Original Article

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# Development of an electronic partogram for safe and secure labor management

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**Abstract**

We have developed an electronic partogram with display and input support functions to obtain accurate on-time display and recording of observation and care data required for safe and secure labor management. Here, we investigated the clinical usefulness of our partogram.

This system is characterized by the functions of touch input support using choices, text input support by voice, and status input support by pictures, promoting on-time recording and providing a highly flexible input environment with easy input of various data. The degrees of freedom for input were enhanced so that midwives can select input methods according to labor progression and the status of care intervention. In addition, input by pictures allowed for recording of situations that are difficult to express in words. The system received a high evaluation for easy operability, on-time recording, and easy recording of occurrences of meconium-stained amniotic fluid.

With regard to information display, there were comments that it is good that all information needed for labor management is covered comprehensively in one screen. However, some issues remain concerning the contribution to the development of midwifery processes, such as evaluation of the thoughts and requirements of midwives.

We confirmed the accurate performance of each function.

However, the study suggested that improvement of voice input accuracy will further enhance the clinical usefulness of our electronic partogram system.

**KEY WORDS**

Midwives, Partogram, Electronic Medical Record System, Labor Management, Development

## Introduction

Although delivery is a natural event, management is necessary to prevent hemorrhage and fetal distress during labor. In addition, the number of high-risk births is increasing due to delivery at advanced maternal ages and an increase in the rate of low birthweight infants. Therefore, midwives need to provide not only care for normal labor but also advanced medical care and individualized care in response to high-risk expectant and nursing mothers. Because the judgment of midwives primarily involved in care has a substantial effect on the health of parturient women and fetuses, particularly during high-risk delivery[1-4] , partograms, which utilize the experiences and knowledge of efficient midwives, are important for safe and secure labor management.

Partograms provide an overview of the course of labor using graphs and records. It is also important to monitor fetal well-being[5] . Nursing care practice recorded in the partogram shows the thoughts and actions of midwives; it not only contributes to information sharing and continuity of care but also serves as precious materials for the evaluation of care and improvement and development of care.

Meanwhile, the introduction of an electronic medical

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record system was promoted[6] by "IT New Reform Strategy (2006)[7]"; in 2014, an electronic medical record system was introduced in approximately 72% of hospitals with over 400 beds[8].

However, several issues have been raised regarding the use of electronic record systems: much time is expended entering data due to the multitude of software windows involved and the complexity of operations required; it is difficult to simultaneously provide care and enter records[9-12], and retrieving patient information is difficult[13,14]. For midwives constantly providing care such as labor-pain relief while in close proximity to parturient women, entering data punctually into an electronic record system is an exceedingly arduous task[11]. Whenever abnormalities appear—and sometimes when participating in multiple deliveries occurring at the same time—the involved obstetricians, midwives, and other staff put together a plan by accurately estimating labor progress and delivery times and using those estimates to prepare their equipment and environment and implement care. This is why the question of how accurately the state of delivery progress can be grasped in real time has become a very important one; the reality is, however, that data is being entered after the fact which results in information being omitted[11] and makes getting a true understanding of a situation in real time problematic.

Furthermore, recording the course of labor is emphasized in cases of the unexpected death of babies and stillbirths in "Medical Accident Investigation System[15]" and in the report of the analysis of cases to which "Obstetric Compensation System[16]", established in 2009, is applicable. Therefore, for records of proof of the normal course of labor, for high-risk labor, and labor management requiring advanced medical care, it is necessary to improve partograms that can display and record data.

## Objectives

The objective of this study was to develop an electronic partogram system with a user-friendly interface and input method that enables efficient real-time recordkeeping, which is required for safe and secure labor management. We also investigated its clinical usefulness.

## Study methods

1. System design of an electronic partogram

We conducted focus-group interviews with midwives who use electronic partograms on the issues and difficulties they encounter when entering information into such systems. We then extracted from that data those problems which related to recording information during delivery and used it to design our system. Study subjects included 21 midwives from four facilities, with an average age of 38years (ranging from 24–54 years) and an average number of years of midwife work experience of 13 years (ranging from 2–31 years).

