An Outcome Evaluation of LifeNet Partograph Training in Masaka, Uganda

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of Master of Science
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ABSTRACT

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Abstract

Background: Prolonged and obstructed labor is a leading cause of maternal mortality and morbidity in low resource settings. To prevent prolonged labor, the Uganda Ministry of Health (MOH) recommends using the partograph to monitor mothers in labor. Published literature has reported low rates of partograph use in Uganda, as well as improved partograph use after training. This study aimed to evaluate the effectiveness of LifeNet International's (LN) partograph training in rural health clinics in Maska, Uganda. Additionally, the study sought to identify factors potentially related to partograph use, and thus to inform future implementations to increase partograph use in these low-resource settings.

Methods: LifeNet works with rural clinics in Uganda by providing training and management strategies to improve healthcare quality for mothers during delivery. In 2017, LifeNet began collaborating with the Duke Global Health Institute (DGHI) to evaluate LN's impacts in six clinics in Masaka District, Uganda. As part of this evaluation project, this study is evaluating the impact of LN partograph training using direct observation, medical chart data, and facility-level data collected by LN. Additionally, semi-structured interviews were conducted by a DGHI researcher. The pre-training data were collected from May 15th to July 17th, 2017 and post-training from August 23rd, 2017 to January 29th, 2018 for this study. Follow-up direct observation data

are scheduled to be collected from May 21st to July 26th, 2018. Quantitative data were analyzed using Stata version 14.2. Interview transcripts were reviewed for themes of health providers' partograph knowledge and challenges of partograph use in practices.

Results: Before the LN partograph training, an estimated 19.8% of deliveries (42 of 212 observed) in study clinics were monitored with a partograph. A diagonal line drawn on the partograph helps the clinician to recognize possible labor complications (i.e. the action line). Sixteen (38.1%) of those that used partographs reached the action lines, among which five (31.2%) had actions under taken. In the first month after the LN partograph training, partograph use increased to 46.8% and was sustained for the remainder of the observation period. The proportion of partograph use did not change over time after the training (prevalence risk ratio, PRR=1.00, 95%CI: 1.00-1.00). Among all partographs reviewed after the training (n=594), health providers gave two interventions to manage abnormal labors. Mean duration of labor and proportion of prolonged labor did not change over time (risk ratio, RR=1.00, p = 0.561; RR=1.00, p=0.757, respectively). However, mean duration of labor was significantly higher among deliveries in which a partograph was used, compared to deliveries in which no partograph was used (RR=4.39, p<0.001). Furthermore, the proportion of deliveries with prolonged labor was higher in the partograph use group compared with the group that did not use the partograph, but the difference was not statistically significant (RR=5.97, p=0.072).

Based on the interviews with clinical providers in these clinics, there seems to be some education in use of the partograph in their schooling; however, there remained some misunderstanding about partograph use and interpretation. Health providers indicated that lack of accessibility to blank partographs in clinics, heavy workload, and lack of periotic check were challenges in using partographs to monitor labor.

Conclusions: Partograph use increased following the LN training and was sustained for at least five months afterwards. This type of clinical training program may be effective in improving maternal healthcare quality in Last Mile health facilities in resource-poor settings, like Masaka, Uganda.

Dedication

I dedicate this thesis to the LifeNet International staff who devote their time to save the lives of mothers and babies, and who gave me tremendous support during my research. And I dedicate to this thesis to the LifeNet nurses, midwives, and clinic managers who help mothers and babies in the most resource-restricted areas.

Contents

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List of Acronyms

AIC – Akaike information criterion

CI – Confidential interval

CLR – confidence limit ratio

CS – Cesarean section

DCO – Direct clinic observation

DGHI – Duke Global Health Institute

IRR – Incidence risk ratio

LL – log likelihood

LN – LifeNet International

MOH – Ministry of Health

PR – prevalence ratio

REDCap – Research Electronic Data Capture

PRR – Prevalence risk ratio

RA – Research assistant

RCT – Randomized controlled trial

RR – Risk ratio

SPA – Service Provision Assessment

WHO – World Health Organization

Acknowledgements

This thesis could not be completed without my mentor Dr. Joseph Egger, who is always supportive and stays with me even at the last minute. I want to thank my committee members, Dr. Megan Huchko and Dr. Bonnie Kaiser, who inspire me and help me to get through all obstacles I encountered in my research.

Special thanks to Dr. Joy Noel Baumgartner, Jennifer Headley, and Min Kyung Kim at DGHI. This is a great team, where I learned doing research in a team from zero. Thanks to LifeNet staffs, Josh and Nadine Guenther, Julius Kirya, Luke Aldridge, and Steven Kyamagwa, as well as Father Joseph at Vila Maria who host me and supported my thesis in Uganda. I cannot name all of people who support me through any form, thanks to you all.

I want to thank my parents. Although you are far from me, every call and message helped me to get through the hardest times.

1. Introduction

1.1 Prolonged labor

Prolonged or obstructed labor is a significant cause of maternal mortality and life-long morbidity. This complication is not a direct cause of maternal death but would result in fatal outcomes, for instance, sepsis, ruptured uterus, or hemorrhage. Prolonged labor resulted in the highest burden of diseases globally in 2013 (IHME, 2013). Studies in LMICs report the prevalence of prolonged labor ranges from 2% to 8% of all institutional deliveries (Ali & Adam, 2010; Gessessew & Mesfin, 2003; Nwogu-Ikojo, et al., 2008). In 2006, a nation-wide survey evaluated the Ugandan emergency obstetric care system in 553 health units, including public national referral hospitals, public and private district hospitals, and Health Centers VI (sub-district clinics). This study estimated that prolonged labor was the second leading cause, responsible for 22% of maternal deaths in Uganda (Mbonye, et al., 2007). However, the study by Mbonye et al. took place in tertiary referral hospitals so that the findings might not be representative to the actual prevalence in Uganda. In 1996, a community-based retrospective study estimated potential risk factors associated with maternal mortality in Gulu district, Uganda. This study recruited 5,522 adult respondents from 27 randomly selected parishes. Three hundred and twenty-four maternal deaths occurred, among which 26.2% resulted from obstructed labor (Orach, 2000). The proportion of deaths resulting from prolonged labor was likely to be an underestimate since the deaths might be recorded under the final

cause of death, for instance, sepsis, ruptured uterus or hemorrhage, instead of prolonged or obstructed labor (Mathai, 2009). Therefore, prolonged labor prediction and intervention are important in reducing maternal mortality and morbidity.

