Analysis of Expert System for Early Diagnosis of Disorders During Pregnancy Using the Forward Chaining Method

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I. Introduction

Pregnancy is happy for the family, but also requires sacrifice[1] that is not easy for a mother. Sometimes pregnancy [2] brings problems to the health of pregnant women. Knowledge of the disorders that occur during pregnancy[1], [3] is needed, especially for pregnant women[4], [5], because they are the ones who feel the disturbances [6], [7] directly. The many disorders caused by pregnancy make it difficult to diagnose, especially since some pregnancy disorders have similar symptoms. This causes the time needed to diagnose disorders[8] that occur in pregnant women to be longer, while pregnant women need fast results [9] to find out what disorders they are experiencing. Therefore we need a computer-based [10] tool that can help them to diagnose disorders in pregnancy to be more accurate[11]. With the rapid advancement of computer technology, technology helps people in various fields of life, one of which is the health sector. Currently, computer technology [12] helps solve problems that occur, such as performing operations, medical check-ups[13], and others. One of the computer technologies used is Artificial Intelligence (artificial intelligence). One part of an artificial intelligence system [14] is an expert system which is a computer program that mimics expert thinking and knowledge to solve a specific problem[15]. The implementation of an expert system is seen as a way of storing expert knowledge in a particular field into a computer program in such a way that it can make decisions[16] and make intelligent reasoning. During its development, expert systems help people in various fields, including in the health sector[17]. Thus, an expert system can be used to assist in diagnosing early pregnancy disorders. [3], [18][19]
II. Research Method

A. Collecting Data

Andhika Adhitama Gama (2015) [20]Expert system for early detection of website-based Herniated Nucleus Purposes (HNP) uses the Naïve Bayes method[21], in his research he says the system is more accurate, it's just that the drawback is that it is not integrated with a clinic or hospital.

B. Maintaining the Integrity of the Specifications

Pregnancy

The following are some definitions of pregnancy:

Pregnancy is the union of sperm from a man and an ovum from a woman. Pregnancy is a period starting from contraception until the fetus is born, the normal length of pregnancy is 280 days, or 9 months and 7 days, which is calculated from the first day of the last menstrual period. Pregnancy is a woman containing a fertilized egg or pregnancy by sperm.

1. Etiology of Pregnancy

will occur if there are the following 5 aspects, namely:

Ovum

The ovum is a cell with a diameter of approximately 0.1 mm consisting of a nucleus floating in the vitellus surrounded by the zona pellucid by Radiata chromosomes.

Spermatozoa

Shaped like a tadpole, consisting of a slightly flattened oval head containing a core, a neck that connects the head to the middle, and a tail that can move so that sperm can move quickly.

Conception

a fusion event between sperm and ovum in the fallopian tube.

Nidation

Nidation is the entry or implantation of the product of conception into the endometrium.

Placentation

Placentation is a very important tool for the fetus which is useful for the exchange of substances between mother and child and vice versa.

2. Signs of pregnancy

Pregnancy has signs of whether a mother is pregnant or not, here are the signs of pregnancy:

a. Amenorrhea

If a woman is pregnant when she is already married complains of having late menstruation, then the mind that she is pregnant, despite the stress, drugs, chronic diseases can also result in delayed menstruation.

b. Nausea and Vomiting

Nausea and vomiting are common symptoms, ranging from bad taste to prolonged vomiting. In medicine, it is often called morning sickness because it occurs often in the morning.

c. Matodynia

Is a feeling of tightness and pain in the breasts caused by enlarged breasts?

d. Complaints of urinating

Increased urinary frequency and frequent nighttime urination, caused by the pressure of the enlarged uterus and the cranial pull by the uterus.

e. Change in weight

In 2-3 months of pregnancy, there is often weight loss, due to decreased appetite and vomiting.

f. Changes in basal temperature

A rise in basal temperature for more than 3 weeks is usually a sign of pregnancy.

g. Breast changes

Due to the stimulation of prolactin and HPL, the breasts secrete colostrum, usually after a gestation of more than 16 weeks.