For convenience, the interviews were conducted with small groups of 2–4 individuals. Each interview required 30–60 minutes to complete.

In the design, we also included items noted as having insufficient descriptions in medical examination records in "The 2nd Obstetric Compensation System: Report on Recurrence Prevention[16]".

We first specified information items required for recording the course of labor and then designed the system to address the following three items related to failure and issues in record keeping that were obtained from midwives' use experience of electronic partograms: "difficulty in on-time data entry," "cumbersome operation required for data entry," and "display format making it difficult to enter necessary information to record the course of labor." Also, based on the report of the Obstetric Compensation System, the system was designed to improve the following: 1) insufficient descriptions about the start time of actions and procedures at the time of abnormality occurrences and the number of procedures; 2) insufficient descriptions of drug dose and dosing speed at the time of labor induction; and 3) insufficient descriptions about meconium-stained amniotic fluid.

Figure 1 shows the data structure of the electronic partogram we developed.

2. Evaluation of the electronic partogram

1) Evaluation of system functions

We evaluated whether the results of the course of actual labor entered into the developed system on-time are accurately entered and displayed. For accuracy evaluation of voice input, a description of records of the course of labor was entered by voice, and the accuracy was evaluated based on the degree of concordance. Assuming actual labor-stage situations, we simulated two environments, a quiet environment and an environment where the parturient woman's voice and fetal heart movement were heard.

