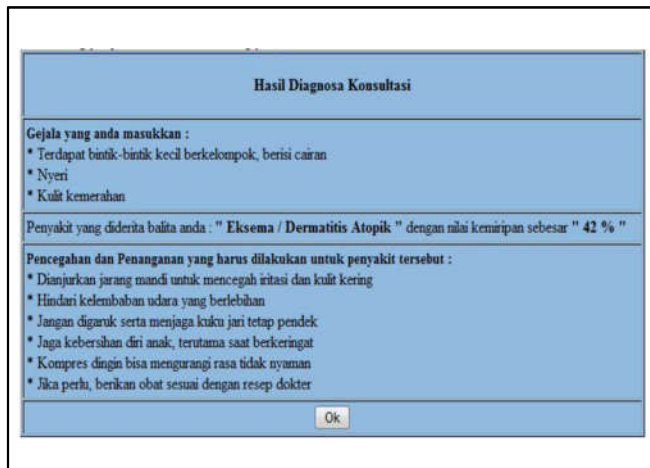

Figure 6. Results of patient consultation diagnosis 3.3

IV. CONCLUSION

Based on the results of the analysis and implementation of an online expert system to diagnose skin diseases in infants with a case-based reasoning method conducted by the author, some conclusions can be drawn as follows:

1) An expert system application to diagnose skin diseases in infants has successfully built.
2) The CBR method in determining the level of similarity on the basis of cases in the system has been implemented properly as a system that helps diagnose the skin disease.
3) The system is able to provide diagnostic results in the form of the name of the disease as well as prevention and treatment solutions according to the symptoms felt by the patient.
4) The expert system is easy to use because it only requires entering the symptoms that are felt by the patient. It is also built in a simple interface and navigation that is easy to learn.
5) This expert system for diagnosing skin diseases in infants needs to be developed so the system performance is better. It can be done by adding more varied case data in order to achieve high accuracy. Besides that, development can also be done by applying other methods, because the CBR method has limitations only in cases that have already existed.

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