Certain Factor Analysis for Ex...

by Heliza Rahmania Hatta

Submission date: 16-Dec-2019 08:43PM (UTC+0700)
Submission ID: 1235389138
File name: Certain Factor Analysis for Extra Pulmonary Tuberculosis Diagnosis.pdf (619.55K)
Word count: 5565
Character count: 25001

Proc. EECSI 2017, Yogyakarta, Indonesia, 19-21 September 2017

Certain Factor Analysis for Extra Pulmonary Tuberculosis Diagnosis

Ramadiani, Nur Aini, Heliza Rahmania Hatta, Fahrul Agus, Zainal Ariffin
Faculty of Computer Science and Information Technology
Mulawarman University,
Samarinda, Indonesia
ilkom.ramadiani@gmail.com

Azainil
Faculty of Teacher Training and Education
Mulawarman University,
Samarinda, Indonesia
nil_unmul@yahoo.com

Abstract— Tuberculosis is an infectious disease that is easily transmitted through the air. Tuberculosis mostly attacks the lungs, but this disease can also attack other organs called extra-pulmonary. The Extra pulmonary tuberculosis can endanger the safety of community and slow in initial diagnosis because of the lack of knowledge. The purpose of this research is to build expert system of the extra pulmonary tuberculosis disease diagnosis. The system can facilitate the user in making the initial diagnosis of the disease, so patients can get the right handling. The system uses forward chaining inference and a Web-based Certainty Factor method with an accuracy rate of 85% has been utilized to assist health and community.

Keywords-–Extra pulmonary tuberculosis; expert System; certain factor; forward chaining

I. INTRODUCTION

Tuberculosis is a direct contagious disease caused by bacterial infection of Mycobacterium tuberculosis. Tuberculosis is a disease that is easily transmitted through the air from positive patients, at the time of coughing or sneezing, the patient spreading germs into the air in the form of spark (droplet nuclei). Once a cough can produce about 3000 sputum sparks [1-3].

Tuberculosis (TB) is considered as one of the life threatening infectious diseases all over the world. It is usually into types, namely Pulmonary TB (PTB) and Extra-pulmonary TB (ETB). PTB affects lungs, while ETB can attack any organ of the body except brain, spine, heart, pancreas, skeletal striated muscle, and thyroid [1-8].

Tuberculosis can affect anyone, especially the productive age or still actively working and children. About 75% of patients are the most economically productive age group (15-50 years). It is estimated that an adult patient, will lose an average working time of 3 to 4 months. If he dies, it will lose about 15 years of income. In addition to economically disadvantageous, it also has other adverse impacts socially even ostracized by society [1-3].

In Indonesia, tuberculosis is a major public health problem. Indonesia still contributes 5.8% of Tuberculosis cases in the world. Tuberculosis remains a challenge in public health problems in Indonesia with approximately 430,000 new patients per year and an incidence rate of 189 / 100,000 people and 61,000 deaths from Tuberculosis per year or 27 / 100,000 inhabitants (Indonesia Ministry of Health 2011) [1-2]. According to the WHO report [3], Indonesia ranks the third in number of cases of tuberculosis after India and China with the amount of 700 thousand cases. The mortality rate is still the same as in 2011 of 27 per 100,000 population, but the incidence rate dropped to 185 per 100,000 population in 2012.

Most tuberculosis germs attack the lungs, but can also affect the other organs or body parts, commonly referred to as Extra pulmonary tuberculosis. Lung tuberculosis is the most common form of 80% of all patients. Tuberculosis that attacks the lung tissue is the only form of infectious tuberculosis. Extra pulmonary tuberculosis is a form of tuberculosis disease that attacks other organs, other than the lungs. Basically Tuberculosis disease is not indiscriminate because this bacteria can attack all organs of the body [1-8].

Insufficient facilities, inexperienced and the lack of knowledge about Tuberculosis often make the late diagnosis of extra pulmonary tuberculosis, that could threaten the health of the patient. A systematic application as a tool for early diagnosis of extra pulmonary tuberculosis disease is necessary to facilitate the expert in finding out which parts of the body are infected with Tuberculosis disease other than the lung. It can accelerate the diagnostic results so the experts can provide appropriate treatment [1-8].

This research aims to build an expert system of extra pulmonary tuberculosis diagnosis by using certainty factor method. It is able to provide an accurate diagnosis of the possibility of a patient suffering an Extra pulmonary tuberculosis disease and how to treatment it.