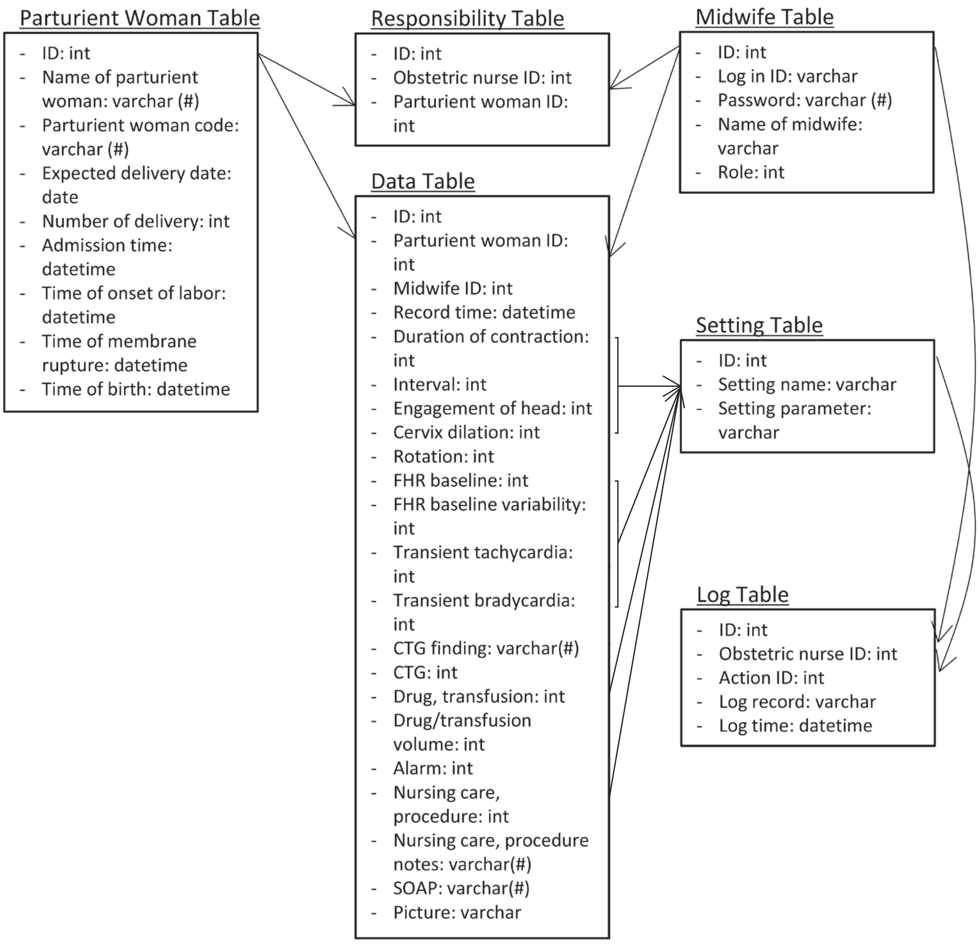


Figure 1. Data structure of the electronic partogram

2) Introduction and usability evaluation of developed system

Midwives who participate in delivery and who utilize electronic record systems were selected as subjects for the study. Subjects were asked to provide their ages and number of years of experience as midwives. We explained to them the functions of the partogram and asked about its usability using a video of the system in semi-structured interviews. The interview contents included ease of performing on-time recording and ease of seeing information. We also had the subjects evaluate 13 question items independently created by the researcher on a five-level Likert scale in order to inquire about the usefulness of the system. These questions were structured around issues related to the input of electronic records as obtained from case studies and other reports corresponding to the Medical Accident Investigation System[15), the Obstetric Compensation System[16), and previous research[9-14).

**Ethical considerations**

We explained the objectives and methods of this study, the voluntary nature of participation in the study, the right to withdraw from the study, protection of anonymity, and safe retention and disposal of data for study participants, and obtained participant's consent to cooperate in the study in writing.

This study was conducted with the approval of the ethical committee of Kanazawa University (January 27, 2014, Review No. 499; January 6, 2016, Review No. 647-1).

**Results**

1. Overview of electronic medical record system developed in this study

Visual C# 2013 and Sqlite were used in the development environment of the electronic partogram. The system operates in computers with Windows 8.1 or newer versions. With regard to voice input, the text input function using Google Speech API ver. 2[17) was installed after considering the accuracy of short text input.

Using the ID of Parturient Women Table, which manages expected delivery date, admission time, delivery start time, and time of membrane rupture as the main information, the system consists of a Midwife Table containing the midwife's name, log-in ID, and password; a Data Table for the management of biological information entered into the partogram; records on drugs, care, and procedures; course records; and data entry time; a Setting Table for the management of option settings; and a Log Table for recording the use conditions of the electronic partogram.

In addition to encryption of the database itself, items marked with (#) in Figure 1 are further encrypted using the Rijndael algorithm[18) , guaranteeing the safety of information entered.

1) Input support function

For data input, the following two systems are supported: a system to collectively enter different types of data at the same time and a system to enter different types of data individually.

For the touch input function, input items for typical care and procedures were stored in the setting table of the database in advance. These are the items whose implementation timing are particularly important and for which intervention with care by midwives are important as labor-stage care and procedures based on textbooks used in midwifery education[19,20)] .

Large categories included [Pain relief during labor] , [Fulfillment of basic needs] , [Promotion of labor progression] , and [Explanation and support] . [Pain relief during labor] included 1) breathing method, 2) oppression method/massage method, and 3) hot fomentation. [Fulfillment of basic needs] included 1) meal and water intake, 2) sleep and rest, and 3) urination; [Promotion of labor progression] included 1) walking and 2) consideration of body positions; and [Explanation and support] included 1) explanation of labor progression, and 2) attending and encouraging parturient women.

Procedures were included under the item of "wearing a labor monitoring de vice."

Items such as rotation can be entered by rotating the image with a flick operation. In order to measure differences in input contents among hospitals and midwives, we designed the system to include new input items, which were not available as options at the time of input, to appear as options at the time of subsequent input operations.

Text input by voice made it possible to input text at locations distant from tablet PCs by using a Bluetooth headset in this prototype.

2) Display function

The basic information for parturient women is to manage the expected delivery date, admission time, time of onset of labor, and time of membrane rupture for each parturient woman. These pieces of information recorded in a Parturient Woman Table can be displayed on electronic partograms for each woman. The list displays records for the course of labor, such as partogram, care, procedures, and subjective, objective, assessment, and plan (SOAP) notes in a time-series list. With admission time as the origin of input, it is possible to display not only actual time but also time elapsed from the onset of labor and time elapsed from membrane rupture. To enable long-time recording, it has the function to display reduced and enlarged graphs. For continuous recording by such devices as the labor monitoring device, information is presented with an arrow against the time course from the start to the end. The timer function allows the timer to go off according to data entered by midwives. It also lets the alarm go off every 24 hours after membrane rupture and displays this on the screen.

