Web-Based Comprehensive Assessment for Postpartum Care using Rule-Based Algorithm

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Abstract Administration of postpartum care has been performed in line with health care standards. Unfortunately the health service medical record data is still incomplete. This results in delays in establishing a diagnosis and providing therapy which results in a worsening of the postpartum mother’s condition. This paper proposes a web-based information system that may become one solution in solving the remaining issues in postpartum care. The system developed here is expected to improve health care quality with better data completion of postpartum mothers and access to them. The system developed here is web-based, in that it applies the rule-based artificial intelligence system. Input of the system are results of physical examination performed by medical professionals. Then processed using the rule-based algorithm to produce diagnosis and proper recommendation. This research is quasi-experimental using posttest only with control group. There were 40 were categorized into intervention group (n=20) who used the information system and control group (n=20) who used the present system endorsed by the government. The rule-based algorithm in the information system uses validation from experts. Results show that the information system developed here is capable of solving the issue of incomprehensive data, as well as effectiveness in providing postpartum care.

1. Introduction
Postpartum period is a critical phase in a mother’s life. There are many major changes taking place here. However, quality health care during this period has often not been properly provided and this may result in fatality, as is evident in cases of maternal morbidity [1]. The goal of postpartum care to detect issues with mothers’ health is often less successful as postpartum is often taken for granted as a physiological condition all mothers giving birth experience [2]. The physical examinations performed are still limited to observations of blood pressure, pulse, temperature, respiration, uterine involution, lochia, and per vaginam observation, as well as breast[3]. Late diagnosis establishment results in worsening condition of the patient at it means late treatment of certain diseases[4-6]. The WHO recommends evaluations and different strategies in implementing recommended postpartum care and the role of mHealth in improving the scope and quality of postpartum care. mHealth it is a WHO program serving as a modified healthcare breakthrough via information system in dealing with health issues affecting mothers and children [7].

This research proposes a web-based, rule-based information system capable of establishing diagnosis and providing online recommendation. Better access to health information has proven to increase trust in diagnosis and treatment, obedience, self-confidence, and independence for patients to treat take
care of their own health, as well as saving cost for treatment [8-10]. This is because the data gained from application and information technology network are different compared to those written manually. Manually written data are still doubtful in terms of accuracy and hence, may result in serious consequences [11]. The rule-based algorithm is a mechanism that generates deductive logic explaining results based on algorithmic rules. Execution flow of rule-based algorithm involves research, identification, and experiment. Activation of each rule consists of a pair of rules that results in information [12].

2. Method
2.1 Framework
Information access is performed online that requires internet connection as the system is web-based. Nurses who have performed physical examination on delivering mothers input data to the system, which will in turn be used to generate diagnosis and proper recommendation. This system automatically report results to the government. A diagram of the information system developed is shown in Figure 1.

![Diagram of the information system developed](image1.png)

**Figure 1.** Diagram of the information system developed

Information of diagnosis establishment and proper recommendation concerning postpartum problems in the information system is validated by 2 experts, who are nurses. Validation test for the information system is performed using calculation of correct data divided by all data and times 100%.

The rule-based algorithm developed inputs all rules applied in establishing diagnosis and giving recommendation on postpartum care issues to the web. Nurses as users input data of examination results into the system, which in turn are automatically processed by the system, along with the rules set, to generate diagnosis and recommendation to end users. A framework of the rule-based algorithm developed is shown in Figure 2.

![Framework of the rule-based algorithm](image2.png)

**Figure 2.** Framework of the rule-based algorithm

Input data are mothers’ identities and examination results of: vital signs, physical examination, lactating issues, and accompanying disease history of delivering mothers comprising 22 items. In the processing stage, input data are processed using the information system to generate diagnoses whether those delivering mothers are having any issues or not, and the kind of recommendations according to those diagnoses based on the rules set. Those data are also managed into documentations and case reports. Hence, generated output includes postpartum diagnoses and their suitable recommendations. A framework of the information system developed is shown in Figure 3.
2.2 Research Type and Design
This research is quasi-experimental with posttest control group. It was carried out in a Community Health Center (Puskesmas). The sampling technique employed was non-probability sampling with consecutive sampling involving 40 respondents. Respondents were categorized into intervention group (n=20), who used the information system, and control group (n=20), who used the present system endorsed by the government. Intervention was performed for 42 days in three examination stages before posttest was carried out for evaluation of system’s effectiveness using questionnaire.

3. Result and Discussion
Respondents were nurses conducting physical examination to postpartum mothers. Data were collected from identities and physical examination results by those nurses. Informed consents were obtained from delivering mothers and nurses by highlighting research procedures and benefit.

3.1 Physical Examination Data Comprehensiveness
Physical examination data contains the type of examinations nurses or healthcare professionals must perform. Details of physical examination data comprehensiveness are shown in Figure 4.