Currently, no consensus has been achieved on the definition of prolonged labor. According to the WHO prolonged labor management guidelines, prolonged labor is often defined as "onset of regular, rhythmical painful contractions accompanied by cervical dilation where labor is longer than 24 hours" (WHO, 2008, p.17). The WHO has also suggested defining prolonged labor by stages of delivery, including prolonged latent phase and prolonged active phase. Prolonged latent phase is "the onset of regular painful contraction with cervical dilation up to 4 cm, and should not be longer than 8 hours.." Prolonged active phase is "regular painful contractions with cervical dilation of more than 4 cm should not last longer than 12 hours" (WHO & ICM, 2008). The International classification for disease (ICD10) suggested the diagnoses of prolonged labor are a) progress of slower than one cm per hour, b) irregular or poor uterine contractions, a labor with regular uterine contractions for more than 12 hours, and/or c) a cervical dilation of ten centimeters more than three hours. Kjærgaard (2008) defined labor dystocia in Danish nulliparous mothers as less than 1/2 cm dilatation of cervix per hour over 4 hours following a guideline from Danish Society of Obstetrics and Gynecology and supplemented with the guideline on dystocia from the American College of Obstetrics and Gynecology. A universal prolonged labor management guide,

including time for active intervention, is lacking without a consensus on prolonged labor definition (Kjærgaard, et al., 2008). Therefore, the current lack of consistent definition resulted to the limitations in understanding of the prolonged labor diagnosis and developing interventions.

Efforts have been made to predict prolonged labor. Mother's height below 150cm or shoe size below 4 was a predictor of cephalopelvic disproportion, which would, in turn, cause prolonged labor. However, the predictive values were too low to warrant any intervention (Connolly & McKenna, 2001). X-Ray pelvimetry was seen as an insufficient predictor of fetopelvic disproportion from a review of four randomized trials. Thus, X-Ray could not be used to indicate the needs of obstructed labor interventions (Pattinson, 2002). The poor predictive values of these screening methods suggested another way to diagnose disproportion: labor. Assessment of labor progress could identify women with abnormal labor, and early diagnosis and intervention could prevent prolonged labor (Mathai, 2009). A partograph is a tool that can be used to accomplish this purpose.

1.2 Description of the partograph

A partograph (also called as partogram) is usually a pre-printed form used to monitor the process of delivery and to assist health providers in identifying any problems with the labor process. The first graphical description of a delivery process occurred in 1954, when Friedman studied cervical dilatation of 100 African women in

their first delivery (Friedman, 1954). On this graph, the progress of delivery was recorded in centimeters of dilatation per hour. This diagram was known as a cervicograph. In 1972, a partograph was first developed to support delivery in Zimbabwe, where doctors were short of resources and efficient recording methods. This tool added intrapartum details to Fridman's cervicograph, including fetal heart rate, membrane rupture, molding, descent of head, contractions, drugs and intravenous fluids, oxytocic stimulation, blood pressure, and maternal pulse and temperature. This graphic record was intended to assist health providers in the rapid identification of dysfunctional labors and promoting referrals to higher level clinics for high quality healthcare (Philpott, 1972). An alert line and an action line were added on the partograph after a prospective study of 624 African women in their first delivery (Philpott & Castle, 1972). The alert line was designed to inform the point that the delivery became inefficient, which indicated the slowest 10% of labors. And if insufficient progress occurs by four hours after the alert line, an action line is reached. Active intervention should be conducted when the action line is crossed but the types of action could vary in different regions and depending on resources (Philpott, 1972). Following the Safe Motherhood Conference in Nairobi, Kenya in 1987, the WHO adopted the use of the partograph to address prolonged or obstructed labor globally (WHO, 1993). Since then, many countries have adopted monitoring labor with a partograph in their clinical practice guidelines.

