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Web-based rule-based system for early detection of anemia among pregnant mothers

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Abstract. Anemia among pregnant mothers is a serious issue that may cause pregnancy complications, premature birth that can lead to mortality, and low birth weight (BBLR). Monitoring for anemia among pregnant mothers is quite a phenomenon for midwives and health professionals due to time constraint as it takes time to establish a proper diagnosis. Late diagnosis establishment results in late treatment. Therefore, this paper proposes a web-based rule-based information system using the rule-based algorithm to ease monitoring and detection of anemia among high risk pregnant mothers. The method employed is online rule-based information system to diagnose anemia among pregnant mothers. Respondents input data of symptoms that will then be processed by the information system to generate diagnoses. Resulting diagnoses are displayed as they are. The rule-based method in the information system validates data of symptoms and diagnoses with experts in the field to serve as reference in providing health care information. This is a pre-experimental research with one posttest group. The intervention group (N=10) was given treatment using the information system, while the control group (N=10) was given treatment manually. Interventions were conducted for 20 days, and measurements were carried out on the 21st day using the Technology Acceptance Model (TAM). The anemia detection system for pregnant mothers developed here is proven to be effective in helping anemia detection and has been validated by experts (midwives) and hence, been declared valid. With effectiveness score of 90 %, this web-based rule-based information system is effective in detecting, monitoring, and reporting anemia among pregnant mothers.

1. Introduction

Anemia among pregnant mothers is a serious issue that may cause pregnancy complications, premature birth that can lead to mortality, and low birth weight (BBLR) [1]. Establishing anemia diagnosis by health professionals requires considerable amount of time [2]. Late diagnosis establishment triggers worsening condition in patients as it will lead to late treatment [3,4]. Clinical diagnosis of all types of anemia is not always easy to perform due to some basic reasons. Once anemia starts, the cause has to be determined to ensure specific and proper therapy. Detection, classification, and treatment of anemia are the priorities of the health system [5].

Health Information System has been used to support everyday health care services administered in health facilities such as Public Health Center and hospitals to provide treatment and perform intervention on health issues [6,7]. However, reporting of health care services from administrative areas to data centers has not been able to produce accurate and timely data/information [8].

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On the other hand, anemia is often taken for granted as it is regarded as a common condition. Common people should have proper knowledge on its types and symptoms and how to prevent or treat anemia to minimize its risks. This can be achieved by making use of information technology for health care [9]. Especially in terms of its function as media to disseminate health information and diagnose illness. This will certainly be helpful for everyone in preventing and treating health problems. Those are some of the reasons why the researchers are interested in conducting this research of early detection of anemia among pregnant mothers using rule-based information system.

2. Methods

This research employed web-based rule-based information system to improve effectiveness of anemia detection and monitoring for pregnant mothers. Diagram of the information system is shown in Figure 1. The web-based rule-based information system is an innovation that helps ease of detection for risky pregnancy. This system can be accessed with a computer or smart phone and it features automated detection of risky pregnancy, once all input data are obtained, simply by visiting its web address.

Pregnant mothers have to fill out forms of biodata and medical, then the information system displays some questions related to symptoms and they must choose some questions concerning what they experienced by clicking the proper questions and then click on the Expert Diagnosis menu to see the results.

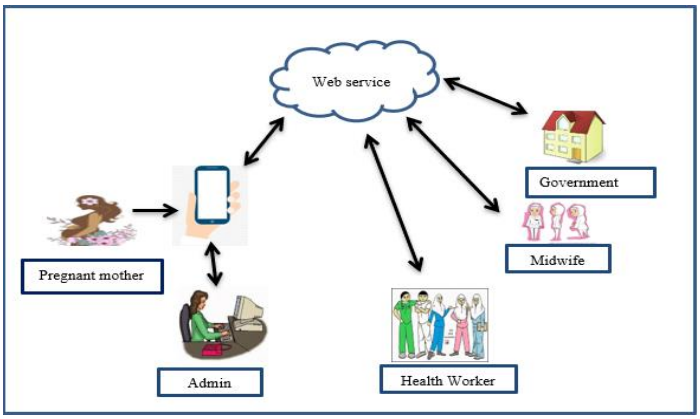

Figure 1. Information system diagram.