![Figure 4. Comprehensiveness of physical examination data from patients](image)

Diagram of prevalence from each diagnosis describes the number of cases found at each examination stage. Details of the number of cases from each examination stage are shown in Figure 5.

![Figure 5. A graph of diagnosis reported data from each examination](image)

A recap of examination data from all patients will automatically be displayed once nurses finish inputting examination results, and this helps nurses and healthcare professionals to perform further
examinations and reporting. Details displayed in the recap include patients’ identity, examination results from stage 1-3, and names of examining nurses. Details of physical examination data recap are shown in Figure 6.

Figure 6. A recap of total data

Results of comprehensive physical examination data analysis are given in detail in Table 1.

| Group                          | n   | %    | Mean | SD  | Mean Rank | p-value |
|-------------------------------|-----|------|------|-----|-----------|---------|
| Intervention (Information System) | 20  | 100  | 2.00 | 0.00| 30.50     | 0.000   |
| Control (Manual)               | 9   | 45   | 1.00 | 0.00| 10.50     |         |

Respondents of the intervention group were all (100%) undergoing thorough physical examination. Meanwhile, only 45% respondents underwent thorough physical examination in the control group. Therefore, it can be concluded that the use of comprehensive assessment information system for postpartum care using rule-based algorithm improves comprehensiveness in physical examination data by 55%.

The ideal postpartum examination for mothers should include head examination, breast examination, uterine involution, per vaginam delivery, perineal wound treatment for a trauma, elimination and defecation, and mobilization. The most commonly performed examinations are blood pressure and per vaginam involution. Incomprehensive physical examination poses risks to postpartum mothers [3,13,14]. The use of information system allows for more comprehensive physical examination data compared to only performing physical examination as required by the government. Data comprehensiveness of the physical examination performed affects diagnosis establishment and the subsequent care administered to patients. Incomprehensive physical examination performed results in improper diagnosis and hence, unsuitable care that is certainly not beneficial for the health of the patient, as well as being disadvantageous to the healthcare professional him/herself[6].

The use of information system can be a solution to data incomprehensiveness that is commonly prevalent during examination or reporting. Healthcare professionals can have a look at patients’ data anytime, anywhere. This means quicker decision making by those healthcare professionals [15]. Information system allows for more comprehensive and quicker physical examination data, especially in rural areas, as it helps nurses and healthcare professionals to communicate in order to determine the proper measure to deal with health problems at hand [16].

3.2. Information System Effectiveness

Results of information system effectiveness analysis are given in detail in Table 2.

| No  | Variable effectiveness | Number of respondents | Score Average | Percentage (%) |
|-----|------------------------|-----------------------|---------------|----------------|
| 1   | Usefulness             | 20                    | 4             | 80             |
| 2   | Promptness             | 20                    | 4.4           | 88             |
| 3   | Suitability            | 20                    | 4.25          | 85             |
| 4   | Ease                   | 20                    | 4.4           | 88             |
| 5   | Accuracy               | 20                    | 4.2           | 84             |
| 6   | Trustworthiness        | 20                    | 4.4           | 88             |
|     | Average                | 20                    | 4.27          | 85.5           |
Information system effectiveness test shows a value of 4.27 (85.5%) in terms of usefulness, speed, ease, accuracy, and trustworthiness. Therefore, it can be concluded that the information system for comprehensive assessment of postpartum care using rule-based algorithm is effective.

This information system is introduced to alter the way data are collected, from the conventional to a more systematic and modern way whilst maintaining and distributing them. It helps healthcare professionals and administration staff to store information on patients’ health digitally and to use them in an efficient and effective way for healthcare services [17]. Negligence and late care by healthcare professionals need to be mitigated. Information technology can be a real-time error monitor that minimizes mistakes in providing proper services, from analysis to drug administration, identification of improper doses and evaluation of newborn care (using computers), with care still being given manually [18]. Information system can be one solution of the many issues related to healthcare services such as lack of resources, lengthy reporting and administration processes, incomplete data, late diagnosis and treatment, distance to healthcare facilities, transportation cost to healthcare facilities, and the likes [11,19-26].

4. Conclusion

Comprehensive assessment in postpartum care using rule-based information system can help solve problems in healthcare services, with improve physical examination comprehensiveness by 55%. It is also evident from 100% validated data on diagnosis establishment and recommendation that physical examination. Therefore, the information system developed here is effective by 85.5% in providing proper postpartum care.

5. Reference

[1] World Health Organization. Who recommendations on postnatal care of the mother and newborn: World Health Organization; 2014.

[2] Haran C, Van Driel M, Mitchell BL, Brodribb WE. Clinical guidelines for postpartum women and infants in primary care—a systematic review. BMC pregnancy and childbirth. 2014;14(1):51.

[3] Walsh D. A review of evidence around postnatal care and breastfeeding. Obstetrics, Gynaecology & Reproductive Medicine. 2011;21(12):346-50.