II. LITERATURE REVIEW

A. *Tuberculosis*

Tuberculosis remains an enormous global health problem, causing morbidity and mortality worldwide. One-third of the world's population is estimated to be latently infected with *Mycobacterium tuberculosis*. The deadly synergy of HIV and tuberculosis, and the emergence of multidrug-resistant *Mycobacterium tuberculosis* (MDRTB), have further

978-1-5386-0549-3/17/$31.00 ©2017 IEEE

complicated tuberculosis control [4-8]. Some of the most common diseases Tuberculosis suffered by people is:

1) Lung Tuberculosis

Lung tuberculosis is a lung parenchymal inflammatory disease caused by infection with the bacteria Mycobacterium Tuberculosis. Lung tuberculosis includes a pneumonia. Lung tuberculosis accounts for 80% of the overall incidence of Tuberculosis while the remaining 20% is Extra Pulmonary Tuberculosis [4-8].

a) The main symptoms

Persistent cough and phlegm for three weeks or more.

b) Additional symptoms are common

Sputum mixed blood/coughing blood, fever for three weeks or more, shortness of breath and chest pain, decreased appetite, weight loss, painful feeling, weak and sweating at night despite not doing anything

2) Extra Pulmonary Tuberculosis

Extra pulmonary tuberculosis is a disease caused by infection with Mycobacterium Tuberculosis that attacks the body parts other than lungs. This disease usually occurs because the germs spread from the lungs (LungTuberculosis) to other organs through the bloodstream.

3) Tuberkulosis Lymph node

Tuberculosis Glandular or Lymphadenitis Tuberculosis is a disease of lymph node inflammation caused by infection with Mycobacterium Tuberculosis. Normal lymph nodes are attacked is the neck, armpits, and groin.

a) Systemic / general symptoms:

Persistent cough and phlegm for three weeks or more, fever for three weeks or more, decreased appetite, weight loss, painful feeling (malaise), weak and sweating at night even though nothing is done.

b) Special Symptoms:

The emergence of lumps on the part of glandular disorders such as the neck, thigh, and armpit, there are signs of inflammation in the area around the lump of the gland, the lump of the gland is easily moved, lumps that arise gland feels supple, lumps up the lumps of the glands that result in day to day conditions worsening and damaging the body, the lump of the gland ruptures and secretes a dirty, dirty fluid and there is injury to the skin or skin tissue caused by rupture of lymph node lumps.

4) Breast Tuberculosis

Breast Tuberculosis is a disease of breast inflammation caused by infection with the bacteria Mycobacterium Tuberculosis. Special symptoms: the appearance of a lump in the breast, pain in the breast, the presence of inflammation marks around the lumps that arise in the breast.

5) Tuberculosis Spine (Spondylitis)

Tuberculosis Spine or Spondylitis Tuberculosis is a disease of inflammation of the spine caused by infection with Mycobacterium Tuberculosis. Special symptoms: pain in the back or back stiffness, patient reluctant to move his back, patient refuse to bend or lift items from the floor, when asked the patient will bend the knee to keep the back straight, pain in the back is reduced when the patient rests and the appearance of a lump in the back/spine.

B. Certainty Factor Method

An expert often analyzes existing information with phrases like "probable," "most likely," "almost certain," to accommodate this. We use Certainty Factor (CF) to describe the level of expert confidence in the current problem [5-8]. The Certainty Factor expresses trust in an event (fact or hypothesis) based on evidence or expert judgment.

The value of CF (Rule) is derived from the interpretation of "term" from the experts, which is converted to a certain CF value according to table 1 below.

TABLE I. CF and Interpretation values

Uncertain Term	CF
Definitely not	- 1.0
Almost certainly not	- 0.8
Probably not	- 0.6
Maybe not	- 0.4
Unknown	- 02 to 0.2
Maybe	0.4
Probably	0.6
Almost certainly	0.8
Definitely	1.0

In general, the rule is represented in the following form:

IF E1 AND E2….AND En THEN H (CF rule) or

IF E1 OR E2….OR En THEN H (CF rule)

Where:

IF E1…En : The facts (evidence) that exists

H : Hypothesis or conclusion that is generated

CF Rule : Confidence level occurring Hypothesis H due to the fact

1. Rule with a single E test and a single H hypothesis

IF E THEN H (CF rule) (1)

CF(H,E) = CF(E) x (CF rule)

2. Rule with double E evidence and a single H hypothesis

IF E1 AND E2….AND En THEN H (CF rule)

CF(H,E) = min[CF(E1), CF(E2)

CF(En) x CF(rule) (2)

IF E1 OR E2….OR En THEN H (CF rule)

CF(H,E) = max[CF(E1), CF(E2)

CF(En)] x CF(rule) (3)

3. The combination of two rules with different evidences (E1 and E2), the same hypothesis.

IF E_1 *THEN* H Rule 1

$CF(H,E_1) = CF_1 = (E_1) \times CF(Rule1)$ (4)

IF E_2 *THEN* H Rule 2

$CF(H,E_2) = CF_2 = C(E_2) \times CF(Rule2)$ (5)

C. Research

Expert system for the diagnosis of Extra sound Tuberculosis disease using forward chaining method and certainty factor theory, in this method user will choose the symptom according to the experience, then the system will check one by one user selected phenomenon whether the rules in the database there are in accordance with user input. If present then the system will calculate the CF value according to the selected rule. The system will provide the output of the name of the disease, the value of the percentage of the diagnosis of the system, the list of symptoms that have been selected by users, as well as an explanation of treatment solutions and treatment of diseases [7-11].