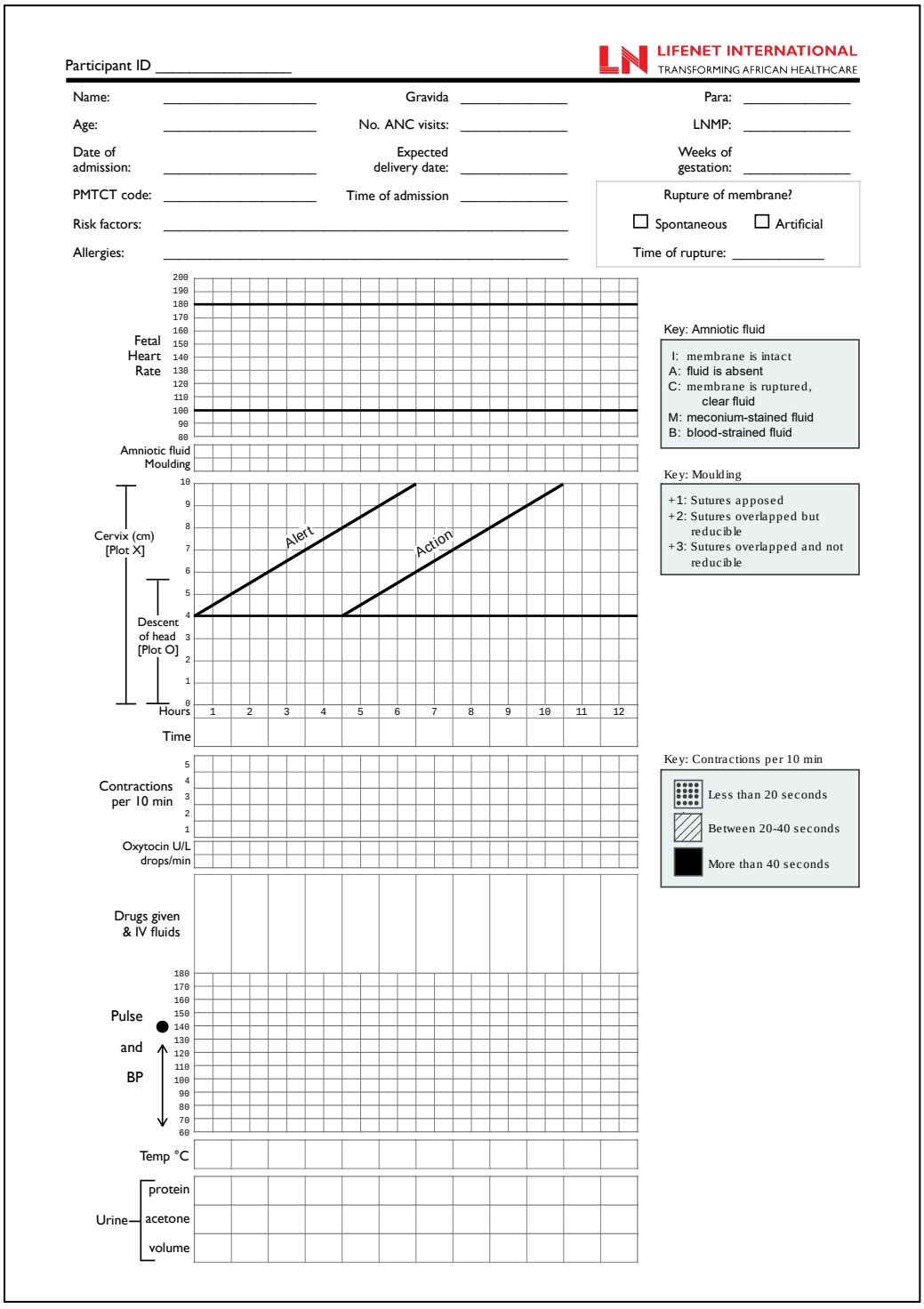


Figure 1: The partograph in a LN labor and delivery chart

The action line is an essential component of the partograph (Figure 1). The WHO recommends that partographs include an action line four hours after the alert line; others recommend earlier intervention, with a 2 or 3- hour action line on the partograph. The effects of different action line positioning on birth outcomes were studied, and the different designs had no significant influence on maternal health outcomes (Lavender, 2013). A randomized controlled trial (RCT) recruited 3,000 women with uncomplicated pregnancies in the northwest of England and randomized these participants into 2-hour and 4-hour action line groups. Women in the 2-hour arm had significantly more labors that crossed the action line than the 4-hour action line arm (RR 1.27, 95%CI: 1.18–1.37) and, in turn, more actions were taken to manage identified abnormal labors (RR 1.23, 95%CI: 1.14–1.33). However, the two groups had no differences in cesarean section (CS) rate (RR=1.00, 95%CI: 0.80–1.26) (Lavender, et al., 2006). In contrast, Pattinson (2003) and coworkers, using the same design in a sample of 696 nulliparous women, found that significantly fewer women in the 2-hour action line group had a CS than in the 4-hour group (16.0% & 23.4%, respectively; RR=0.68, 95%CI: 0.50- 0.93). The two groups were very similar demographically. Although the CS rates were different between two groups, neonatal outcomes were not significantly different (Pattinson et al., 2003). Therefore, considering the similar impacts on health outcomes, the 4-hour action line

might be a better choice in low resource settings since this type of partograph requires fewer interventions.

1.3 Partograph effectiveness research

Evidence of the effectiveness of partograph use to improve maternal and neonatal outcomes is mixed. A systematic review identified six RCTs performed prior to 2013, involving 7,706 women in spontaneous labor. As a part of inclusion criteria, the intervention and control groups in a study had to differ only in the partograph use: studies that also contain any other labor interventions, for instance, differences in giving psychological support, early amniotomy, or supervision, were excluded. This systematic review concluded there to be no evidence of lower rate of Caesarean section after implementing the partograph, therefore routine use of the partograph cannot be universally recommended (Lavender, et al., 2013). An RCT from Canada randomized 1,932 women into a partograph use group and a control group that health providers noted medical information on a piece of paper (Windrim et al., 2007). This study found no significant difference between the groups in CS rate (partograph 24%, notes 25%), or in rates of oxytocin use (78% in both groups). Another RCT conducted at a teaching hospital in Birhar, India (Rani et al. 2015) randomized 400 high-risk primigravidae into partograph or no-partograph groups, and both groups received healthcare services from the same group of health providers. Health providers did not give additional interventions. This RCT concluded that partograph use had no significant impact on the

rate of CS (partograph group, 16.5%; no partograph group, 18.5%), duration of labor, and oxytocin infusion (partograph group, 83.5%; no partograph group, 89%).

Although limited evidence from RCTs did not support partograph use, some argued that RCT, which restricts the range of population, might not be an appropriate design to evaluate the effectiveness of a widely implemented policy (Vandenbroucke, 2011; Lavender, 2013). In fact, studies that were not RCTs did find benefits of partograph use. A prospective non-randomized trial of 35,484 South East Asian women conducted by the WHO showed benefits of partograph use. The study reported a reduction in prolonged labor (from 5.5% to 2.7%) (Kwast et al., 1994). Furthermore, some interventional and observational cross-sectional studies showed that partograph use was significantly associated with a reduction in negative maternal or neonatal health outcomes, including CS rate and perinatal mortality (Getiye & Fantahun, 2017; Javed et al., 2007; Meda et al., 2016; Millogo et al., 2016). Therefore, partograph use might be efficient in prolonged labor prevention and other undesired maternal health outcomes.

1.4 Partograph implementation

The WHO strongly recommends monitoring labor with the partograph, especially in low resource settings (WHO, 2014). However, previous research found the implementation gaps. Partographs are far from consistently used in many settings. Among cash transfer program facilities in India, 6% of reviewed records indicated a partograph was used (Oladapo, et al., 2006). Another retrospective observational study

in Ethiopia showed 67.3% deliveries had a partograph used; however, of these deliveries, 30.1% had nothing recorded (Markos & Bogale, 2015). In Brazil, De Melo (2017) observed that the partograph was used in 48.3% of births.

Other studies measured partograph use at the health provider level and reported low proportions of health providers who had monitored labors with partographs in their daily work. Previous studies reported the percentages of partograph use ranging from 18% to 32.4% (Dwivedi, 2009; Sama et al., 2017) in low-resource settings. Furthermore, even when the partograph is used, it is often left incomplete or used improperly. Yisma (2013) reviewed 420 partographs collected from five public health institutions in Addis Ababa, Ethiopia, and reported 30.7% and 32.9% standard documentation of fetal heart rate and cervical dilatation respectively. Kamath (2015) reported 51.9% correctly documented fetal health rate and 48.8% cervical dilatation among 502 partographs from tertiary hospitals of south India. The consistency and accuracy of partograph use is a concern.

In Uganda, use of the partograph to monitor deliveries as a method to prevent obstructed labor is part of clinical guidelines (MOH Uganda, 2016). The Ugandan Service Prevision Assessment survey (SPA) evaluated overall healthcare quality in 2007. According to the report, about 39% of delivery facilities have blank partographs available, about 17%of health providers reported using a partograph during the last week, and only nine percent of health providers had received training on partograph

use during last one year (MOH Uganda, 2008). Consequently, there is a strong need to improve both the use, as well as the proper implementation and understanding of the partograph in resource-limited settings, such as Masaka, Uganda.

