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RESEARCH ARTICLE

USABILITY AND ACCEPTABILITY OF ELECTRONIC PARTOGRAPH IN NORTH-EAST STATES, INDIA

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ABSTRACT

Background: DAKSH is a tablet-based device developed to improve maternal and child healthcare by addressing challenges in the use of partograph. This device is developed to help in decision making, automated partograph development, and alerts for complications. The aim of the study is to evaluate the usability and acceptability of this tablet-based device in low resource areas. **Methods:** This study is a mixed-methods cross-sectional study. It was done at four primary health care settings in the Northeast states of India. Staff nurses and medical officers were trained to use this device. The data was collected for 13 months from November 2017 to November 2018. After the training and use of the device, surveillance questionnaire forms were sent to the healthcare settings which they filled. **Results:** Data for 292 mothers were recorded for the study for 13 months. It was observed that more than 50% of women arrived at the later phase of labor, 37 referrals were made to higher healthcare facilities and most of the women were anemic for which alerts were given. Daksh generated 141 complications alerts. **Conclusion:** Staff nurses and medical officers concluded that tablet-based partograph is better than paper partograph as it saves time and is easy to use. It is helpful for healthcare workers as it generates reminders and alerts for the patient. There is a need for technology in remote healthcare settings.

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INTRODUCTION

Globally, an estimated 2.6 million stillbirths occur each year which accounts for nearly 7,200 babies stillborn each day. The World Health Organization (WHO) estimated that 3,03,000 maternal deaths occur worldwide each year. A global burden of disease study estimated that 6.4% of maternal deaths annually were due to obstructed labor. In addition, 1.3 million intrapartum stillbirths and 904,000 newborn deaths due to hypoxia occur each year (Sanghvi *et al.,* 2020). Identification and management of intrapartum complications on time can prevent these deaths. The death of a fetus during labor or intrapartum fetal death is a tragic outcome of pregnancy. The death rate of a country is a reflection of the care obtained by mothers and babies in labor and different areas of improvement can be identified by a thorough analysis of such kinds of cases (McNamara *et al.,* 2018). Regular and timely monitoring of maternal and fetal parameters during labor is very important to check maternal and fetal well-being, supporting normal labor, identifying complications and spurring clinical decision-making to address them in a timely manner.

With the global impetus toward universal health coverage, more women are choosing to give birth in health facilities; however, health outcomes will not improve unless-timely access to services and "institutional birth" quality is assured. WHO recognizes the monitoring of labor to guide timely, suitable actions as a high-priority quality improvement intervention (McNamara *et al.,* 2018). Labor monitoring needs skilled birth attendants to record observations of maternal and fetal well being, which is used to distinguish between "normal" and "abnormal progress" and plan the next steps (Sanghvi *et al., 2020*). The concept of partograph and labor curve was conceived by E.A. Friedman, who was an obstetrician. R.H. Philpott, later in 1972 incorporated alert lines upon Friedman's Partograph which gave access to the partograph to serve as a tool for recording all intrapartum observations and to identify the chances of risk (Rahman *et al.,* 2019). The use of partograph is recommended by WHO, it is in the form of a low- tech paper and is an effective tool for the identification of maternal and fetal complications during childbirth. Universally, the use of the WHO partograph is established as a gold standard labor monitoring tool (5). Continuous use of partograph using advanced technologies can save maternal and neonatal lives.

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By this, it is ensured that labor is monitored closely and complications such as obstructed labor are identified as well as treated. In spite of decades of training and investment, implementation rates and correct use of the partograph remain low in resource-limited settings (Fistulacare, 2020). Partograph is a useful intrapartum tool, still, it is a barrier in itself due to lack of training, limited healthcare staff, shortage of supply of partograph. In November 2011, the 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 (Dalal, 2017). The main focus of this pilot study was to conduct usability testing and to decide on how to make the enhanced user interface based on user feedback. or the purpose of this study we have introduced DAKSH, a mobile/tablet-based application that generates digital partograph. It is developed by JANITRI INNOVATIONS PVT. LTD. It is an intelligent labor monitoring application that consists of five features: Intrapartum record measurement, registration, delivery records, records of investigations, intrapartum and postpartum referral features. In this application, the intrapartum data is entered using a touch interface which automatically plots the partograph. It is error-free and easy to use the application as the intrapartum data can be entered directly without plotting it in a graph. This application needs minimal interpretation skills as the interpretation of the action line is available to a health worker which is an added advantage for low skilled health care workers, especially in primary health care settings. Unlike paper partograph, the graph is plotted automatically when labor parameters are filled. All these merits of using a digital partograph will contribute benefits to health workers. The Partograph is a main component of DAKSH. WHO has removed latent labor from the simplified partograph but we choose to add this in our digital application in a more simplified manner to help health care workers throughout the labor. This digital partograph in our tablet-based mobile application is accessible all times from the intrapartum period along with the postpartum period.