2. Function evaluation of the electronic medical record system

We evaluated the input support and display function using evaluation cases.

For data input, we entered data 20 times and confirmed that touch operation for options and rotation could be executed without problems. For voice input, "Jabra® BOOST" was used with a Bluetooth headset in consideration of the convenience of input capability from locations distant from tablet PCs. Simulating the labor-stage environment, we simulated two environment patterns, a quiet environment and an environment where a parturient woman's voice and fetal heart movement could be heard. We conducted voice input five times in each environment and evaluated the accuracy of the system.

A total of 100 inputs by voice in five evaluations were correct. For interventions, procedures, drug administration, and recording of course in the SOAP format, some of the medical terms and drug names were

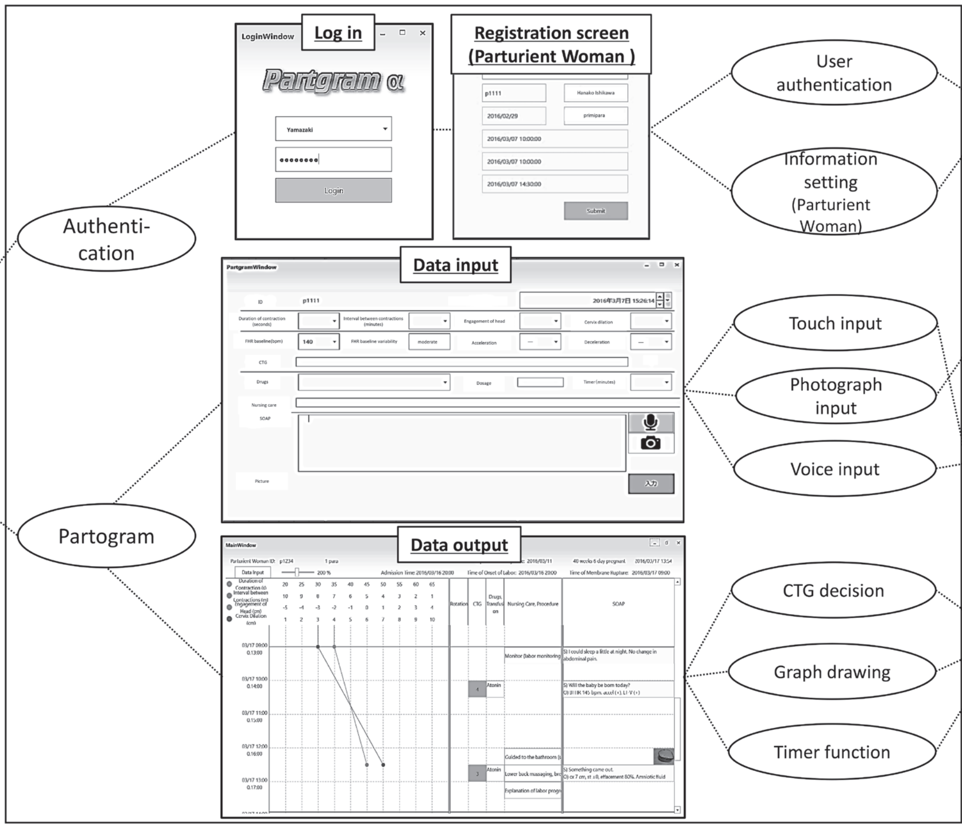


Figure 2. Electron partogram configuration

not converted correctly, resulting in incorrect descriptions. In addition, punctuation, space, and line breaks required in recording could not be entered by voice. Moreover, for alphanumeric characters, upper and lower case letters could be differentiated, and the unit of "mL" was described as katakana in some cases.

The percentages of correct conversion and entry by voice input were 73.7%, 988 out of 1340 characters (mean of 5 evaluations) in a quiet environment and 73.2%, 981 characters (mean of 5 evaluations) in a labor-stage environment. We also confirmed the accurate performance of the display and timer functions.

3. Improvement of system design and usability evaluation by midwives

Interviews were conducted on 10 subjects. The average age of the subjects was 43 years (ranging from 25–60 years) and the average number of years of midwife work experience was 25 years (ranging from 2–33 years) .