1.5 LifeNet International mission and the purpose of the study

LifeNet International (LN) is a not-for-profit, faith-based healthcare quality promoter, which provides logistics, financing, equipment and training services to existing Christian health centers in East Africa to strengthen local capacity in providing quality healthcare services (LN, 2017). LifeNet provides a comprehensive solution to local clinics, including medical training, management training, a pharmaceutical supply program, and a loan program. Beginning in 2015, LN began expanding into Uganda from operations in Burundi and Democratic Republic of the Congo and expects to be formally affiliated with 90 clinics in the country by year-end, 2019. As a part of impact measurement, LN engaged the Duke Global Health Institute (DGHI) Evidence Lab to carry out a 15-month quasi-experimental longitudinal study to evaluate impact of the LN training intervention on quality of care and maternal and child morbidity and mortality in six rural health clinics in Masaka District, Uganda. Proper use of the partograph and medical record chartings are two training modules of this approximately eight-month, 13-module training. The current study is a part of this LN evaluation study, focusing on the effect of the partograph training, including the training workshop and providing basic resources.

This study aims to estimate partograph use among six rural Ugandan clinics before the LN intervention, evaluate the impact of the LN training on partograph use, and investigate factors related to partograph use before and after the training. Understanding the baseline partograph use behaviors and partograph use after the training could assist with refinement of the LN training to further improve protocols in partograph use and response, as an essential part of healthcare quality improvement.

2. Methods

2.1 Study design

This study utilized a mix-methods approach that included a cross-sectional survey of 212 mothers who delivered in one of six study clinics, as well as semi-structured interviews with ten healthcare workers who were qualified to assist deliveries during the baseline period, from May 15th to July 17th, 2017. The study also included a longitudinal time series chart review of 594 maternal deliveries in six LN study clinics from August 23rd, 2017 to January 29th, 2018.

2.2 Setting and Participants

The study was conducted during an eight-month period from May 18th, 2017 to January 31st, 2018 at Masaka District, Uganda. The district has 297,004 residents, with 151,452 females, and is mainly Luganda-speaking. Approximately 10% of households in the district are 5km or more from the nearest public or private health facility. Clinics affiliated with LifeNet are Christian-run centers in this district, whose managers were accredited to the Roman Catholic Diocese of Masaka. Different from governmental public health centers or private health facilities, the Catholic clinics are private, not-for-profit facilities. Like other private health centers, these facilities are not funded by the government, and thus have to charge high enough fees to sustain the clinics. Therefore, the Catholic clinics charge higher than public clinics but lower than other private ones.

Delivery in a Catholic health facility will cost a mother 30,000 UGX (approximately 8.5 USD).

LN staff identified six health centers in the Masaka District area to participate in the study. At the time of study initiation, all six health centers were new to partnering with LifeNet. The facilities were selected based on their service level and ability to perform deliveries, participating in LN training program, and their locations that were geographically near to other enrolled health centers in Masaka District. Health clinic was the primary intervention unit, where the trainings were delivered. Clinical health providers in each health center were sub-units, and it was assumed that health centers would have some staff turnover during the study period. The number of medical employees per clinic ranged from three to nine. Each clinic employed two to six health providers working in delivery departments, with low turnover during the study period.

Midwives and comprehensive nurses were selected to participate in one-on-one in-depth interviews in each facility. A comprehensive nurse is trained and authorized to work in all department of a clinic. In other words, both midwives and comprehensive nurses are health providers who have been trained and licensed to assist delivery. They also have been trained to use the MOH partograph during their education. A majority of midwives get 1.5 years training in midwifery schools. One clinic manager graduated from a medical university and is also licensed to work in labor wards.

2.3 Procedures

Health centers were de-identified for this study to protect their confidentiality. Baseline maternal and neonatal care was directly observed for the two-month period from May 15th to July 17th, 2017 to establish pre-training quality of care metrics. In partnership with DGHI, LifeNet hired ten research assistants (RAs) from Uganda to aid in data collection through direct clinic observation (DCO) of clinical encounters and completion of facility checklists. Half of the RAs are licensed nurses, and the others had non-clinical health research backgrounds. RAs were trained to use the data collection tools and research ethics.

The ten RAs were assigned to study facilities based on health center self-reported delivery volume, with one to three per facility. Similar to medical staff, RAs were "on-call" to respond to a delivery when a woman presented at their respective health center. RAs' accommodations were arranged in or close to clinic areas. A shift-schedule was made to ensure high rate of clinical encounters could be observed. RAs recorded all relevant procedures on a paper-based DCO form (Appendix A), before entering data electronically into a Research Electronic Data Capture (REDCap) form. RAs also noted the sections of the delivery process that they observed and which sections they did not observe. Since RAs may have changed shifts during a delivery, it was possible for more than one RA to observe a single delivery.

A Facility checklist (Appendix B) was completed almost daily for each facility during the baseline DCO period. A checklist could not be completed when no RA was on shift that day, and this only happened in health centers that were assigned one RA. The RA was encouraged to complete the checklist in the afternoon so that there would be sufficient data on length of time without electricity in the clinics.

During the baseline period, a DGHI researcher conducted semi-structured interviews with health providers participating in LN training programs, who were eligible to conduct delivery in each study clinic. The interviews were conducted in English. Informants were selected using convenience sampling in each facility. Interviews covered. Midwives, comprehensive nurses, and a clinic manager. Each facility had one or two health providers interviewed. The interviews were audio recorded after obtaining verbal consent.

Following baseline data collection, LN training staff conducted a series of trainings for all medical staff in the six clinics. The modules were delivered in order, such that a later module will be postponed if an earlier module did not happen at the originally scheduled date. Medical documentation and partograph use is the first part of the LN training. LifeNet trainers traveled to six clinics twice a month to perform these trainings. Six health clinics took one training module in turn. The partograph training was given to each facility from August 16th to September 11th according to a training schedule.

Over the course of the trainings, LN staff collected medical charts and then obtained information from LN partographs. For the post-training phase, RAs visited each clinic about once every two weeks to abstract information from completed medical charts, including partographs. Data were collected in the clinics, and no partographs were taken out of the clinics.

2.4 Data collection

Direct clinical observation (DCO) form. A DCO form (Appendix A, relevant fields for this study are highlighted in yellow) was developed based on the 2007 SPA observation protocol. For initial client assessment, first stage of labor, second and third stage of labor, immediate newborn and postpartum care, newborn resuscitation, medical information documentation, and postpartum hemorrhage management, the RAs assessed the extent to which health providers adhered to standard of care in accordance with general accepted best delivery practices.

For this study, information related with partograph use, delivery, and admitted time was used. In DCO, whether a partograph was used was asked twice in different parts of the form.

