



DAKSH: Digital Partograph and Intrapartum Monitoring Mobile Application

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ABSTRACT

Study design: This is a cross-sectional study which reports the development and pilot of a digital mobile partograph application in 5 primary healthcare centers of North Karnataka, India. **Background:** The DAKSH is a tablet-based application designed to improve care for women in the intrapartum period by addressing the issue related to paper partograph usage. Application is designed to provide real-time labor monitoring, basic decision making support by alerts and better record-keeping. The primary objective of the study was to evaluate the feasibility and acceptability of mobile partograph in low resource primary healthcare centers. **Methods:** The digital partograph was introduced at 5 primary healthcare centers in North Karnataka, India. Following 2 days of training, remote monitoring was done through a dashboard and a bi-monthly evaluation visit was conducted. Results were analyzed in terms of quantitative analysis (data filled into the application was compared against hospital records) and qualitative analysis (during each bi-monthly visit staff nurses were interviewed). **Results:** A total of 10 staff nurses from these healthcare centers used the application to monitor 424 pregnancies for a period of 10-months. During this period the hospital observed around 463 childbirths and out of which 91.56% (n=424) were recorded into the application. **Conclusion:** This shows good acceptability of application among staff nurses. Plotting of partograph, auditory reminders to monitor labour vitals were helpful.

Keywords: Partograph, Partogram, Mobile partograph, Labour monitoring, Primary healthcare centers, DAKSH

INTRODUCTION

Annually intrapartum causes results in 2,25,000 maternal deaths [1]. Prolonged and obstructed labor ranks high among the most common causes of maternal deaths [2]. About 99% of these deaths occur in low and middle-income countries like India where 44,000 women die due to preventable pregnancy-related causes [3]. WHO partograph is a paper-based tool where observations are recorded to provide an overview of labour and alerts the midwives in case of any deviation in progress of normal labour [4,5] when deviations in labour progress are recognized early and corrected, complications are prevented and normal labour and delivery can occur. When partograph is appropriately used it shows a reduction in obstructed labour [4,5].

Despite being a useful intrapartum tool the complexity of partograph is a barrier in itself. In November 2011, fistula care and maternal health task force organized a meeting to review the effectiveness of partograph particularly in low resource healthcare settings and found complexity as a major barrier in its usage. Lack of training, the overburden of work, limited healthcare staff, shortage in supply of partograph were some of the barriers reported. The task force also discussed challenges such as poor or non-existence of referral protocols and poor skills of healthcare workers which avert partograph use [6]. While digitizing the partograph will not only address all of these issues, it could allow a room towards simplified intrapartum monitoring which will lead to better outcomes.

DAKSH: An Intelligent Labour Monitoring Application

A digital partograph has following benefits over paper partograph:

- Easy to use and error-free: Since intrapartum data checked can just be entered directly, without plotting it on the graph, this makes digital partograph easy to use and error free
- Requires no interpretation skills: Interpretation of the action line is readily available to a healthcare worker, this is an added advantage for a low skilled healthcare worker
- Saves time: Unlike paper-based partograph, digital partograph is plotted on its own when the labour parameters are filled; this saves the time of healthcare workers spend on filling complex partograph

Even with all these advantages using a digital partograph alone will contribute fewer benefits to healthcare workers. Thus we developed an application which includes workflows for registering the patients during the intrapartum period, enter their investigation details, update delivery/referral status and to enter postpartum data until hospital discharge.

Mobile Partograph

The partograph is a core component of DAKSH; it is generated as the user enters intrapartum parameters, making it easy to use and error free. Latent labour has been removed from the simplified partograph of WHO but we choose to include this in DAKSH in a more simplified manner to assist a health care worker throughout labour. This is particularly relevant in case when a patient approaches during the latent phase of labour where any deviation in normal labour can be picked up on time. Digital partograph is accessible at all times from the intrapartum period along with the postpartum period.

Alerts and alarms: Digital medium allows integrating more innovations and features to simplify and enhance the user experience. DAKSH has a feature of reminding staff nurse for the next intrapartum examination due by providing alarms. In case of deviation in from normal intrapartum parameters, alerts were provided to help health care worker in decision making.

Labour Management User Interface

DAKSH has 3 screens to sort intrapartum parturient, post-partum and discharged mothers. DAKSH intrapartum screen is a list of patients which are sorted by their admission date and time.