III. RESULT AND DISCUSSION

A. System Description

Expert system diagnosis of Pulmonary Tuberculosis and Extra Lung is not used to diagnose Tuberculosis disease in children that is 0-12 years old [1-3]. The diagnosis of Pulmonary Tuberculosis and Extra Lung disease in children has its own method by using Scoring method. Thus, users who can consult using this expert system are users over the age of 12.

Users can fill out a risk questionnaire before the user selects symptoms according to their experience by answering general questions about the risk of Tuberculosis incidence to determine the extent of the user's risk for Tuberculosis disease by looking at the risk factors present to the user. The system will check the user's reply, whether it matches the risk factor rules and gives the result, the user is at risk for disease or not. If the user is at risk of illness, then the system will advise the user to consult by choosing the appropriate symptoms they experienced, if not at risk, the system will give freedom to the user to continue to be consulted or not. The system provides disease information about the type of Tuberculosis disease also the functions like an information system.

B. Risk Factors of Tuberculosis Occurrence

Based on the literature review and interview with Tuberculosis Experts, the factors that can make a person at risk for stricken Pulmonary Tuberculosis is someone who has criteria such as unhealthy lifestyle, living in unhealthy environment, live in homes that do not qualify for good home conditions, have low body resistance, and contact with patients with Pulmonary Tuberculosis. Several risk factors for Tuberculosis incidence and the magnitude of risk for each risk factor can be seen in table 2 below.

TABLE II. List of Tuberculosis Factors

Factor Risk	Name Risk Factor	Description	Big Risk of TB Occurrence
R1	Not available Ventilation	House conditions are not met / home conditions	1.18 times the risk of contracting pulmonary tuberculosis
R2	The window of the house is not open every day or does not have a house window	are not good	
R3	The house is musty and humid		
R4	The incoming sunlight into the house is not enough that is marked by the absence of bright light from the sunlight during the day in the house		
R5	Living in a shabby environment	Unhealthy environment	More at risk of contracting pulmonary tuberculosis than living in an environment that is not shabby and clean
R6	Drinking Alcohol	Unhealthy lifestyle	More at risk for contracting pulmonary tuberculosis than not drinking alcohol
R7	Smokers and former smokers		2.7 times at risk for contracting pulmonary tuberculosis
R8	experienced malnutrition or malnutrition	Low immunity	2,184 times the risk of contracting pulmonary tuberculosis
R9	Having HIV / AIDS		10 times is at risk for contracting pulmonary tuberculosis
R10	Diabetes suffer		2-3 times the risk of contracting pulmonary tuberculosis
R11	Live at home with Pulmonary TB patient	Contact with tuberculosis patient	3,897 times for lung TB infection
R12	Living at home with> 1 (more than one) Pulmonary TB patients		4 times the risk of contracting pulmonary tuberculosis
R13	There is intense contact with people with Intensive Pulmonary TB such as workplaces, schools, etc.		More at risk for contracting pulmonary tuberculosis compared with no contact at all

The expert system design of early diagnosis of Extra Pulmonary Tuberculosis disease developed using unified modeling language diagram (UML) such as, use case diagram and activity diagram. Use case diagram is an important step that must be done in solving a problem. Contains a groove to help how a system can run [7-11].

Each type of Tuberculosis disease especially extra lungs must have symptoms that can be identified based on expert knowledge. Facts and knowledge that have been obtained will be translated knowledge engineer into a knowledge base stored in expert systems that have been created. The facts are

displayed in the symptom table and symptom weight. Each symptom is represented by the code as depicted in Table 3.