j. Uterine changes

The uterus changes in size, shape, and consistency. The uterus turns soft and globular in shape.

k. There is a fetal pulse (FHR from 18-20 weeks)

l. Feel the movement of the child (started at 18-20 weeks UK)
III. Result

In advanced reasoning, the rules are tested one by one in a particular order. When every rule is tested, an expert system will evaluate whether the conditions are true or false. If the conditions are correct, then the rule is saved and then the next rule is tested. This process will be repeated until the entire rule base is tested under various conditions. According to Giarattano and Reley (1994), the advanced inference method is very suitable for handling control (controlling) and forecasting (diagnosis). Knowledge in production rules is presented in the form (1):

\[
\text{IF [antecedent] THEN [konsekuen]}
\]

\[
\text{IF [kondisi] THEN [aksi]}
\]

\[
\text{IF [premis] THEN [konklusi]}
\]

The rules in the production rule are classified into the first-degree rule and the meta-rule. Rule (2) the first degree is a rule whose concluding part is not the premise of another rule. on the other hand, the meta-rule is a rule whose conclusions are the premise for other rules. The following shows how, how the advanced continuous inference method works.

\[
A = 1 \quad \text{IF A = 1 AND B = 2}
\]

\[
B = 2 \quad \text{THEN C = 3 AND D = 4}
\]

\[
\text{IF C = 3 THEN D = 4}
\]

A. Knowledge Acquisition

Table 1. Symptom/disease coding matrix

| No | SymptomCodes | Disease Code |
|----|--------------|--------------|
|    | 0 1 2 0 0 0 0 0 0 1 1 1 1 |              |
| 1  | G001         | 1 1          |
| 2  | G002         | 1 1          |
| 3  | G003         | 1            |
| 4  | G004         | 1 1          |
| 5  | G005         | 1 1          |
| 6  | G006         | 1 1          |
| 7  | G007         | 1 1 1        |
| 8  | G008         | 1 1 1        |
| 9  | G009         | 1 1 1 1      |
| 10 | G010         | 1 1          |
| 11 | G011         | 1            |
| 12 | G012         | 1            |
| 13 | G013         | 1            |
| 14 | G014         | 1            |
| 15 | G015         | 1 1 1        |
| 16 | G016         | 1 1 1        |
| 17 | G017         | 1 1          |
| 18 | G018         | 1            |
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| Symptom Codes | Symptom                        |
|---------------|--------------------------------|
| G001          | Excess headaches               |
| G002          | Gaining excess weight          |
| G003          | Blood pressure between 140/90 or 160/110 |
| G004          | Proteinuria                    |
| G005          | Swelling of the face and hands |
| G006          | There is swelling in other parts |
| G007          | Yellow eyes                     |
| G008          | Pain in the stomach            |
| G008          | Nausea and vomiting            |
| G009          | Vaginal bleeding               |
| G010          | Vaginal bleeding               |
| G011          | Blurred vision                 |
| G012          | Proteinuria +3                 |
| G013          | Blood pressure greater than or equal to 160/110 |
| G014          | Convulsions                    |
| G015          | The tongue is dry and dirty    |
| G016          | Vomiting continuously until the mother feels weak |
| G017          | Difficulty defecating          |
| G018          | Loss of consciousness          |
| G019          | Double vision                  |

Explanation:

1. Codes beginning with the letter G are codes for symptoms. The following is a description of each code:
Symptom Codes

| Symptom                          |
|---------------------------------|
| G020 Vaginal bleeding occurs before 20 weeks of gestation |
| G021 Vaginal bleeding occurs after 20 weeks of gestation |
| G022 Lower abdominal pain        |
| G023 Upper abdominal pain        |
| G024 Pain that radiates throughout the lower abdomen |
| G025 Shoulder pain               |
| G026 Pain during bowel movements |
| G027 There is a lump on the back of the hip |
| G028 Fresh red blood             |
| G029 colic                       |
| G030 Blackish blood              |
| G031 Uterus tense like a plank   |