The application contains 5 workflows:

- Registration: The patient is registered into DAKSH, this form includes patient name, phone number, doctor in charge, delivery status (since this is particularly relevant at our study hospital where patients come after home delivery/ambulance delivery), cervical dilatation and membrane rupture status. Capturing cervical dilatation during registration helps in deciding the frequency of examination alarms to be given
- Intrapartum record measurement: Quantitative intrapartum measurements are taken during the examination, filling these parameters will help to generate the digital partograph
- Investigation: Here a user can add basic blood and urine examinations done during the antenatal period
- Delivery record: This application includes one form to record delivery and postpartum examination details of mother and baby
- Referral feature: Application includes intrapartum and postpartum referral form to document a patient transfer to another facility. If referral out and referral in facilities are equipped with DAKSH then, referral in the facility is informed in prior by means of alarms. This helps in better emergency preparedness

Design Tensions

While designing DAKSH we made a balance between different design requirements by users. Deciding how to make the best user interface out of different user feedback and usability testing was the main part of this pilot. The main purpose of this section is to define this different user feedback and the rationale we used to choose one approach over another.

User friendliness vs digitalization: Any change in the existing system requires users to adapt to a new change to an extent but the new interface has to be balanced with the user's familiarity and innovation. Since a core part of DAKSH is digital partograph, we had a set of dialogues about how closely digital partograph should mimic the paper-based

partograph. The user interface of collecting labour parameters was made as easy as possible by providing scrolls, options, etc. in application since most of these users in low resource healthcare settings are first-time mobile users.

Latent phase labour parameters were removed from WHO simplified partograph but we chose to include it in DAKSH which was done to provide continuous support throughout labour despite stage. Being electronic, DAKSH's partograph can accommodate to any duration of labour. The alert and action lines in this digital partograph are depicted in green and red color respectively.

For the contraction graph, we chose a different representation than the conventional shading which is being done on paper partograph. We have used bold colors rather than shading thereby taking advantage of the colored screen available to us. We believed that this will be more intuitive for our users since colors are more distinguishable than shaded regions. This change also allowed us to make use of standard data visualization libraries and ease our development efforts. In the beginning, we were not sure about the acceptance of this change. However, after validating the new design with the staff nurse on the ground we found that none of them had trouble in interpreting it.

Digitalization vs interpretation: Partograph interpretation requires training and skills. To innovate and for better user experience which will aid in decision making, intelligent alerts were provided for obstructed and prolonged labour. To provide these alerts our application triggered an alarm for a staff nurse to measure cervical dilatation, based on the progress of cervical dilatation, audio, and visual alerts were provided. In addition to these primary alerts, secondary alerts were also provided by monitoring various blood and urine investigations and other maternal and fetal parameters.

Accountability vs easy to operate: The application is not limited to one user who directly operates the application in one healthcare center. This emerged a bigger need that application must be acceptable to the facility. In our application hospital's need conflicted with the staff's need for an easy feature to access the application.

While there could be 3 or more staff nurses in a primary healthcare center and one tablet was given to each health facility. Sharing nature of one tablet among 3 or more staff nurses made individual account keeping difficult. Logging in each time when a staff nurse is registering a patient would be burdensome for a staff nurse. For these reasons, each healthcare facility had one single login. However, this emerged an institutional need the hospital needed to know which staff nurse has registered a particular patient.

To work around this problem, we created a handover feature. Logins were created for all the nurses of a particular health facility and now the name of a staff nurses showed on top of the application. A single tap allowed the users to enter the name of the duty staff nurse. But, this feature emerged a security concern among staff nurses and thus to overcome this challenge a 4 digit unique pin was provided to each nurse which was used for authentication purpose.

Also, the doctor's name of a particular setting was included in their login and when a staff nurse entered duty doctor's name a SMS was sent to the doctor with the condition of the patient.

Device security vs usability: After the study began we found security concerns regarding loss or damage of tablet among staff nurses. At some of these healthcare settings applications were uninstalled unintentionally and some used the device for other purposes which led to faster battery drainage. Broken tablets were collected from a few of these health facilities.

To subdue these challenges installation of a device stand along with kiosk mode application was done in these facilities.

- Device stand: Device stand is a 4 feet tall stand designed by looking at normal average Indian female height. After trying out different design models we froze a model which was having minimal quaking, easy to move and a lock feature to avoid the theft and breakage
- Kiosk mode application: Kiosk mode allowed only DAKSH application to run in the tablet provided. This provided more control to the developers and helped in reducing faster battery drainage

Recordkeeping vs time-saving: What one user considers appropriate, another may find it deficient. For DAKSH to meet the needs of a variety of individuals including stakeholders, it needs to maintain a balance between individual needs without making it a cumbersome task.