TABLE III. List of Symptoms of Tuberculosis Disease

Symptom Code	Symptom	CF Value
G01	Continuous cough and phlegm for three weeks / more	0.8
G02	Sputum mixed blood / coughing blood	0.6
G03	Longstanding fever	0.6
G04	Shortness of breath and chest pain	0.6
G05	Decreased appetite	0.8
G06	Weight loss	0.8
G07	Painful feeling, weak	0.8
G08	Sweats at night despite not doing anything	0.6
G01a	Continuous cough and phlegm for three weeks / more	0.4
G01b	Persistent cough and phlegm for three weeks / more	0.4
G01c	Continuous cough and sputum for three weeks / more	-0.6
G03a	Long-standing fever	0.4
G03b	Long lasting fever	0.6
G03c	Long-standing fever	-0.4
G05a	Decreased appetite	0.6
G05b	Decreased appetite	0.4
G05c	Decreased appetite	0.6
G06a	Weight loss	0.6
G06b	Weight loss	0.4
G06c	Weight loss	0.8
G07a	Painful feeling (discomfort), weak	1.0
G07b	Painful feeling (discomfort), weak	1.0
G07c	Painful feeling (discomfort), weak	1.0
G08a	Sweating at night despite not doing anything	-0.4
G08b	Sweating at night despite not doing anything	-0.4
G08c	Sweating at night despite not doing anything	0.4
G09	The emergence of lumps that occur in parts of glandular disorders such as the neck, thigh, and armpits	1.0
G10	There are signs of inflammation in the area around the lump of gland	0.8
G11	Glandular lump is easy to move	0.8
G12	The lumps of the glands that arise feel chewy	0.8
G13	Lumps up the lumps of the glands that cause day by day the condition worsens and damages the body.	1.0
G14	The lump of the gland breaks out and secretes a dirty, dirty fluid	0.8
G15	There is injury to the skin or skin tissue caused by the outbreak of the lymph node lymph node	1.0
G16	The appearance of a lump in the breast.	1.0
G17	Pain in the breast.	0.8
G18	The presence of an inflammation mark around the lump that arises in the breast	0.8
G19	Pain / back pain or back stiffness	1.0
G20	Patients are reluctant to move his back.	1.0
G21	Patients refuse to bend or lift items from the floor, when asked the patient will bend the knee to keep the back straight.	1.0
G22	Pain / back pain is reduced when the patient is at rest.	1.0
G23	The appearance of a lump in the back / spine	0.6

Each type of Tuberculosis disease is represented by the code as listed from Table 4 until Table 6 below:

TABLE IV. List of Tuberculosis Disease.

Disease Code	Disease Name
P01	Pulmonary Tuberculosis
P02	Tuberculosis Lymph node
P03	Breast Tuberculosis
P04	Tuberculosis Spine

TABLE V. Pulmonary Tuberculosis (P01)

No.	Role	Role Based for P01	CF
1.	R01	IF G01 THEN P01	0,4
2.	R02	IF G01 AND G02 THEN P01	0,6
3.	R03	IF G01 AND G02 AND G03 THEN P01	0,6
4.	R04	IF G01 AND G02 AND G04 THEN P01	0,6
5.	R05	IF G01 AND G02 AND G05 AND G06 THEN P01	0,6
6.	R06	IF G01 AND G02 AND G07 THEN P01	0,6
7.	R07	IF G01 AND G02 AND G08 THEN P01	0,6
8.	R08	IF G01 AND G02 AND G07 AND G08 THEN P01	0,6
9.	R09	IF G01 AND G02 AND G03 AND G04 THEN P01	0,6
10.	R10	IF G01 AND G02 AND G03 AND G05 AND G06 THEN P01	0,7
11.	R11	IF G01 AND G02 AND G03 AND G07 THEN P01	0,6
12.	R12	IF G01 AND G02 AND G03 AND G08 THEN P01	0,6
13.	R13	IF G01 AND G02 AND G03 AND G04 AND G05 AND G06 THEN P01	0,75
14.	R14	IF G01 AND G02 AND G03 AND G04 AND G07 THEN P01	0,7
15.	R15	IF G01 AND G02 AND G03 AND G04 AND G08 THEN P01	0,7
16.	R16	IF G01 AND G02 AND G03 AND G04 AND G05 AND G06 AND G07 THEN P01	0,8
17.	R17	IF G01 AND G02 AND G03 AND G04 AND G05 AND G06 AND G08 THEN P01	0,8
18.	R18	IF G01 AND G02 AND G03 AND G04 AND G05 AND G06 AND G07 AND G08 THEN P01	0,92
19.	R19	IF G01 AND G02 AND G03 AND G07 AND G08 THEN P01	0,7
20.	R20	IF G01 AND G02 AND G03 AND G04 AND G07 AND G08 THEN P01	0,75
21.	R21	IF G01 AND G02 AND G03 AND G05 AND G06 AND G07 THEN P01	0,75
22.	R22	IF G01 AND G02 AND G03 AND G05 AND G06 AND G08 THEN P01	0,75
23.	R23	IF G01 AND G02 AND G03 AND G05 AND G06 AND G07 AND G08 THEN P01	0,8
24.	R24	IF G01 AND G02 AND G04 AND G05 AND G06 THEN P01	0,7
25.	R25	IF G01 AND G02 AND G04 AND G07 THEN P01	0,6
26.	R26	IF G01 AND G02 AND G04 AND G08 THEN P01	0,6
27.	R27	IF G01 AND G02 AND G04 AND G07 AND G08 THEN P01	0,7
28.	R28	IF G01 AND G02 AND G04 AND G05 AND G06 AND G07 THEN P01	0,75
29.	R29	IF G01 AND G02 AND G04 AND G05 AND G06 AND G08 THEN P01	0,75
30.	R30	IF G01 AND G02 AND G04 AND G05 AND G06 AND G07 AND G08 THEN P01	0,8
31.	R31	IF G01 AND G02 AND G05 AND G06 AND G07 THEN P01	0,7
32.	R32	IF G01 AND G02 AND G05 AND G06 AND G08 THEN P01	0,7