Codes beginning with the letter P are codes for disturbances. The following is a description of each code:

| Disease Code | Disease Data               | Keterangan                  |
|--------------|----------------------------|-----------------------------|
| P001         | Mild Pre Eclampsia         |                             |
| P002         | Severe Pre-Eclampsia       |                             |
| P003         | Hyperemesis Gravidarum level 1 |                         |
| P004         | Hyperemesis Gravidarum level 2 |                         |
| P005         | Hyperemesis Gravidarum level 3 |                         |
| P006         | Abortus                    |                             |
| P007         | Disturbed ectopic pregnancy|                             |
| P008         | Retrouterine hematocoele   |                             |
| P009         | Placenta Previa            |                             |
| P010         | Mild Placenta Solution     |                             |
| P011         | Medium Placental Solution  |                             |
| P012         | Heavy Placental Solution   |                             |
| P013         | Mola Hidatidosa            |                             |
| P014         | Eclampsia                  |                             |

B. Rule Production

Production rules are usually written in the form if-then (IF-THEN) which can be said to be a two-part implication relationship, namely the premise (if) and the concluding part (then). Premise and conclusion rules can relate to "OR" or "AND". The following are production principles in identifying disease:
Rule 1
IF Excessive headache '20'
AND Excessive weight gain '20'
AND Blood pressure between 140/90 or 160/110 '15'
AND Proteinuria '45'
THEN Mild Pre-Eclampsia
Aturan 2
Rule 2
IF Vomiting continuously until the mother feels weak
AND Vaginal bleeding occurs before 20 weeks of gestation
THEN Impaired ectopic pregnancy

In the case of tracing the decision tree above, there is a problem, that is, not all symptoms can be
detected according to the facts in the field, therefore as an expert, give a weight of 50% if a disease
is detected that has a weight of more than 50% then the disease is detected and if it is less than 50%
doubtful disease.

C. Matrix Value

Symptom / Disease matrix table

| Symptoms (G) / Disease (P) | Value Table |
|---------------------------|-------------|
|                           | P0 01 | P0 02 | P0 03 | P0 04 | P0 05 | P0 06 | P0 07 | P0 08 | P0 09 | P0 10 | P0 11 | P0 12 | P0 13 | P0 14 |
| G001                      | 20    | 30    | 30    | 20    | 20    | 20    |       |       |       |       |       |       |       |       |
| G002                      | 20    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G003                      | 15    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G004                      | 45    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G005                      | 40    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G006                      | 30    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G007                      | 45    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G008                      | 40    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G009                      | 40    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G010                      | 40    |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G011                      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G012                      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G013                      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G014                      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| G015                      |       |       |       |       |       |       |       |       |       |       |       |       | 45    | 30    |
Sample case

| Code  | Answer | Weight | Direction | Description |
|-------|--------|--------|-----------|-------------|
| G001  | Ya     | 45     | right     | G002        |
| G002  | Ya     | 20     | right     | G003        |
| G003  | Ya     | 15     | right     | G004        |
| G004  | Ya     | 15     | right     | G001        |

In the case example above the symptoms are met with a weight of 90%, the disease detected is P001 disease.

In Figure 1 above are the symptoms used in the initial question in an expert system for the early diagnosis of pregnancy disorders. If G001 is answered "YES" then it will go to G002 until P001 is found and so on. After the symptoms are grouped according to each disease and an examination is carried out on the knowledge base, the system can provide analysis results in the form of diseases attacked, symptoms that arise and diseases and suggestions for handling them.
IV. Conclusion

Expert System for Early Diagnosis of Disorders During Pregnancy Using the forward-chaining approach can help the process of diagnosing pregnancy disorders so that the diagnosis process is faster and this expert system has an output in the form of solutions about disorders that occur during pregnancy and provides explanations, levels of risk, anticipation and methods. treatment that must be done for the disorder that is being experienced. A Suggestion in developing Early Diagnosis of Disorders during Pregnancy with an Expert System Approach is that the making of the matrix should be done automatically by the system to make it easier for experts to analyze the system. The knowledge base of the system, namely data on pregnancy disorders, will be even better if it is added with data from the latest findings or research therefore the results of the diagnosis will be more accurate and the information obtained will be more complete.

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