We asked midwives about the usefulness of the electronic partogram we had de veloped (Figure 3) . All subjects responded with “Agree” for 10 of the 13 items. The item receiving the highest evaluation was “Recording of meconium stains.” A common opinion was that storing images by taking pictures enables more accurate recording than text input and that is simply an easier process. Also highly rated was “Recording drug dosage and rate of administration” due to the ease of entering data and the availability of voice input, which allows midwives to record administration times and other information while providing care or assistance during delivery. For "On-time recording," we received comments that it is easier to enter data while providing care because it is based on touch operation instead of text input and it is easy to carry. Many midwives commented that a high degree of freedom in record input makes it easy to input records when labor is progressing. With regard to the method and operation of data entry, they responded that it can be operated more easily than electronic medical records they currently use, because almost all content can be collectively entered on the "data input" screen, and the details of records can be viewed easily just by touching the screen. Regarding information display, there was a comment that it is good that all information needed in the labor stage is comprehensively covered in one screen.

On the other hand, there was a comment that small characters associated with the overview and differentiation of the level of risk of information and priority required improvement.

Concerning the usefulness of the developed electronic partogram, one or more midwives responded “Don’t Agree” to “Risk reduction due to timer,” “Treatment such as oxygen administration,” and “Continuous nursing care.” Regarding these responses, there were comments that although the portability and readability of the system makes it useful for sharing information among a team, it does not sufficiently contribute to the advancement of midwifery mechanisms such as care evaluations and the thought processes of midwives. With regard to the timer function, there was a comment that setting the timer for the next dose increase in advance will serve as an action to prevent mistakes when midwives looking after more than one parturient woman undergoing labor induction, and many commented that it seems useful for accident prevention when they are busy. However, it was also pointed out that no one except for the one who set the timer knows why the timer was set.

Other comments were also given freely. Many requested a graphical presentation of cervical effacement and vital signs, linkage of multiple tablet PCs to realize operations and browsing among staff, and the capability to perform not only course recording but also all operations by voice input. Some midwives were concerned about the small character size and difficulty in reading records on tablet PCs due to the screen size of 10.1 inches and the possibility