No.	Role	Role Based for P01	CF
33.	R33	IF G01 AND G02 AND G05 AND G06 AND G07 AND G08 THEN P01	0,75
34.	R34	IF G01 AND G03 THEN P01	0,45
35.	R35	IF G01 AND G03 AND G04 THEN P01	0,5
36.	R36	IF G01 AND G03 AND G05 AND G06 THEN P01	0,6
37.	R37	IF G01 AND G03 AND G07 THEN P01	0,5
38.	R38	IF G01 AND G03 AND G08 THEN P01	0,5
39.	R39	IF G01 AND G03 AND G04 AND G05 AND G06 THEN P01	0,7
40.	R40	IF G01 AND G03 AND G04 AND G07 THEN P01	0,6
41.	R41	IF G01 AND G03 AND G04 AND G08 THEN P01	0,6
42.	R42	IF G01 AND G03 AND G04 AND G05 AND G06 AND G07 THEN P01	0,75
43.	R43	IF G01 AND G03 AND G04 AND G05 AND G06 AND G08 THEN P01	0,75
44.	R44	IF G01 AND G03 AND G04 AND G05 AND G06 AND G07 AND G08 THEN P01	0,8
45.	R45	IF G01 AND G03 AND G04 AND G07 AND G08 THEN P01	0,7
46.	R46	IF G01 AND G03 AND G05 AND G06 AND G07 THEN P01	0,7
47.	R47	IF G01 AND G03 AND G05 AND G06 AND G08 THEN P01	0,7
48.	R48	IF G01 AND G03 AND G05 AND G06 AND G07 AND G08 THEN P01	0,75
49.	R49	IF G01 AND G03 AND G07 AND G08 THEN P01	0,6
50.	R50	IF G01 AND G04 THEN P01	0,45
51.	R51	IF G01 AND G04 AND G05 AND G06 THEN P01	0,6
52.	R52	IF G01 AND G04 AND G07 THEN P01	0,5
53.	R53	IF G01 AND G04 AND G08 THEN P01	0,5
54.	R54	IF G01 AND G04 AND G07 AND G08 THEN P01	0,6
55.	R55	IF G01 AND G04 AND G05 AND G06 AND G07 THEN P01	0,7
56.	R56	IF G01 AND G04 AND G05 AND G06 AND G08 THEN P01	0,7
57.	R57	IF G01 AND G04 AND G05 AND G06 AND G07 AND G08 THEN P01	0,75
58.	R58	IF G01 AND G05 AND G06 THEN P01	0,5
59.	R59	IF G01 AND G05 AND G06 AND G07 THEN P01	0,5
60.	R60	IF G01 AND G05 AND G06 AND G08 THEN P01	0,6
61.	R61	IF G01 AND G05 AND G06 AND G07 AND G08 THEN P01	0,7
62.	R62	IF G01 AND G07 THEN P01	0,35
63.	R63	IF G01 AND G08 THEN P01	0,45
64.	R64	IF G01 AND G07 AND G08 THEN P01	0,5
65.	R65	IF G04 AND G05 AND G06 AND G07 THEN P01	0,4
66.	R66	IF G04 AND G05 AND G06 AND G08 THEN P01	0,4
67.	R67	IF G04 AND G05 AND G06 AND G07 AND G08 THEN P01	0,4
68.	R68	IF G05 AND G06 AND G08 THEN P01	0,4
69.	R69	IF G05 AND G06 AND G07 AND G08 THEN P01	0,4

TABLE VI. Tuberculosis of the Lymph Nodes (P02)