This system can also be accessed by health professionals, midwives, and government officials. Registration only requires logging in as an administrator by choosing a user name and a password before clicking user registration to be enrolled by the administrator of this information system. Once registered as an administrator, a user can log in and access recap of pregnant mother data and graphs and also classifications of anemia among pregnant mothers provided on a monthly basis. These data and graphs are updated and edited by the administrator.

This research involved two groups intervention, which is treated with the rule-based information system, and control, which is treated with the manual method. The dependent variables are anemia detection and effectiveness of information system, while the independent variable is web-based rule-based information system. This is a pre-experimental research using only one posttest group design. Samples of this research were midwives fulfilling inclusion criteria of 20-35 years old age range, able to operate computers or use smart phones, and willing to participate. The number of midwives as samples were 20.

The research instrument was web-based rule-based information system. Meanwhile, the materials used was TAM checklists to measure effectiveness of the information system. Detection results using this information system has been validated by experts (midwives). Diagnoses of anemia symptoms from the information system match those established by experts (midwives) and help to provide health care for pregnant mothers suffering from anemia.

3. Results and discussion

3.1. Displayed results from information system

Detection of anemia among pregnant mothers using web-based rule based information system is an innovation from the currently available system. This innovation to detect anemia among pregnant mothers helps with easy detection of risky pregnancy. It can be accessed via computers or hand phones with the advantage of automatic detection of risky pregnancy, once all input data are in. Recap menu on the information system is shown in Figure 2.

3.2. Graph menu of anemia among pregnant mothers on the information system

The graph shows automatic numbers of pregnant mothers registered in the system. The graph will also show interpretation and classification of anemia, which means whether a mother is suffering from iron deficiency, folic acid deficiency, B12 anemia, hemolytic anemia, aplastic anemia, or even just having a normal pregnancy. This menu helps with easy and speedy reporting of data of pregnant mothers with anemia by midwives. In terms of information system, diagnosis for anemia is obtained after input if symptoms data is done. Symptoms of anemia is shown in Figure 3. Graph menu of anemia among pregnant mothers on the information system is shown in Figure 4.

3.3. Comparison of service speed between the web-based and the manual methods

Shows speedy detection of pregnant mothers with anemia using the web-based method is 23 minutes faster. It is 23 minutes faster for pregnant mothers with anemia to get treatment. This reduced time needed for diagnosis is the result of automated time from input data to the time they are converted into status of anemia among pregnant mothers. Longer detection affects further intervention and treatment. comparison of service speed between the web-based and the manual methods on the information system is shown in Table 1.

No	I	Name of Pregnant Woman	Age	Gestational age	No HP	Address	Husband's name	Husband's Education	Husband's work	Blood Group	Interest rate	HB	Hypotension	Pulsating	Breathing	Diagnosis of Disease	Action
1	18100201049400002	Rahayu ningsih	21	20	08126708354	mataram	only raw	High school	entrepreneur	B	Java	10	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Iron Deficiency Anemia	
2	18100205603850005	Lesmy	33	31	085768966680	tulung agung	nurdan	High school	entrepreneur	B	Java	10	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Normal	
3	18090406804870002	goddess apriyani	31	35	085299786543	tegalrejo	riko	High school	entrepreneur	A	Java	10	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Normal	
4	18100206304870003	partini	33	36	082239765432	mataram	tasyari	High school	Farmer	B	Java	10	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Normal	
5	18100206008940002	elma yesiantika	26	34	085245569987	klaten	stir	High school	entrepreneur	B	Java	11	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Normal	
6	18100204708900007	Arniss Agustina	28	32	082147789678	klaten	deni ariyanto	High school	entrepreneur	B	Java	10	Normal : 100/90 mmhg	Normal : 80 x/menit	Normal, 20 x/menit	Normal	
7	18002410788000 60	retna	31	34	085268799004	ivory	want	High school	Farmer	A	Java	10	Hypotension: <90/80	Normal : 80 x/menit	Bradipneu: <16 x / minute	Iron Deficiency Anemia	
8	18100204903980002	Rantika	26	30	085266785342	addrejo	what	S1	entrepreneur	B	Java	10	Hypotension: <90/80	Bradicardia: <60 x / min	Bradipneu: <16 x / minute	Iron Deficiency Anemia	

Figure 2. Recap menu of anemia among pregnant mothers.