Facility checklist. A facility checklist (Appendix B) was developed based on the 2007 Service Provision Assessment (SPA) facility Audit Questionnaires. RAs collected information on the availability of resources, support systems, and facility infrastructure elements that were necessary to provide a level of service that generally met national or

international standards. For the current study, information about clinic access to a blank partograph, basic medical instruments, and electric power was used.

Medical chart form. LN developed a medical chart form (Appendix C) in partnership with DGHI. This medical chart was designed for health providers to monitor labor with a partograph and document maternal and neonatal outcomes. For this study, information related with partograph use was included.

REDCap. REDCap was used to collect data from all three forms. REDCap is a secure, online data management system for building and managing databases. LifeNet managers were authorized to view the REDCap form during piloting of the survey forms, however, to maintain objectivity no LN employee was authorized to access the data in REDCap once the study was initiated. **Semi-structured interviews.** The semi-structured interviews (Appendix D) included questions on the health providers' previous partograph training before the LN partograph training was given, criteria to start a partograph and use a partograph, potential challenges of partograph use, and expectations of upcoming LN trainings. This semi-structured interview guide was developed with DGHI researchers and pilot tested with two professional maternal healthcare providers in Uganda.

2.5 Measures

Partograph use. Any partograph use was defined as any part of the partograph used to monitor a delivery, and was measured separately in each of the two data

collection instruments. In the DCO form, *any partograph use* was measured as a yes or no question that RAs observed and checked according to health providers' practices. In the medical chart form, *any partograph use* was measured as a binomial variable generated from eight yes or no survey questions. A partograph was defined as used when at least one of eight components on the partograph was used.

Proper partograph use was defined as a partograph in which all eight components were recorded according to the Uganda MOH clinical practice guideline (2016). For each component in the partograph, the guideline indicates that the fetal heart rate, uterine contractions, and maternal pulse should be recorded every 30 minutes; maternal temperature should be recorded every two hours; and amniotic fluid, diameter of cervix, descent of fetal head, and maternal blood pressure should be recorded every four hours.

Daytime or nighttime delivery. A daytime delivery was defined as a birth that occurred from 6 am (included) to 6 pm (excluded). A nighttime delivery was defined as a birth that occurred from 6 pm (included) to 6 am (excluded).

Days power loss. Days power loss was a continuous variable. This variable was defined as number of days a clinic had experienced any power loss in the day or night.

Action line reached. This is a binomial variable indicating whether an action line on a partograph was crossed (action line reached=1) or not crossed (action line reached=0). This question appeared on the DCO forms and medical chart forms for RAs to observe used partograph.

Duration of labor. This study adopted Hendrick (1970) and O'Driscoll (1973)'s suggestion that duration of labor should be measured from the admission time until birth. This estimation is considered as practical and valid for this study setting. Mothers who delivered in the six facilities during the study period rarely came to the facility early. These mothers usually came to the health clinics when they started contractions or even in the second stage of labor. Therefore, measuring duration of time from admission to birth is likely to underestimate duration of labor in this setting.

Prolonged labor. A prolonged labor was defined as a labor that lasted longer than 24 hours. Currently, there is no universal definition of prolonged labor, and definitions rarely have a specific time cut-point. However, considering this study needed a practical prolonged labor definition and the fact that the LN partograph was generated from the WHO partograph, the WHO's 24 hour definition of prolonged labor was used.

2.6 Analysis

Data were cleaned, coded, and analyzed using Stata 14.2 software (StataCorp, College Station, TX). Partograph use, action line reached, daytime delivery, components of partograph use, and days having access to essential facility resources or equipment were described using frequencies and proportions, as appropriate. Fishers' exact tests were used to test relationships between categorical variables. Separate Modified Poisson regression models with a log link and robust standard errors were fitted to study data to

estimate the probability of partograph use and the probability of prolonged labor over time after the training as a function of measured variables. This Modified Poisson method, with Huber White sandwich estimated variance has been shown to provide as a valid and efficient method to estimate relative risks (Zou, 2003). A linear regression model was also fitted to study data to estimate the mean duration of labor as a function of measured variables. The parameter of primary interest in each model was calendar time (continuous) and was generated to indicate the number of days after the LN partograph training in each of the six clinics. This time variable aligned the first day of LN training in each clinic to estimate the change in the response variable over times since training. Additional variables, such as clinic (categorical) and partograph use (binominal) were included in models to adjust for potential confounding.

The qualitative interviews were audio recorded after getting informants' oral consensus and transcribed. The transcripts were reviewed for themes of health providers' partograph knowledge and challenges health providers encountered when monitoring labor with a partograph.

2.7 Ethics

Duke IRB at Durham, NC, USA, and Uganda national ethics and research institutes (Uganda National Council of Science and Technology, UNCST, and The Aids Support Organization, TASO) approved the study protocol. There were no known physical risks associated with this study; however, there might be some risks to the

privacy of the patient due to the patient being observed by a RA, and of the interview participants being identified by the quotes. All efforts were made to maintain the confidentiality of each patient.

3. Results

3.1 Pre-training results

3.1.1 Descriptions of study facilities and partograph use

During the baseline period, 217 deliveries were directly observed. On the DCO, partograph use was ascertained twice in different ways; five records were removed from analysis due to discordant results for these two questions. During the baseline period, a partograph was used to monitor 42 deliveries, representing 19.8% of total estimated deliveries occurring across the six facilities during the baseline period. Partograph use varied significantly by study clinic. Two clinics did not use the partograph for any deliveries during the baseline period. Among the 42 deliveries in which the partograph was used, a total of 16 reached the action line; however, of these 16, only 5 deliveries were intervened upon.

Table 1: Partograph use and available delivery instrument in clinics

	Clinic 1		Clinic 2		Clinic 3		Clinic 4		Clinic 5		Clinic 6		Total	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Total number of deliveries	22		20		48		24		36		62		212	
Daytime delivery	8	36.4	12	60.0	26	54.2	10	41.7	20	55.6	28	45.2	104	49.1
Nighttime delivery	11	50.0	6	30.0	20	41.7	14	58.3	13	36.1	30	48.4	94	44.3
Missing	3	13.6	2	10.0	2	4.2	0	0	2	8.3	4	6.4	14	6.6
Partograph used	1	4.6	0	0	24	50.0	0	0	2	5.6	15	24.2	42	19.8
Action line reached	0	0	--		15	62.5	--		0	0	1	6.7	16	38.1
Action taken if action line reached	--		--		5	33.3	--		--		0	0	5	31.2
Facility-level factors related to partograph use (days applicable)														
Blank partograph	62	100.0	67	100.0	85	100.0	0	0	70	88.6	87	100.0	371	82.6
Power loss	2	3.2	0	0	22	25.9	28	40.6	19	24.0	49	56.3	120	26.7
Blood pressure cuff	62	100.0	66	98.5	85	100.0	0	0	79	100.0	87	100.0	379	84.4
Fetal stethoscope	62	100.0	67	100.0	81	95.3	69	100.0	77	100.0	82	97.6	438	98.6
Maternal stethoscope	62	100.0	67	100.0	85	100.0	0	0	3	3.9	0	0	217	48.9