This application allows integrating several features like alerts and alarms to simplify and enhance the user experience. Alarms in the application remind the staff nurse for the next intrapartum examination. In case there are abnormal intrapartum parameters the feature of alerts in the application helps health workers in decision making. We made a balance between different design requirements by users while designing DAKSH. The main goal of the application was not to limit the use of the application to a single user in one healthcare center but to make it acceptable for all kinds of scenarios pertaining to healthcare settings including handling the application by multiple users. This created the need to make the application ergonomically acceptable by the doctors/staff to create a better user experience. Other challenges included accountability for data entered by each staff nurse. To prevent this commotion, a new feature was incorporated. It included a separate login ID for each nurse, a 4-digit unique pin for authentication. Sharing the 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 as 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 nurse 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 purposes.

METHODOLOGY

Study Design and settings: A mixed-method cross-sectional observational study was conducted to check the usability and acceptability of electronic partograph in the labor room in the North-eastern states of India.

The area of study was North-East Indian states: Meghalaya & Arunachal Pradesh.

From each state, two primary healthcare settings were selected purposely.

They were:

- Sangram Primary Health Centre, Kurung Kumey
- Anpum Primary Health Centre, Lower Dibang valley
- Kynrud Primary Health Centre, West Khasi Hills
- Myriaw Primary Health Centre, West Khasi Hills

The above healthcare settings were catered by a public-private mode organization “Karuna Trust”. Before the commencement of the study proper training was provided to staff nurses working in the labor room and medical officers from these 4 healthcare settings. The implementation was done in the month of October 2017. The data was collected for a period of 13 months from November 2017 to November 2018. The data was stored in MS Excel 2019 for further data analysis. A questionnaire was developed that included aspects of usability such as comfort in data entry, navigation with the application and maintenance of the device. The acceptability of the device was determined by evaluating the comfort and confidence of staff nurses and doctors while using the device for intrapartum monitoring. 4 doctors and 2 staff nurses from these 4 PHCs were interviewed by mail. The analysis of the above-mentioned data was done using Atlas.Ti 8.

Inclusion Criteria: Any pregnant woman approaching with true labor pain was chosen to be registered into DAKSH.

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 written consent will be difficult from women in labor and a shortage of staff might not provide enough time for a maternity staff to obtain written informed consent. All the staff nurses and medical officers interviewed provided written consent.

RESULTS AND DISCUSSION

The data in the application was added by the users in real-time. Application usage was remotely monitored through the dashboard by a public health researcher. During the study

period of 13 months from November 2017 to November 2018, 292 women were registered in Daksh Application.

General details

Age Group of women registered: Most of the pregnant women were between 25-29 years of age (n=66). Elderly pregnancies were observed in 26 women. Few Teenage pregnancies (n= 24) were also recorded and data was not entered for 76 pregnant women as shown in Table1. It has been observed in studies that newborn to elderly mothers have a higher risk of certain chromosome problems, such as Down syndrome. The risk of pregnancy loss is higher and can happen by miscarriage and stillbirth, the risk increases as you get older, perhaps due to pre-existing medical conditions or fetal chromosomal abnormalities (Mayo Clinic, 2020) Studies suggest that for better pregnancy outcomes, women with advanced maternal age should be provided close supervision. It is associated with elevated risks for pregnancy complications. It leads to various other antenatal and postnatal complications such as miscarriage, pre-eclampsia, gestational diabetes mellitus, antepartum hemorrhage, and low birth weight babies, which are more common during the pregnancy. These women are at higher risk of complications compared to the younger group, they should be advised to follow frequent antenatal visits and should be kept under the close supervision of a senior Obstetrician. It has been found that increased maternal and fetal surveillance will ensure a better perinatal outcome (Pawde *et al.*, 2014; https://www.researchgate.net/publication/327678670_Effects_of_advanced_maternal_age_on_pregnancy_outcome> [Accessed 5 April 2020].). India is one of the ten countries with the largest burden of teenage pregnancies and is home to more stunted children than in any other country. Complications of teenage pregnancy include the low birth weight of the infant, high pre and postneonatal mortality, congenital malformations, anemia, postpartum depression among mothers (Black *et al.*, 2013).

Table 1. Age group of women registred

Age Group	Number of women
Below 20 years	24
20-24 years	64
25-29 years	66
30-34 years	36
35 and above	26
Not Entered	76

Time of delivery: Out of total deliveries, 136 (46%) were day deliveries and 124 (42%) were night deliveries.