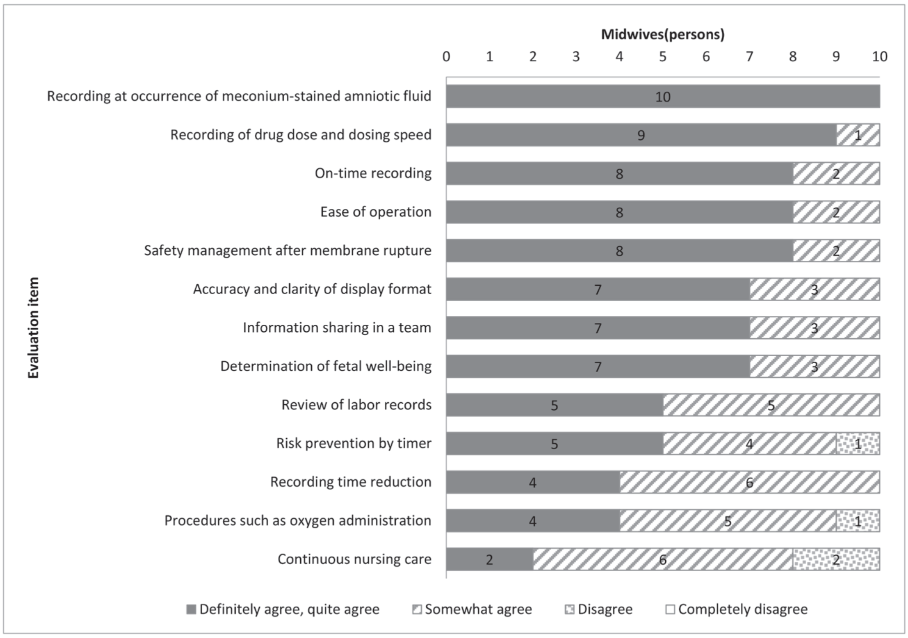


Figure 3. Usability evaluation by midwives

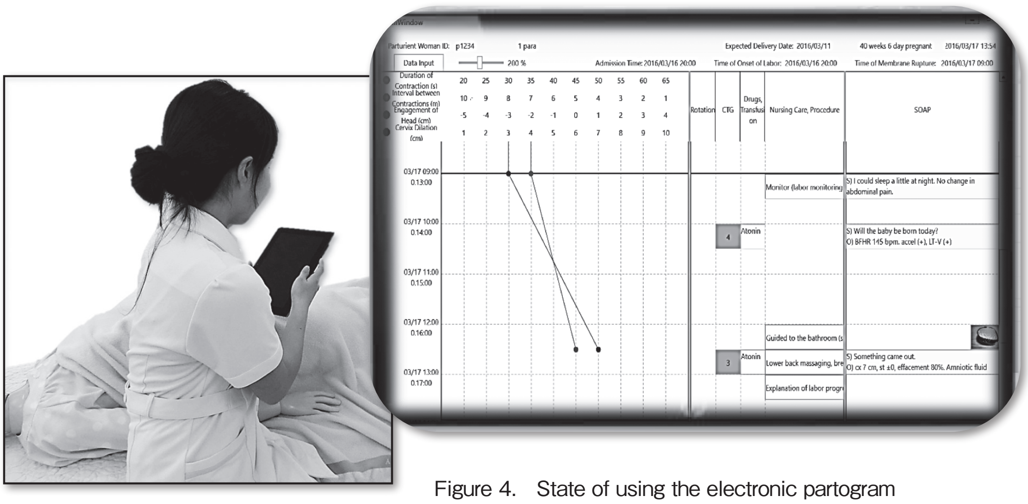

Figure 4. State of using the electronic partogram

of damage and failure caused by dropping the tablets.

**Discussion**

1. Clinical usefulness of the electronic partogram

The electronic partogram we developed is characterized by the functions of touch input support using choices, text input support by voice, and status input support by pictures, promoting on-time recording and providing a highly flexible input environment to enable easy input of various types of data. In addition, input with a keyboard is also possible with hybrid tablet PCs.

At present, the electronic medical system is insufficient to support on-time data entry, and its complex operation is viewed as an issue[9-14,21,22] . As an improvement measure, the degree of freedom for input was enhanced so that midwives can select input methods according to labor progression and the status of care intervention; in addition, input by pictures allowed for recording of situations that are difficult to express in words. As a result, the system received a high evaluation for easy operability, on-time recording, and easy recording of occurrences of meconium-stained of amniotic fluid.

These results suggest that this system has highly efficient operability for data input and enables easy data entry when providing labor-stage care, contributing to accurate on-time recording. With the capability for on-time recording, information can be viewed in real time. This will enable real-time information sharing not only among midwives but also among the team of physicians and other professionals, providing the whole team involved with each parturient woman with a unified aim. This will allow for early identification of abnormalities and early pre-emptive actions.

In the labor stage, which has increasingly become high-risk in recent years, it is necessary to detect abnormalities and take action early; in addition, preventing deviations from the normal condition is also important. A systematic review of randomized controlled trials of continuous care during labor[23] showed that continuous care resulted in more cases of natural vaginal delivery and fewer cases of vacuum extraction/forceps delivery and caesarean section; accordingly, the provision of effective and continuous medical care will result in safer and more secure labor management. However, our system has remaining issues concerning information display methods useful for the continuity and review of care. Further improvement is needed to improve the provision of appropriate information to midwives, forecast and review the course of labor, and support the development of the midwifery process. In order for midwives and other professionals to make appropriate decisions in their respective roles and various circumstances, we wish to further improve the display method to promote unification of information and knowledge.

With recent increases in high-risk labor, provision of more complex and higher-level nursing care is required. Midwives need to respond to different situations and the levels of risk of each individual. When abnormalities occur, responses to them are prioritized and data recording tends to be postponed, often resulting in an insufficient description of responses and procedures at the onset of the abnormalities[11] . Although our system can accurately record time by voice, items other than course recording were out of the scope of voice input; thus, there are remaining issues for recording of procedures performed. In addition, multiple labors simultaneously progress day and night in some settings; therefore, midwives have to look after more than one parturient woman at the same time. In principle, labor progresses with time, thus time management is very important. If the timer function of this system can display the purpose of the timer on the screen, the team can share their recognition of the need for the timer, leading to further risk prevention.