Information System Results Early Detection of Pregnant Women Anemia

Selected Symptom ID	Symptom Name selected
GP002	Do you like to complain about being tired quickly and tired when doing activities during this pregnancy?
GP004	Is the mother's diet irregular and loss of appetite?
GP007	Do you often feel headaches and are difficult to concentrate?
GP008	Do you often feel weak and often sleepy?

Results of Anemia Disease for Every Disease

P001 Normal = 0

P002 Iron deficiency anemia = 0.121212121212

P003 Folic acid deficiency anemia = 0

P004 Anemia Aplastik = 0

P005 Anemia Aplastik = 0

P006 Anemia Deficiency B12 = 0

Value of Information Systems Early Detection of Pregnant Women Anemia = **0.121212121212**

With Disease = **Iron Deficiency Anemia**

Handling Solution = **You experience symptoms of anemia, iron deficiency. Treatment of iron deficiency anemia by taking iron supplement supplements is done to increase iron levels in the body. Iron intake through food consumption also needs to be increased, this is in order to**

Figure 3. Symptoms of anemia.

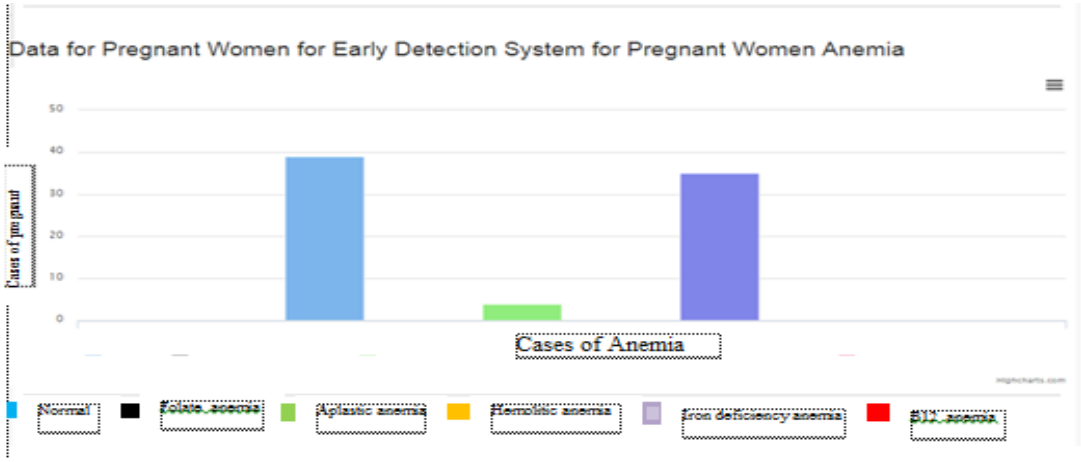

Figure 4. Graph menu of anemia among pregnant mothers.

Table 1. Comparison of service speed between the web-based and the manual methods.

Variable	Method	Mean Time
Speed (minute)	Manual Method	38 minutes
	Web-based Method	15 minutes

However, the speed of service from this web-based rule-based information system also depends on Internet connection. The better the Internet connection, the faster health care services can be provided for pregnant mothers. On the contrary, the worse the Internet connection, the slower health care services can be provided for pregnant mothers. Nonetheless, information on this web-based rule-based information system can still be accessed when the computer is offline or not connected to any Internet network. Hence, there is no need for real concern.

Information technology has transformed into many forms, including information system. Information system as part of information technology is required to improve organizational performance. Information that is assembled in orderly, clear, precise, and speedy way and is presented in a decent report certainly facilitate smooth operation of organizations and decision-making processes. The

aforementioned analyses lead to a conclusion that early detection of anemia among pregnant mothers using information system built here can also serve as a means of recording and reporting [10].

Health Information System (SIK) has been used to support everyday health care services administered in health facilities such as Public Health Center and hospitals to provide treatment and perform intervention on health issues. However, reporting of health care services from administrative areas to data centers has not been able to produce accurate and timely data/information.