Sex Ratio: In the recorded data the sex ratio at birth was 904. Out of total deliveries, 123 were female births and 136 male births.

Admission: Out of 292 registered women, 256 women came in active labor i.e with cervix dilation 4-10cm (4 and 10 included). We observed that some women were approaching healthcare centers at later stages for childbirth. 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. Approximately 62% (n=182) of the mothers approached at later stages. Patients with almost complete cervical dilatation are the biggest challenge in rural India which leaves no scope for labor monitoring and partograph use during the intrapartum period.

The data recorded suggests that more importance should be given to community awareness for a timely approach to a healthcare facility. The partograph was generated for 253 registered women. Out of these 253 registered women, 36 (12.3%) women were in latent phase (0-3cm), 105 women were in early active phase (4-8 cm) and 151 women in later active phase (9-10 cm).

Referrals: The tablet-based application "Daksh" has a feature of referral. If needed, pregnant women can be referred to the first referral unit (FRU) before delivery, after delivery and neonates based on the complications recorded which are listed in the application. 37 women and neonates were referred to FRU, which is approximately 13% of total women registered. Out of total referrals, 25 (68%) women were referred before delivery i.e during intrapartum. Total referrals after delivery were 12. After delivery 9 women and 3 neonates were referred. Table 2 shows the reasons behind the referrals before delivery:

Table 2. Reasons for Mother referrals before delivery

Reasons	Number of referrals
Others	6
Prolonged labor	4
CPD (cephalic pelvic disproportion)	3
Fetal distress	2
Malpresentation / Breech Presentation	2
Epilepsy / Seizures	1
LAMA	1
Meconium stained amniotic fluid	1
No fetal movement	1
Oligohydramnios	1
Anemic	1
Elderly Pregnancy	1
PIH (pregnancy-induced hypertension)	1

Table 3. Reasons for Mother and neonate referrals after delivery

Mother	LAMA	5
	Other	2
	Convulsion	1
	Low Blood Pressure	1
Neonate	Imperforate penis	1
	Low birth weight	1
	Apnea/Breathing Difficulty	1

Alerts: Daksh has a feature of alerts that are given based on the data entered to highlight the complication of women, which differentiates them as high-risk pregnancies and required care or action can be taken to avoid mortality and morbidity. This feature of DAKSH helps SBAs (Skilled Birth Attendants) in decision making. Table 4 shows the number of alerts created in registered pregnant women by Daksh.

Table 4. Various Alerts created by Daksh

Alert Message	Number of Alerts created
Moderate Anaemia	80
Elderly Woman	26
Cervix Diameter Not Progressing	14
Amniotic Fluid Is Meconium	8
Mother's Systolic Pressure Is Above 140mm Hg	6
Mother's Diastolic Pressure Is Above 90mm Hg	4
Fetal Heart Rate Is Below 110	2
Fetal Heart Rate Is Above 170	1

Usability and acceptability: A small questionnaire was developed for checking usability and acceptability based on the comfort and benefits of the application. This questionnaire was filled by them, and consent was taken to publish the filled data.

The information collected in the questionnaire included basic information such as (age, gender, educational status), the attitude of users towards the DAKSH application, experiences, challenges faced and motivating factors. This involved 4 doctors and 2 staff nurses from 4 PHCs. On average, the DAKSH application was used for a period of 19 months since the day of implementation by them. Currently 50% of them are still using this device.

Following were the results for "Attitude of users towards the program"

- Users strongly agreed that tablet-based data entry is better than the paper-based entry of partograph, partograph becomes easy after implementation of the DAKSH application. Users suggested that there should be only one data entry system either paper or tablet-based.
- Most of the users agreed that the DAKSH brings real benefits to mother and child health care, regular monitoring and supportive supervision was there from Janitri to continue this DAKSH, alarm features in the tablet helped them to fill up the due date, monthly report generation became easier after implementation of DAKSH application, DAKSH application will benefit manpower deficient health care setting, Government should take positive steps to continue this DAKSH application as they feel mentally exhausted as a result of both papers based and tablet-based data entry.
- The training was adequate to operate this tablet. Most of the users agreed that DAKSH helps to reduce MMR & IMR. Users also suggest that doctors should install the mobile version of this application. The referral system has also been strengthened after the implementation of the DAKSH application.

Following results were based on their experiences

Users have adequate knowledge of DAKSH.

"Daksh is a digital tool through which we can monitor the progress of delivery and also detect the high risk delivery" -Medical Officer

"Daksh is a skill application launched by Janitri which provides a platform for augmentation of skill health personnel involved in the delivery of services across Public Health institutions. -Medical Officer

"The Daksh is training for the health professions working in PHCs regarding improving and monitoring Maternal and infant health services in the country through digital mobile application." -Medical Officer

According to the users they have changed in many ways like record keeping after using DAKSH and it also helped in developing digital partograph.