The next problem is the performance status of the system. Although there were no system failures, time entry by touch operations needs to be optimized by making the interface smaller to further improve the efficiency of input operation. In addition, the conditions of camera devices installed in table PCs and lighting may result in slight differences in color tones of images, which requires attention when taking pictures. The accuracy of voice input was 70% in the quiet environment as well as in the labor-stage environment. This point should be studied further as we can expect to improve the accuracy through registration of technical terms, names of drugs, and abbreviations in dictionaries in advance. In addition, further study is needed to respond to various conditions such as speed of voice input and tones of voice. However, there was no difference in how accurately various sounds such as the midwife's voice and fetal heart movement were heard between the quiet environment and the labor-stage environment. Therefore, we consider it can be used in clinical practice through term registration in dictionaries.

2. Limitations and prospect of this study

In this study, ten midwives evaluated the usability of the developed partogram; as these evaluations were not performed under proper usage conditions, however, further assessment is needed which involves midwives actually using the system while assisting with deliveries.

This electronic partogram requires further study and improvement to enhance quality, efficiency, and the safety of nursing care and recording; in addition, improvement of secure portability of tablet PCs needs to be examined.

## Conclusions

We have developed an electronic partogram with display and input support functions to realize accurate on-time display and recording of observation and care data required for safe and secure labor management. The following are the results of our study of this partogram in clinical setting :

1. The use of the input support function, a characteristic of this partogram, realizes easy operability, on-time recording of the course of labor, and accurate recording through image storage, which received high evaluations.

2. The display of the partogram allows the course of labor to be grasped quickly and easily by combining graphs and images corresponding to the characteristics of the information.

3. We could confirm accurate performance of each function. However, further study is needed to improve input accuracy and display methods.