3.1.2 Factors related to partograph use

During the baseline period, the availability of specific key instruments and materials used in performing the partograph varied significantly by health clinic (Table 1). For example, clinic 4 did not have any partograph forms, blood pressure cuffs, or stethoscopes accessible on any day during baseline period. On the other hand, clinics 1, 2, 3, and 6 had full access to partographs, as well as most instruments to evaluate the status of mothers and babies. Clinic 6 lost power at least once per day for 49 (56.3%) days, which was the most days experienced power loss among six clinics. Clinic 2, on the other hand, did not experience any power loss during the baseline period.

Table 2: Results from a log-risk regression model estimating potential factors of partograph use among deliveries in six LifeNet clinics, Masaka District, Uganda, May 15th–July 17th, 2017, n=212.

	PR	95% CI	CLR
Power loss	0.89	(0.49, 1.60)	3.26
Daytime delivery	0.90	(0.53, 1.55)	2.92
Clinic			
1	Ref	--	--
2	--	--	--
3	11.00	(1.59, 76.22)	47.94
4	--	--	--
5	1.22	(0.12, 12.70)	105.83
6	5.32	(0.75, 37.97)	50.63

*PR = prevalence ratio; CI=confidence interval; CLR=confidence limit ratio

Generalized linear models were fitted to study data to assess the association between partograph use and these clinic-level factors, including clinic, power loss (ever),

and daytime delivery (Table 1). The probability of partograph use was statistically significantly different among clinics (p-value<0.001). For example, Clinic 3 was 11.00 (95%CI: 1.59-76.22) times more likely to use the partograph than Clinic 1. The power loss and time of delivery were not associated with use (PR=0.89, 95%CI: 0.49-1.60; PR=0.90, 95%CI: 0.53-1.55, retrospectively).

3.1.3 Health providers' perspectives—semi-structured interviews

Health providers' knowledge about partograph use. Participants mentioned that using the partograph to monitor labor is part of their training in nursing schools and using the partograph in practices is required. One participant said, "*Yes, we learnt from the school and we do the same thing in the clinics*." Meanwhile, all participants said they had not received any training in partograph use after school. Most participants could correctly describe the criteria of starting a partograph and standards of each parameter on the partograph. However, some participants had a misunderstanding about how to use a partograph and how to interpret information from the chart. One participant said, "*the fetal heart should be plotted every four hours,*" whereas the fetal heart rate should be tested every 30 minutes according to MOH guidelines. Another participant stated, "*You check the descent [of fetal head] every time after two hours. The VE, every time after two hours*"; while both descendent of fetal head and vaginal exam should be examined and recorded every four hours. Aside from the standards to plot the partograph correctly, some participants presented misunderstanding about partograph

interpretation. One participant said, "*When I started the partograph, my mother was 4 centimeters in diameter with regular contractions… I was hope this mother will labor. But there is no more labor. That's when I run out of [the space on] partograph.*" An action line would be crossed before a partograph ran out of space, and a health provider should have intervened when the action line was reached.

Challenges of partograph use. Some informants mentioned that partograph use were challenging due to their multi-responsibilities in practices. One informant said, "*You may find that there is a mother in maternity and you are covering antenatal. So you may find it hard to monitor every thirty minutes..*" Therefore, having different work at the same time could be possible to hinder a health provider from staying with a mother and continuously monitoring the delivery.

Some participants felt confident in their own experience and using it to decisions; thus, using the partograph was seen as an extra burden. One participant said, "*Mother comes and we do not use partograph. To use the partograph, is to know what could be something to tackle. For me, I can know it. But my staff, she tries to treat someone and shows like it's kind of a burden to her..*" The lack of available blank partographs was seen as a challenge. Two participants said there were no blank partographs in the clinics. Although they had talked with the managers to store some copies of the partograph, they did not have access to the partograph yet when the interviews were done. When asked about periotic healthcare quality check, one participant claimed that the partograph was not "*a main*

thing" to check. She said, "*They do not take partograph as a main thing. They check the registration book. They take some statistics, but not necessary that*."

3.2 Post-training results

3.2.1 Descriptions of partograph use

There were 594 deliveries that occurred in the six study clinics during the post-training data collection period, from August 23rd, 2017 to January 29th, 2018. Of these 594 deliveries, 278 partographs (46.8%) were at least partially completed and therefore eligible for review. Table 3 shows the results related to partograph use from the phase 2 data collection period in the six study clinics. Among 278 deliveries where the partograph was at least partially completed, only one partograph (0.36%) was determined to have been correctly used according to the Uganda MOH guideline.

Table 3 also reports results of usage of the various components of the partograph. 270 (45.5%) partographs showed plotting of the diameter of cervix, with 156 (26.3%)recorded to the recommended standard. The diameter of the cervix was the most used parameter on the partograph, followed by uterine contractions, which was plotted on 263 (44.3%) partographs, with 145 (24.4%) plotted every four hours based on the guideline. Maternal temperature, maternal pulse, and maternal blood pressure were less likely to be plotted: 13.8%, 25.3%, and 30.3% respectively among the 594 recorded deliveries.

The incidence of partograph use varied by clinic over the study period (p-value<0.001). The incidence of use was highest in Clinic 1 at 61.0% (Table 3). Clinic 2 and 5 had the lowest incidence of the partograph use, which were 19.5% and 15.8%, respectively.

A generalized linear model (log-risk) was used to examine the difference in the probability of partograph use by clinic. Compared to Clinic 1 (the referent group), Clinic 2, Clinic 4, and Clinic 6 were 0.32 (95%CI: 0.17-0.61, p=0.001), 0.69 (95%CI: 0.50-0.95, p = 0.021), and 0.26 (95%CI: 0.15-0.44, p < 0.001) less likely to use the partograph, respectively.

Table 3: Overall partograph use and use of components of the partograph in six clinics following LifeNet training, Masaka District, Uganda, August 23rd–January 29th, 2017.