[4] Cheng S, Chen W, Yang Y, Chu P, Liu X, Zhao M, et al. Effect of diagnostic and treatment delay on the risk of tuberculosis transmission in shenzhen, china: An observational cohort study, 1993–2010. PLOS ONE. 2013;8(6):e67516.

[5] Kristensen KL, Podlekareva D, Ravn P. Delayed diagnosis of severe tuberculous spondylodiscitis in an asylum seeker: patient or doctors delay? Respiratory medicine case reports. 2017;21:145-6.

[6] Minghella E, Lakhani M, Hughes C, Thomas. B. Delayed diagnosis of cancer: Thematic review presents the findings of a project at the npsa which was designed to explore issues of patient safety around delayed diagnosis of cancer, and provide the nhs with potential solutions.: National Patient Safety Agency; 2010. Available from: http://www.nrls.npsa.nhs.uk/resources/?entryid45=69894.

[7] Kay M, Santos J, Takane M. Mhealth: New horizons for health through mobile technologies. World Health Organization. 2011;64(7):66-71.

[8] Giglia R, Binns C. The effectiveness of the internet in improving breastfeeding outcomes: A systematic review. Journal of human lactation: official journal of International Lactation Consultant Association. 2014;30(2):156-60.

[9] Alianmoghaddam N, Phibbs S, Benn C. Resistance to breastfeeding: A foucauldian analysis of breastfeeding support from health professionals. Women and birth: journal of the Australian College of Midwives. 2017;30(6):e218-e281.

[10] Martinez-Brockman JL, Shebl FM, Harari N, Perez-Escamilla R. An assessment of the social cognitive predictors of exclusive breastfeeding behavior using the health action process approach. Soc Sci Med. 2017;182:106-16.

[11] Craswell A, Moxham L, Broadbent M. Perinatal data collection: Current practice in the australian nursing and midwifery healthcare context. Health Information Management Journal. 2013;42(1):11-7.
[12] Minutolo A, Esposito M, De Pietro G. Optimization of rule-based systems in mhealth applications. Engineering Applications of Artificial Intelligence. 2017;59:103-21.

[13] Departemen Kesehatan RI. Pedoman pemantauan wilayah setempat kesehatan ibu dan anak (pws-kia). Depkes RI: Jakarta. 2010.

[14] Helsloot K, Walraevens M, Besauw SV, Van Parys A-S, Devos H, Holsbeeck AV, et al. A systematic approach towards the development of quality indicators for postnatal care after discharge in flanders, Belgium. Midwifery. 2017;48(Supplement C):60-8.

[15] Graham W, Woodd S, Byass P, Filippi V, Gon G, Virgo S, et al. Diversity and divergence: The dynamic burden of poor maternal health. The Lancet. 2016;388(10056):2164-75.

[16] Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mhealth) projects in Africa. BMC Public Health. 2014;14(1):188.

[17] Mohamadali NA, Ab Aziz NF. The technology factors as barriers for sustainable health information systems (his) – a review. Procedia Computer Science. 2017;124:370-8.

[18] Li Q, Kirkendall ES, Hall ES, Ni Y, Lingren T, Kaiser M, et al. Automated detection of medication administration errors in neonatal intensive care. Journal of biomedical informatics. 2015;57:124-33.

[19] Agarwal S, LeFevre AE, Lee J, L’Engle K, Mehl G, Sinha C, et al. Guidelines for reporting of health interventions using mobile phones: Mobile health (mhealth) evidence reporting and assessment (mera) checklist. Bmj. 2016;352:i1174.

[20] Barrote A, Silva P, Gonçalves F, Cruz-Correia R. Obstetric information system: Effectiveness in health care practice. Procedia Technology. 2014;16:1411-6.

[21] Bert F, Giacometti M, Gualano MR, Siliquini R. Smartphones and health promotion: A review of the evidence. Journal of medical systems. 2014;38(1):9995.

[22] Bogren MU, Berg M, Edgren L, van Teijlingen E, Wigert H. Shaping the midwifery profession in Nepal – uncovering actors’ connections using a complex adaptive systems framework. Sexual & Reproductive Healthcare. 2016;10(Supplement C):48-55.

[23] Izudi J, Amongin D. Use of early postnatal care among postpartum women in eastern Uganda. International Journal of Gynecology & Obstetrics. 2015;129(2):161-4.

[24] Koblinsky M, Moyer CA, Calvert C, Campbell J, Campbell OMR, Feigl AB, et al. Quality maternity care for every woman, everywhere: A call to action. The Lancet. 2016;388(10057):2307-20.

[25] Labrique AB, Vasudevan L, Kochi E, Fabricant R, Mehl G. Mhealth innovations as health system strengthening tools: 12 common applications and a visual framework. Global Health: Science and Practice. 2013;1(2):160-71.

[26] Wan S-X, Li H-L, Wang W, Shen Q, Li C-H, Lyon ME, et al. Psychometric properties of the postpartum women health quotient scale among Chinese postpartum women. Midwifery. 2016;39(Supplement C):63-70.