## Acknowledgements

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**References**


1) Price A, Prace B: Making midwifery decisions. Modern Midwife 7 (10) : 15-19, 1997
2) Narita S, Murakami M, Ohara R, et al: Structural visualization of highly-specialized practice on nursing and midwifery; Nurse-midwife's monitoring and caring during labor and delivery. Studies in Health Technology and Informatics 122: 936-937, 2006
3) Masaoka K, Maruyama T: Midwives' viewpoints on the connection between information and experience concerning intrapartal care. Journal of Japan Academy of Midwifery 23 (1) : 16-25, 2009 (in Japanese)
4) Watanabe J, Emisu F: Clues to judgment made by expert midwives in assisting labor. Journal of Japan Academy of Midwifery 24 (1) : 53-64, 2010 (in Japanese)
5) Japan Society of Obstetrics and Gynecology, Japan Association of Obstetricians and Gynecologists: Guideline for Obstetrical Practice in Japan 2014. Japan Society of Obstetrics and Gynecology secretariat: 241-251, 2014 (in Japanese)
6) Kuroda Y, Kashiwagi K, Hayashi M, et al: A nation wide investigation of the rate of diffusion of computerized medical records as reported by nursing staff. Japan Journal of Nursing Science 4 (2) : 79-84, 2007
7) Ministry of Health, Labour and Welfare: Informationization grandeur design in medical care, healthy, nursing, and welfare field. http://www.mhlw. go.jp/hodou/2007/03/h0327-3.html 〔access on 9 Dec.2015〕 (in Japanese)
8) Ministry of Health, Labour and Welfare: Medical facility (static and kinetics) 2014 fiscal year survey, first volume, Nosocomial number (Duplication summing up) , Situation of medical record computerization (electronic medical record) /Psychiatry department-General hospital/Each dimension of sickbed. http://www.estat.go.jp/SG1/estat/List.do?lid=000001141080. 〔access on 21 Jan 2016〕 (in Japanese)
9) Kurihara Y: Realized effects by the implementation of electronic nursing records. Journal of Japanese Nursing Association 56 (14) : 63-68, 2004 (in Japanese)
10) Horikoshi M, Sugimoto A, Saito Y: Evaluation of Nursing Information before and after Introduction of the Electronic Chart System. The KITAKANTO medical journal 55: 115-122, 2005 (in Japanese)
11) Yamazaki C: Exploration for reasons and situations for recording midwifery practice. Journal of Japan Society of Nursing and Health Care 16 (2) : 26-33, 2014 (in Japanese)
12) Maekawa Y: Issues to be improved after introduction of a non-customized Electronic Medical Record system (EMR) in a Private General Hospital and efforts toward improvement. Studies In Health Technology And Informatics 122: 919-920, 2006
13) Viitanen J, Kuusisto A, Nykänen P: Usability of electronic nursing record systems; definition and results from an evaluation study in Finland. Studies In Health Technology And Informatics 164: 333-338, 2011
14) Kurihara Y, Fujii H: Acquisition of patient information from nurses by other health professionals under electronic medical record implementation. Studies In Health Technology And Informatics 192: 1025, 2013
15) Ministry of Health, Labour and Welfare: About the Medical Accident Investigation System. http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000061201.htm. 〔access on 7 Mar 2016〕 (in Japanese)
16) Japan Council for Quality Health Care: The 2nd the Obstetric Compensation System Report concerning relapse prevention. Japan Council for Quality Health Care: 40-71, 2012
17) Google Speech API V2. https://github.com/gillesdemey/google-speech-v2/ 〔access on 11 Mar. 2016〕
18) Daemen J, Rijmen V: The Design of Rijndael; AES - The Advanced Encryption Standard. Springer, 2002
19) Machiura M: Basic Midwifery Education Textbook Vol. 5; Diagnosis and Care during Delivery. 2015 version. Japanese Nursing Association Publishing Company: 123-146, 2015 (in Japanese)
20) Kabeyama K, Taketani Y : Midwifery Course 7: Midwifery Diagnostics and Techniques II (2) -During Delivery and Postpartum. Igaku-Shoin: 136-137, 2015 (in Japanese)
21) Kuroda Y, Tanahashi Y, Oda M, et al : Survey about Computer-Based Nursing Records Which Were Used Now or Were Planned to Be Used Further at Clinical Nursing Setting in Japan; Focus on Analysis of Terminology about Nursing Practice. Journal of Japan Society of Nursing Diagnosis 10 (1) : 88-94, 2005 (in Japanese)
22) Sagara K, Kuroda Y, Oda M, et al: Actual Conditions Survey on Nursing Support Systems in Japan ; Semistructured Interview Report as Pilot Study. Journal of Japan Society of Nursing Diagnosis 11 (1) : 18-28, 2006 (in Japanese)
23) Hodnett ED, Gates S, Hofmeyr GJ, et al: Continuous support for women during childbirth. Cochrane Database of Systematic Reviews 16 (2) : 2011 DOI: 10.1002/14651858.CD003766.pub5.

# 安全・安心な分娩管理に向けた電子パルトグラムの開発

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**要　　旨**

安全・安心な分娩管理に必要な観察・ケア記録をオンタイムで的確に表示・記録できるよう、表示・入力支援機能を備えた電子パルトグラムを開発し、臨床での有用性を探った。

本システムの特徴は、選択肢を利用したタッチ入力支援、音声によるテキスト入力支援、写真による状況入力支援が付加されており、オンタイムでの記録を促進し、様々なデータの入力を容易に行える柔軟性の高い入力環境を提供していることである。このような入力の自由度を上げることで、助産師が分娩進行状況やケア介入の状況に応じて入力方法を選択することができ、また、写真入力によって、言葉で表現しづらい状況などを記録することが可能となった。その結果、操作の容易性やオンタイムでの記録、羊水混濁時の記録がしやすいといった点で高評価が得られた。

表示機能に関しては、分娩期に必要な情報が一画面で網羅できる点がよいとの助産師の評価が得られた。しかし、助産師の思考やケア評価などの助産過程の展開に対する貢献度には課題が残った。

機能評価については、各機能の正確な動作確認が行えたが、音声入力精度の向上を図ることで、より臨床での有用性が高まることが示唆された。