	Clinic 1		Clinic 2		Clinic 3		Clinic 4		Clinic 5		Clinic 6		Total	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Total (N)	82	100	41	100	163	100	74	100	82	100	152	100	594	100
Partograph														
Not used	32	39.0	33	80.5	69	42.3	43	58.1	69	84.2	70	46.0	316	53.2
Substandard	50	61.0	8	19.5	94	57.7	30	40.5	13	15.8	82	54.0	277	46.6
Recorded by standard	0	0	0	0	0	0	1	1.4	0	0	0	0	1	0.2
Time of deliveries														
Daytime deliveries	49	59.8	27	65.8	87	53.4	34	46.0	42	51.2	78	51.3	317	53.4
Nighttime deliveries	31	37.8	12	29.3	70	42.9	31	41.9	28	34.2	62	40.8	234	39.4
Missing	2	2.4	2	4.9	6	3.7	9	12.2	12	14.6	12	7.9	43	7.2
Components of the partograph														
Fetal Heart Rate														
Not used	32	39.0	33	80.5	83	50.9	44	59.5	70	85.4	73	48.0	335	56.4
Substandard	19	23.2	3	7.3	60	36.8	12	16.2	5	6.1	34	22.4	133	22.4
Recorded by standard	31	37.8	5	12.2	20	12.3	18	24.3	7	8.5	45	29.6	126	21.2
Amniotic Fluid														
Not used	36	43.9	34	82.9	87	53.4	46	62.2	74	90.2	97	63.8	374	63.0
Substandard	27	32.9	5	12.2	56	34.4	13	17.6	4	4.9	33	21.7	138	23.2
Recorded by standard	19	23.2	2	4.9	20	12.3	15	20.3	4	4.9	22	14.5	82	13.8
Diameter of cervix														
Not used	32	39.0	33	80.5	72	44.2	46	62.2	70	85.4	71	46.7	324	54.5
Substandard	17	20.7	4	9.8	52	31.9	9	12.2	3	3.7	29	19.1	114	19.2
Recorded by standard	33	40.2	4	9.8	39	23.9	19	25.7	9	11.0	52	34.2	156	26.3

Descent of Fetal Head														
Not used	33	40.2	34	82.9	77	47.2	47	63.5	70	85.4	78	51.3	339	57.1
Substandard	17	20.7	3	7.3	48	29.4	11	14.9	3	3.7	27	17.8	109	18.4
Recorded by standard	32	39.0	4	9.8	38	23.3	16	21.6	9	11.0	47	30.9	146	24.6
Uterine Contractions														
Not used	32	39.0	33	80.5	80	49.1	44	59.5	70	85.4	72	47.4	331	55.7
Substandard	21	25.6	3	7.3	48	29.4	12	16.2	2	2.4	32	21.1	118	19.9
Recorded by standard	29	35.4	5	12.2	35	21.5	18	24.3	10	12.2	48	31.6	145	24.4
Maternal Pulse														
Not used	35	42.7	34	82.9	144	88.3	58	78.4	72	87.8	101	66.4	444	74.7
Substandard	38	46.3	5	12.2	19	11.7	13	17.6	10	12.2	29	19.1	114	19.2
Recorded by standard	9	11.0	2	4.9	0	0	3	4.0	0	0	22	14.5	36	6.1
Maternal Blood Pressure														
Not used	34	41.5	33	80.5	135	82.8	45	60.8	71	86.6	96	63.2	414	69.7
Substandard	13	15.9	5	12.2	27	16.6	16	21.6	6	7.3	30	19.7	97	16.3
Recorded by standard	35	42.7	3	7.3	1	0.6	13	17.6	5	6.1	26	17.1	83	14.0
Maternal Temperature														
Not used	64	78.0	37	90.2	151	92.6	49	66.2	73	89.0	138	90.8	512	86.2
Substandard	13	15.8	4	9.8	10	6.1	21	28.4	3	3.7	11	7.2	62	10.4
Recorded by standard	5	6.1	0	0	2	1.2	4	5.4	6	7.3	3	2.0	20	3.4

* According to the standard guidelines for partograph use, the fetal heart rate, uterine contractions, and maternal pulse should be record every 30 minutes; maternal temperature should be recorded every two hours; and amniotic fluid, diameter of cervix, descent of fetal head, and maternal blood pressure should be recorded every four hours. Any recorded parameter that failed to be plotted by the standard frequency was considered as substandard.

** Recorded by standard partograph indicating all eight parameters were recorded according to the standard.

Table 4: Results from a log-risk regression model estimating clinic partograph use among deliveries in six clinics following LifeNet training, Masaka District, Uganda, August 23rd, 2017 –January 29th, 2017. N=594.

Clinic ID	RR	95% CI	CLR	p-value
1	Ref			
2	0.32	(0.17, 0.61)	3.59	0.001
3	0.95	(0.76, 1.18)	1.55	0.615
4	0.69	(0.50, 0.95)	1.90	0.021
5	0.26	(0.15, 0.44)	2.93	<0.001
6	0.88	(0.70, 1.11)	1.59	0.290

*RR: Risk ratio; CI=confidence interval; CLR=confidence limit ratio

3.2.2 Time series analysis of partograph use

Table 5: Number of deliveries in each 30-day interval after the LN training in six study clinics. N=559.

Number of 30 days after training	Number (N)	Percentage (%)	AverageiesperAverage deliveries per day (n)
1	108	19.32	3.60
2	100	17.89	3.33
3	109	19.50	3.63
4	96	17.17	3.20
5	127	22.72	4.23
6*	19	3.40	2.11

* Data were collected for nine days in the sixth 30 days after the LN training. Since six clinics were not visited everyday according to the schedule, some deliveries happened in the last nine days were not collected in this database by the time this study stopped data collection.

The number of deliveries in the six clinics in each 30-interval following the LN partograph training were very similar (Table 5). A chi-square test was used to analyze number of deliveries by 30-day interval after the training. Deliveries happened in the sixth 30 days were excluded in this test since the data collection was not completed

among all six study clinics. Across the 5 intervals, numbers of deliveries were not statistically significantly different (χ^2=18.00, DF=20, p-value=0.587). Meanwhile, as shown in the figure 2, the percentages of deliveries by clinic in each interval were very close to even.