DAKSH was able to capture labour data, delivery details, and postpartum details but stakeholders expressed the need

to include preliminary details, obstetric history, past history and WHO safe birth checklists to digitalized the whole intrapartum record keeping.

These components were later incorporated into the application. Increasing more components into the application should not interfere with the normal workflow of a user. By keeping this in mind user interface was designed duly to get the complete patient information by consuming a nominal amount of time.

MATERIALS AND METHODS

Study Design

A cross-sectional study was performed.

Study Setting

The study was conducted at the labour ward of following healthcare settings in the northern part of Karnataka, India.

- Hudem Primary healthcare center
- SRR Pura Primary healthcare center
- Anegundi Primary healthcare center
- GH Koppa Primary healthcare center
- Hirehal Primary healthcare center

Above healthcare settings were catered by a public-private mode organization “Karuna Trust” and hence permission to conduct this study was obtained from them.

Inclusion Criteria

Any pregnant woman approaching with true labour pain was chosen to be registered into DAKSH.

Methodology

A total of 10 staff nurses from these 5 healthcare settings were trained and they used the application from February 2017 to November 2017. Application design testing and patient registration into DAKSH started concurrently. This helped us in learning about more design issues and to develop a more robust system suitable for every individual while learning the usability of this tool for staff nurses.

Ethics Approval and Consent to Participate

This pilot study was approved by the Karuna trust which is a public-private mode organization managing our study healthcare centers. Oral consent was obtained from all the participants as the research team decided that obtaining a written consent will be difficult from women in labor and shortage of staff might not provide enough time for a maternity staff to obtain written informed consent. All the staff nurses interviewed provided oral consent.

RESULTS AND DISCUSSION

Application usage was remotely monitored through the dashboard by a public health researcher and a bi-monthly visit was made to track the application used by comparing the data from hospital records.

Qualitative Feedback

At the end of the study, we conducted a few one to one interviews with staff nurses who provided some productive and helpful feedback.

Application user experience was very simple for the staff nurses and alarms were very helpful during their busy schedule: “This application is very easy and if you are a smartphone user then you can handle this with almost no training.”

“Alarms are good reminders during our busy OPD, but sometimes we are so busy that we have to ignore these alarms.”

The tablet along with stand design was appreciated by all of them: “This stand provides security to the tablet and makes my life easier.”

Regarding the digital partograph, replacing the manual partograph with automatic plotting was advancement. Healthcare workers easily understood the minor changes which were incorporated into digital partograph.

The nurses had many suggestions to improve the application to boost patient care: they wanted DAKSH to incorporate the consent forms, nurse's notes, and medication chart. The participants said that current alarms are also not very audible sometimes and they would like a louder data monitoring reminders. In all these healthcare settings alarms generally, reduced the chances of negligence during the labour period.

“Alarm is very loud and if we ignore it once, it keeps reminding until we check the patient. This doesn't let us forget to check on the patient.”

Quantitative Feedback

This study was conducted for a period of 10 months starting from February 2017 to November 2017 in 5 primary healthcare centers of north Karnataka, India. During this time period a total of 463 childbirths were conducted and out of this 91.56 % (n=424) were registered into DAKSH.

Out of these 424 registered patients, 25.23% (n=107) patients were referred. We observed a post-childbirth registration in DAKSH application. Reasons for late registration into application were studied which brought into light the issues such as insufficiency of time needed in registration due to mothers approaching at later stages for childbirth and behavioral issues in adapting to newer technology. Approximately 41% (n=174) of patients were registered after delivery/referral. These patients were excluded from the analysis of studying the effectiveness of data monitoring alarms.

Later arrival of mothers was defined as: mothers who arrived at a primary care center with 8 cm or more than 8 cm of cervical dilatation. Our study shows that approximately 47% (n=117) of the mothers approached at later stages.

Patients arriving with almost complete cervical dilatation are the biggest challenge in rural India. This leaves no scope for labour monitoring and partograph use during the intrapartum period. This data suggests that more importance should be given on community awareness to a timely approach to a healthcare facility. Registration of the patient in DAKSH application was studied with time duration of registration in our application comparing it with on paper registration (Figure 1).