3.4. Accurate diagnosis of anemia detection among pregnant mothers using web-based rule-based information system. Accurate diagnosis from web-based rule-based information system as validated by experts (midwives)

Monitoring for pregnancy anemia is not only meant for mothers who are not well. It is aimed at knowing and dealing with health problems among pregnant mothers with the help of health professionals to maintain their healthy diet and lifestyle. Earlier accurate diagnosis is advantageous as it helps with efforts to prevent, stimulate proper treatment and referral to obstetricians for even better care. An earlier study comparing clinical diagnosis written manually in letters accepted by hospital consultants and those being given as inputs in a computer revealed that the latter is more satisfactory in many clinical settings. Diagnoses established by general practitioners are often not independently verified. They require further research to determine their accuracy [11,12].

Shows results from the web-based system and from expert (midwives) validation of 5 anemia classifications revealed an accuracy of 100 % valid. The system's diagnosis accuracy reveals good sensitivity scores of 83% and 80% specification. The information system developed is capable of accurate detection of anemia among pregnant mothers in terms of classifying types of anemia such as iron anemia, folic acid anemia, hemolytic anemia, aplastic anemia, and B12 anemia. Therefore, it can be said that the matches between diagnoses from the information system and those from the experts (midwives) are accurate. diagnosis accuracy of the web-based system and the experts (midwives) validation on the information system is shown in Table 2.

Table 2. Diagnosis accuracy of the web-based system and the experts (midwives) validation.

Anemia Score	Hb	System Diagnosis	Expert Diagnosis	Explanation
B (4)	10 g/dl	Iron anemia	Iron anemia	Valid
A (1)	11g/dl	Normal	Normal	Valid
B (5)	10g/dl	Iron anemia	Iron anemia	Valid
A (1)	11g/dl	Normal	Normal	Valid
A (1)	11g/dl	Normal	Normal	Valid
C (3)	9 g/dl	Aplastic anemia	Aplastic anemia	Valid
D (4)	9 g/dl	Hemolytic anemia	Hemolytic anemia	Valid
E (3)	10 g/dl	B12 anemia	B12 anemia	Valid
F (3)	9 g/dl	Folic acid anemia	Folic acid anemia	Valid
A (1)	12 g/dl	Normal	Normal	Valid
Total		10	10	
Diagnosis validation		100 %		Valid

3.5. Validation for effectiveness of the web-based rule-based information system is carried out using the TAM checklist that cover all related aspects

Shows validated effectiveness of the web-based rule-based information system from 10 experts (midwives) using the web-based information system who gave TAM score based on aspects of completeness, ease, match, accuracy, and precision, results in a total score of 90 %, which means that the web-based rule-based information system is proven to be effective. This proves that the web-based rule-based information system developed here is worth using to help with early detection of anemia among pregnant mothers. validation of web-based rule-based information system effectiveness on the information system is shown in Table 3.

The various facilities provided by the rule-based web-based information system for the detection of anemia in pregnant women by the user have a positive impact. Users no longer just judge, but users can

make this rule-based web-based information system like a need to monitor, detect anemia of pregnant women in health services [13]. If someone feels the internet is easy to use, it will be more often or more willing to use it [14].

Table 3. Validation of web-based rule-based information system effectiveness.

Variable Effectiveness	Score										Total	
	SB		B		C		KB		BR			
	N	BB	N	BB	N	BB	N	BB	N	BB	BB	%
Completeness	5	5	5	4	-	3	-	2	-	1	4.5	90
Ease	5	5	5	4	-	3	-	2	-	1	4.5	90
Matches	4	5	6	4	-	3	-	2	-	1	4.4	86
Accuracy	5	5	5	4	-	3	-	2	-	1	4.5	90
Precision	6	5	4	4	-	3	-	2	-	1	4.6	92
Speed	5	5	5	4	-	3	-	2	-	1	4.5	90
Total effectiveness score											4.5	90

4. Conclusion

Results show that the web-based rule-based information system developed here is an innovation that helps the process of detection among pregnant mothers with 23 faster diagnoses to suggest proper treatments. The web-based rule-based information system has also been successfully validated by experts (midwives) and has been granted validity for its capability in automatically providing accurate diagnosis of pregnancy anemia categorization The web-based rule-based information system is also effective to detect, monitoring, and report cases of anemia among pregnant mothers for proper health care services to be administered.

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