No.	Role	Role Based for P02	CF
1.	R70	IF G09 THEN P02	0,35
2.	R71	IF G09 AND G10 THEN P02	0,4
3.	R72	IF G09 AND G10 AND G11 AND G12 THEN P02	0,45
4.	R73	IF G09 AND G10 AND G13 THEN P02	0,55
5.	R74	IF G09 AND G11 AND G12 THEN P02	0,4
6.	R75	IF G09 AND G11 AND G12 AND G13 THEN P02	0,6
7.	R76	IF G09 AND G10 AND G11 AND G12 AND G13 THEN P02	0,6
8.	R77	IF G09 AND G10 AND G13 AND G14 AND G15 THEN P02	0,65
9.	R78	IF G09 AND G11 AND G12 AND G13 AND G14 AND G15 THEN P02	0,7
10.	R79	IF G09 AND G10 AND G11 AND G12 AND G13 AND G14 AND G15 THEN P02	0,75
11.	R80	IF G01a AND G03a AND G05a AND G06a AND G07a AND G08a AND G09 AND G10 AND G11 AND G12 THEN P02	0,4

TABLE VII. Breast Tuberculosis P03

No.	Role	Role Based for P03	CF
1.	R81	IF G16 THEN P03	0,35
2.	R82	IF G16 AND G17 THEN P03	0,45
3.	R83	IF G16 AND G17 AND G18 THEN P03	0,6
4.	R84	IF G01b AND G03b AND G05b AND G06b AND G07b AND G08b AND G16 AND G17 AND G18 THEN P03	0,4

TABLE VIII. Tuberculosis of the Spine (P04)

No	Role	Role Based for P04	CF
1.	R85	IF G19 AND G20 AND G21 AND G22 AND G23 THEN P04	0,85
2.	R86:	IF G01c AND G03c AND G05c AND G06c AND G07c AND G08c AND G19 AND G20 AND G21 AND G22 AND G23 THEN P04	0,4

IV. Inference Engine

Inference method used is forward chaining, where the fact of the symptoms experienced by the user then searched for the type of disorder (goal). Based on the representation of each symptom that arises, the rules for the disease of Pulmonary and Extra-Pulmonary Tuberculosis are formulated. Here's an example of calculating the Certainty Factor method values from several rules:

1) Example calculation for first rule (R01) Tuberculosis Lung disease.

R01: IF G01 THEN P01 CF = 0.4

With the weight value of symptoms as follows:

G01 = 0.8

CF Expert R01 of 0.4, then the big CF Sequential:

CF (R01) = 0.8 × 0.4 = 0.32

Possible value = 0.32 × 100% = 32%

Then the probable value of Lung Tuberculosis with symptoms of persistent cough and phlegm for three weeks / more is 32%.

2) Sample calculation for second rule (R02) Tuberculosis Lung disease with accompanying hypothema / coughing blood symptoms.

R02: IF G01 AND G02 THEN P01 CF = 0.6

With the weight value of symptoms as follows:

G01 = 0.8, G02 = 0.6
CF Parallel = min [CF (G01), CF (G02)]
= Min [0.8, 0.6]
= 0.6

CF Expert R02 of 0.6, then the big CF Sequential:
CF (R02) = 0.6 × 0.6 = 0.36

R02 arises because of R01 (a symptom of a bleeding cough arises in case of cough for three weeks/more). Combination R01 and R02:

CF Combine CF (R01, R02)
= CF (R01) + CF (R02) (1 - CF (R01))
= 0.32 + 0.36 (1 - 0.32)
= 0.32 + 0.36 (0.68)
= 0.32 + 0.245
= 0.565
Possible value = 0.565 × 100% = 56.5%

Then the probable value of Lung Tuberculosis disease with symptoms of persistent coughing of phlegm for three weeks / more and accompanied by a bloody cough is 56.5%.

3) Example calculation for R70 Tuberculosis disease Lymph node.

R70: IF G09 THEN P02 CF = 0.35
With the weight value of symptoms as follows:
G09 = 1.0
CF Expert R70 of 0.35, then the big CF Sequential:
CF (R70) = 1 × 0.35 = 0.35
Possible value = 0.35 × 100% = 35%

Then the value of the likelihood of Tuberculosis with lymph nodes with symptoms of the emergence of lumps that occur in parts of glandular disorders such as the neck, thigh, and armpit is 35%.

4) Example calculation for R71 Tuberculosis disease Lymph node.

R71: IF G09 AND G10 THEN P02 CF = 0.4
With the weight value of symptoms as follows:
G09 = 1.0, G10 = 0.8
CF Parallel = min [CF (G09), CF (G10)] = min [1.0, 0.8] = 0.8
CF Expert R71 of 0.4, then the big CF Sequential:
CF (R71) = 0.8 × 0.4 = 0.32

The main symptom is the emergence of a lump in the lymph nodes must arise in the disease of lymph node TB so R70 always combined with the rule of another TB lymph node. Combination R70 and R71:

CF Combine CF (R70, R71)
= CF (R70) + CF (R71) (1 - CF (R70))
= 0.35 + 0. 32 (1 - 0.35)
= 0.35 + 0. 32 (0.65)
= 0.35 + 0.208
= 0.558
Possible value = 0. 558 × 100% = 55.8%

Then the value of the likelihood of Tuberculosis of lymph nodes with symptoms of the emergence of lumps that occur in parts of glandular disorders such as the neck, thighs, and armpits and There are signs of inflammation in the area around the lump of the gland is 55.8%.