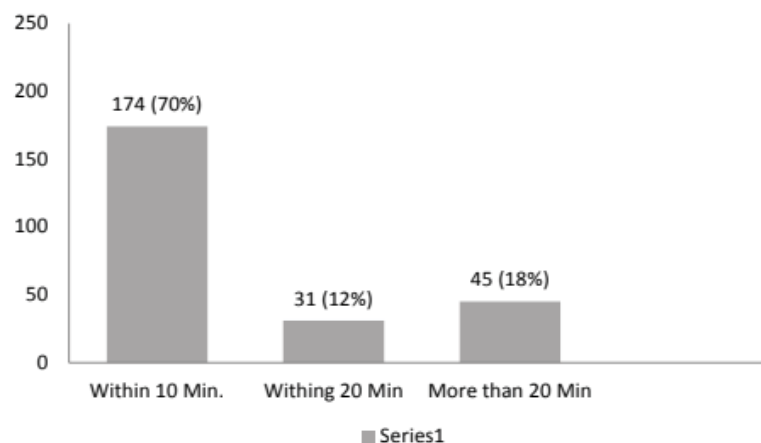


Figure 1 The number of patients registered within 10 min, within 20 min and more than 20 min

Data Monitoring Alarms

The application provides alarms to monitor labour vitals according to WHO standard protocols. Out of the 250 patients, 110 patients delivered within 40 minutes of their admission and thus application triggered a labour data monitoring alarm only once which was followed by 86% (n=95) of the time.

Remaining 140 patients delivered after 40 minutes and for those particular cases alarms were triggered every time when a patient's examination was due. Alarms were followed for 41% (n=58) of the registered patients (Figure 2).

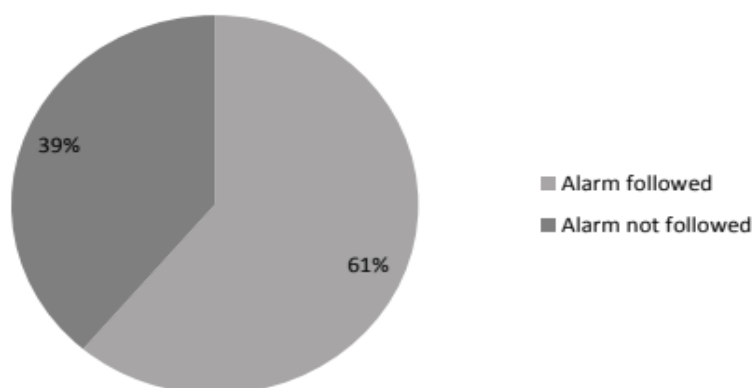


Figure 2 The overall picture of adherence to alarms provided during the intrapartum period

Accuracy of parameters filled into the application was compared with the information filled in paper records. Our study shows good adaptability to the digitalization of the partograph and intrapartum records (Table 1).

Table 1 Data accuracy in paper versus digital application

| Parameters | Accurate % (n) | Inaccurate % (n) | Data Missing % (n) |
|-----------------|----------------|------------------|--------------------|
| Blood group | 90% (n=383) | 3% (n=12) | 7% (n=29) |
| Hemoglobin | 91% (n=390) | 2% (n=12) | 5% (n=22) |
| Neonatal weight | 95% (n=404) | 4% (n=18) | 0.4% (n=02) |

CONCLUSION

DAKSH application was developed with multiple detailed scenario testing and by incorporating valid user feedback. Digital partograph is the main component of our application aimed to simplify the use of partograph for better labour monitoring and to help staff nurses in their decision making throughout the intrapartum period. Beyond the partograph DAKSH application also includes complication alerts, a system to refer mother and baby, antenatal history, laboratory investigations and all the support which is required from patient admission till discharge.

Primary evaluation data proposed a good probability to provide better patient care and decrease the burden of work in healthcare settings. Patient records were better maintained since the application had multiple checks to make sure that a case record is completed. However, more research is necessary to demonstrate that this application improves patient care.

Strengths of the Study

Daily monitoring of data and frequent evaluations visits to these healthcare settings were some of the strengths which helped us develop a robust labor monitoring application for the staff nurses.

Limitations of the Study

Since the application was in developing phase through the pilot, uniformity of data was a challenge. Also, data available in the hospital was unreliable for comparison against data filled in the application.

DECLARATIONS

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Conflict of Interest

Ms. Megha Singh was working at Janitri Innovations Pvt. Ltd. as Research Associate during the period of research. Mr. Abhas Tandon is working at Janitri Innovations Pvt. Ltd. as Chief Software Architect. Dr. H. Sudarshan has no competing interests.

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