"Yes, record keeping in electronic media like tablets is a good device to share data and make a partograph and we can get these data as a hard copy by printing." -Medical Officer

"Indeed it makes it helpful to close the monitor of delivery and reduce paper work". -Medical Officer

After the implementation of DAKSH, users experienced it as a better labor monitoring tool as it is paperless and because of easy documentation and it helps in reduction of IMR and MMR rates.

"It's nice to show an outlook on labor monitoring because it's paperless and easy to use the device." - Staff Nurse

"It is really helpful in close monitoring of normal delivery, which will help in reducing IMR and MMR." -Medical Officer

Initially users had problems with DAKSH, but then Karuna trust encouraged them and helped them to solve the problems which they were facing.

"When it's not working or any problem then support from Karuna Trust encourage us for doing best" - Staff Nurse

"When the device has some defects then Karuna trust helps." -Medical Officer

Users had a good experience with the device because it is easy to use, partographs are automatically generated after entering the data, also all the data can be saved in the device. They encountered one problem which is if there is any error or application crash, in the device all the data will be deleted from the device.

"It is an easily usable device, Partograph automatically made when data enters and all data can be saved easily. But when it has any defect then all the data gets deleted from the device automatically. " - Staff Nurse

"It's totally paperless and helps to monitor the delivery very closely." -Medical Officer

"Helpful in monitoring the Process of labor and the referral System has been made easier and notification alarms make it much easier to fill missed updates. Bad point is It is difficult to use in poor network areas." -Medical Officer

Following results showed the challenges faced

When asked about obstacles faced while using the device, the only obstacle users came across was that sometimes due to internet connectivity, the device showed login issues

"When it's log in than it show sometime unable to log in" - Staff Nurse

"Sometimes it gives problem which makes the difficult for entry data" -Medical Officer

"Network is causing many problems in updating the details at the correct time." -Medical Officer

To overcome the obstacles faced while using DAKSH they reported to Karuna Trust, who then reported to Janitri Innovations for the solution.

"I have reported to the Karuna Trust office and they gave us a solution to this problem." -Medical Officer

"We talked to janitri experts from janitri officials through mobile video calling but still it's not working." -Medical Officer

Following results showed the motivating factors

The most motivating factor about this device is that it is paperless, the data can be entered easily in tablet-based devices and helps in monitoring patient's details and history with a partograph.

"It's paperless, easily enters data like in an android phone for monitoring patient's detail and all the history with a partograph. So, it motivates to use this tablet based labor monitoring tool." - Staff Nurse

"It makes compulsory entry of family history of mother, past obstetric history of mother, which gives a brief summary of the mother and makes it easy to decide for further steps." -Medical Officer

Users recommended that all the private and government healthcare institutions should use this tablet-based labor monitoring tool.

"I would like to say all the private or govt health care institution use this tablet based labor monitoring toolI will request them to use this app for a safe delivery."- Staff Nurse

"We always tell other healthcare providers to use digital Partograph." -Medical Officer

Conclusion

Our findings show that introduction of this tablet-based device has the potential to improve maternal and child health service delivery in low resources. It is totally a new domain. This study demonstrated that this tablet-based device is easy to use and was accepted by the staff nurses and medical officers in resource-constrained areas. When compared to paper partograph the results were totally in -accordance with electronic partograph as it is easy to use, can save all kinds of data such as labor parameters, basic information, blood examination, physical examination, etc. it's less time consuming and the alerts in the device helped in protocol adherence. This study was done in the Northeast states of India, where most of the areas were low resource and hilly.

The use of this device in such areas can be monitored remotely by the doctor and the health care workers. Which Plays an important role in the development of the healthcare system.

The device was developed by vigorous testing incorporating valid user feedback. Partograph is the main component in this tablet-based device that aims to solve the problem of health care workers for better labor monitoring and decision making throughout the intrapartum postpartum period. This device follows WHO protocols for monitoring pregnant women in labor. Other than partograph it also includes complication alerts, referral details of mother and child, antenatal history, laboratory investigations and all support which is needed till the patient is discharged. This study concluded the usability and acceptability of DAKSH by the staff nurses and medical officers because the device automatically develops partograph which eventually helped them in decision making, patient records are maintained, alerts are available for any complications and real-time data can be obtained by printing. However, more research is going on to demonstrate the use of the device on district and state levels.

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Conflict of Interest

Ms. Priyanka Singh is working at Janitri Innovations Pvt. Ltd. as Public Health Manager and Dr. Ansu Narwal is working at Janitri Innovations Pvt. Ltd. as a Public Health Intern. The authors have no competing interests.

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