5) The Home Page Website

The users of this expert system website are visitors and admins. This page is the front page when the user and the admin have not logged into their respective accounts as well as the website visitors who have not registered as the user. Users can see a brief explanation of the Extra-Pulmonary Tuberculosis Diagnostic on the main page of the website covering the purpose, the type of diagnosed tuberculosis disease and the method used in the process of diagnosing the disease. The main page of the website has a main menu located on the left which consists of the Login menu, Help menu, and information.

Users can use the Risk Questionnaire widget on the user home page to fill out the questionnaire. Risk Questionnaire is a questionnaire that contains questions about several risk factors for Tuberculosis events. Questions posed to the user consist of 13 Tuberculosis risk factor questions and provided two "yes" and "no" answers. Display images Home page Website can be seen in Fig. 1.

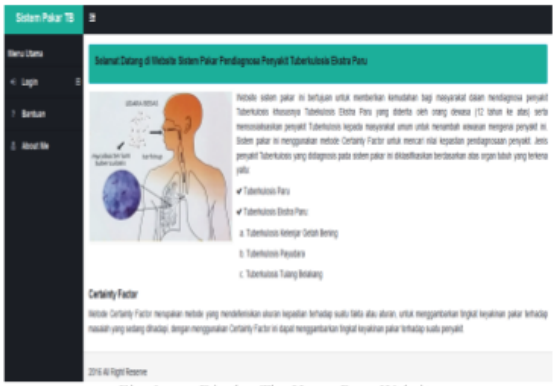

Fig. 1. Display The Home Page Website

The results page of the Risk Questionnaire contains the results of whether the user has a possible risk for Tuberculosis disease, based on the user's chosen answer. Users can see the amount of risk factor of Tuberculosis before continue to Consultation menu.

Users can start a consultation on this page by selecting the symptoms that exist as experienced by the user. The system will check whether the symptoms of the user is the appropriate rule or not. If user input symptoms in accordance with the existing rule of the disease will be calculated using the method Certainty Factor and produce diagnostic results of the possibility of disease Tuberculosis Lung and Extra Lung along with the percentage of probability value. If it is not in accordance with the rule of the existing disease then the system will provide output that the user is not diagnosed with Tuberculosis.

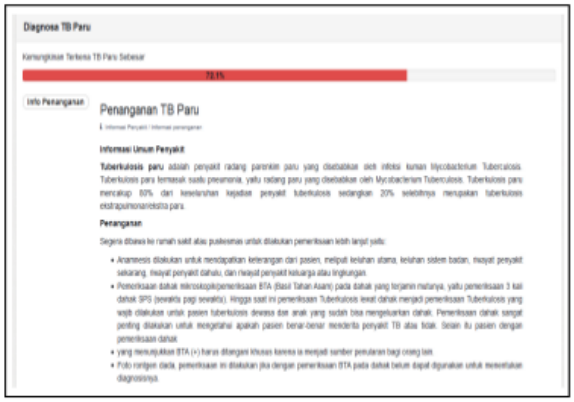

Fig. 2. Pulmonary TB Handling Information Page

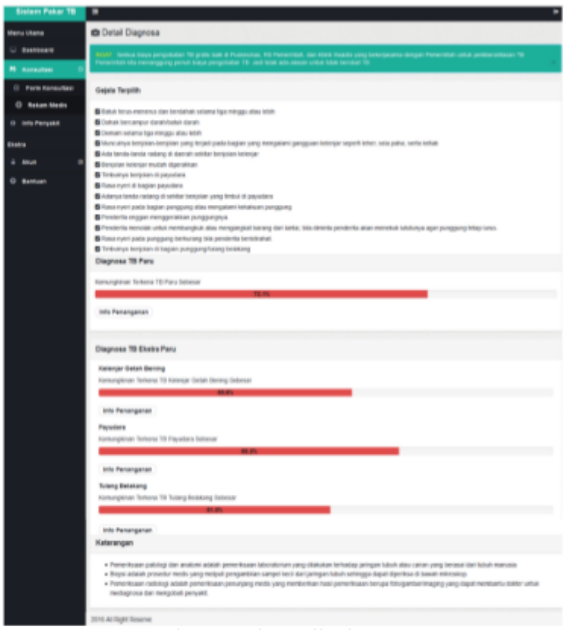

Fig. 3. The Details Diagnose

Tested on 20 Tuberculosis patients, the expert system of Diagnostic Extra Lungs Tuberculosis has an accuracy of 85%. After calculated the patient data, the value of its accuracy. This accuracy value will determine the quality of the applications that have been made. To calculate the system's accuracy:

Amount of data = 20

The number of correct diagnoses = 17 cases

Number of false diagnoses = 3 cases

The wrong diagnostic data on referral result because the difference of diagnosis calculation using Certainty Factor. So obtained calculation as follows:

$$= 17/20 \; x \; 100\%$$

$$= 85\%$$

Based on the results of tests conducted, Expert System Diagnostic Disease Tuberculosis has an accuracy of 85%.

V. CONCLUSION

Only a few people know that Tuberculosis disease can attack other organs than Lung, with this expert system can provide information to the public about the disease Pulmonary Tuberculosis and Extras Lungs. This study produced the expert system of the Extra Pulmonary Tuberculosis diagnosis. The system has been developed for early diagnosis of Extra pulmonary tuberculosis in adult (over 12 years old) using forward chaining inference and Certainty Factor (CF). It works based on user-selected symptoms then processed to produce the output of the disease, the percentage of diagnostic beliefs and disease management information. Expert System Diagnose Disease Tuberculosis has a disease diagnosis accuracy of 85%.

VI. REFERENCES

[1] Ministry of Health RI. 2014. National Guidelines for Tuberculosis Control. Jakarta: Ministry of Health RI.

[2] MOH RI, 2008. DG of Disease Control and Environmental Health. National Guidelines for the Control of Tuberculosis and International Standards for Tuberculosis Services. Ministry of Health of the Republic of Indonesia.

[3] World Health Organization. 2015. The End TB Strategy. Publications of the World Health Organization are available on the WHO website or WHO Press, 20 Avenue Appia, 1211 Geneva 27, Switzerla

[4] Hossain M.S, Ahmed F., Johora F.J., Andersson K. 2017. A Belief Rule Based Expert System to Assess Tuberculosis under Uncertainty. Mobile & Wireless Health, *JMedSyst* 41:43

[5]. Zhenhua Yang et.al. 2004. Identification of Risk Factors Extrapulmonary Tuberculosis. *Clin Infect Dis.*;38(2):199-205. by the fectious Diseases Society of America.

[6] Lawn, S. D., & Zumla, A. I.. 2012. Diagnosis of extrapulmonary tuberculosis using the Xpert® MTB/RIF assay. Expert Review of Anti-Infective Therapy, 10(6), 631–635.

[7] Rasha Abd El Rahim Abd El Rahman Badi. 2014. Design an Expert System for the Diagnosis of Pulmonary Tuberculosis. A Thesis Submitted For Degree Of M.Sc In Biomedical Engineering.

[8] Budi Sunarko. 2013. An application of expert system for diagnosis tuberculosis diseases. Engineering International Conference "UNNES Conservation" Proceeding p-ISBN: 979-25-2783 Jan 08, Semarang, Indonesia

[9] Turban, 2005. *Decision Support System, Intelligent System*. Jilid II. Edisi 7. Yogyakarta. Percetakan Andi Offset. Penerbit Andi

[10] Sutejo, T., Mulyanto, E., dan Suhartono, V. 2011. Kecerdasan Buatan. Yogyakarta: Andi

[11] Ramadiani, Nurbazar, 2011. Sistem Pakar Identifikasi Kerusakan Pada Mobil. Jurnal Informatika Mulawarman Vol 6 No.1 Febuari; 29-38.

Certain Factor Analysis for Ex...

ORIGINALITY REPORT

8%	5%	4%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	e-journal.uajy.ac.id Internet Source	1%
2	Submitted to Universitas Muria Kudus Student Paper	1%
3	Mohammad Shahadat Hossain, Faisal Ahmed, Fatema-Tuj-Johora, Karl Andersson. "A Belief Rule Based Expert System to Assess Tuberculosis under Uncertainty", Journal of Medical Systems, 2017 Publication	1%
4	journal.unnes.ac.id Internet Source	1%
5	Yang, Zhenhua, Ying Kong, Frank Wilson, Betsy Foxman, Annadell H. Fowler, Carl F. Marrs, M. Donald Cave, and Joseph H. Bates. "Identification of Risk Factors for Extrapulmonary Tuberculosis", Clinical Infectious Diseases, 2004. Publication	1%
	Submitted to Sultan Agung Islamic University	

6	Student Paper	1%
7	repository.petra.ac.id Internet Source	1%
8	Submitted to University of Warwick Student Paper	1%
9	jurnal.stielmii-medan.ac.id Internet Source	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		