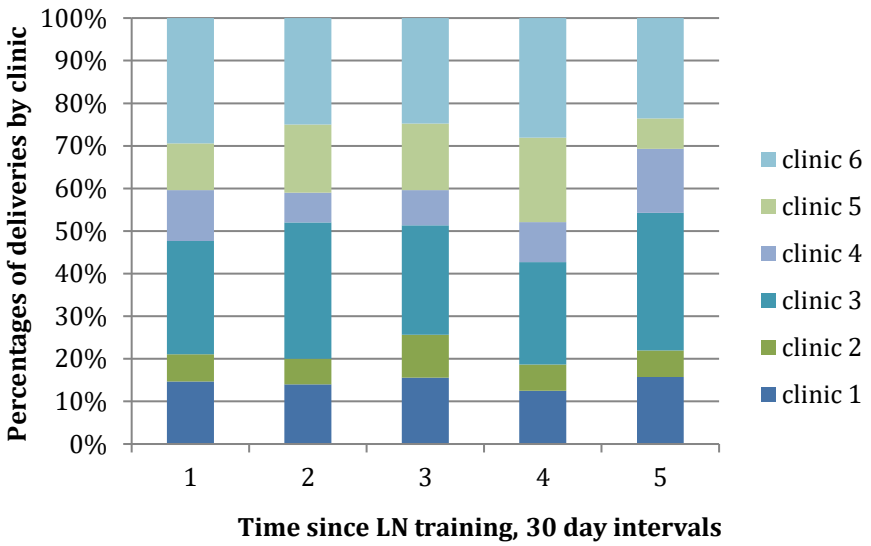


Figure 2: Percentages of deliveries by clinic in each 30-day after the training

A lowess curve (Figure 1) was fitted to the data to describe the average incidence of partograph use after the LN training. Thirty-five of 594 records were excluded since the records' dates were missing, leaving 559 records for a time series analysis to describe the trend of the partograph use after LN partograph training. The incidence of partograph use appeared to increase slightly, before decreasing until approximately 100 days after the training occurred. At this point, the average incidence appears to increase until the end of the study period, 29th January 2018, 159 days after the training.

Figure 3: Trend of the partograph use by day after the training, from August 23th, 2017 -January 29th, 2018. N=559.

Results of graphing the observed proportion of partograph use by 30-day interval after the LN partograph training (Figure 4) gives similar results as the loess curve. Specifically, the incidence of partograph use appeared to decrease over the first three intervals after the training. The fourth 30 days had relatively similar level of the partograph use with the third 30 days. Then, the incidence of the partograph use appeared to slightly increase from the fourth to sixth interval with an observed rate of use similar to that observed in the first 30 days post-training.

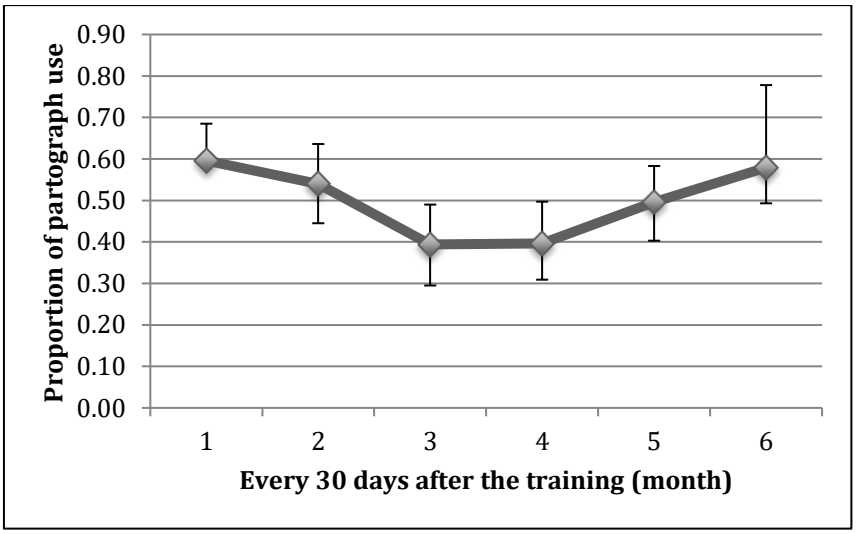


Figure 4: Proportion and 95%CI of the partograph use for each 30-day interval after the LN partograph training. N=559.

Figures 5 to 10 present the trends in partograph use for each clinic. The trends were heterogeneous by clinic, although sparse data make interpretation of these graphs a bit difficult. Clinic 1, Clinic 2, and Clinic 6 showed a similar trend. In these three clinics, incidence of partograph use started at a relatively high level and then decreased over time. Clinic 3, Clinic 4, and Clinic 5 increased their incidence of partograph use at about 50 days after the LN training. Then, incidence of partograph use dropped, before increasing again at about 100 days after the training.

Figure 5: Trend of partograph use after the training in Clinic 1. N=80.

Figure 6: Trend of partograph use after the training in Clinic 2. N=41.

Figure 7: Trend of partograph use after the training in Clinic 3. N=159.

Figure 8: Trend of partograph use after the training in Clinic 4. N=65.

Figure 9: Trend of partograph use after the training in Clinic 5. N=73.

Figure 10: Trend of partograph use after the training in Clinic 6. N=141.

3.2.3 Partograph use in daytime and nighttime

Five hundred and fifty-one of 594 (92.8%) recorded medical charts from the study had time recorded and thus were included in the analysis. In regression analysis, no significant difference between daytime and nighttime deliveries (PRR=0.98, 95% CI: 0.83-1.17, p-value=0.860) was observed.

3.2.4 Estimation of partograph use trends by day

Generalized linear models were fitted to predict the probability of partograph use as a linear and non-linear function of calendar time (continuous). The main model was incidence of the partograph use changing over days after the partograph training (Model 1). The models were:

Model 1: ln(Risk) = β_0 + β_1× time after intervention (time) + ε_t

Where, ln(Risk) is the probability of partograph use in t days after the training. *Time* is a continuous variable at day t from the training day. β_0 estimates the proportion of partograph use right after the training. β_1 estimates the changes in proportion that occur with each day after the training. The error term ε_t is the random error at day t.

Results of Model 1 (Table 6) show that the probability of partograph use did not change over time after the training (PRR=1.00, 95%CI: 1.00-1.00). Quadratic and cubic models were also fitted since the descriptive loess curve (Figure 2) indicated a non-linear relationship. Neither the time square (AIC=1.64) nor the time cube (AIC=1.64) terms

significantly improved the fit of the log-risk model to predict the probability of partograph use.

Table 6: Results from Poisson regression models estimating the proportion of partograph use in six LN clinics by day (Model 1) and by 30-day interval (Model 2) after the LN partograph training, Masaka District, Uganda, August 23rd–January 29th, 2018. N=559.

	IRR	95%CI	LL	AIC
Model1				
Intercept	0.54	(0.46, 0.63)	-386.44	1.68
time	1.00	(1.00, 1.00)		
Model 2				
Intercept	0.60	(0.51, 0.70)		
First 30 days	Ref	--		
Second 30 days	0.91	(0.71, 1.15)		
Third 30 days	0.66	(0.50, 0.87)	-381.02	1.38
Fourth 30 days	0.66	(0.50, 0.89)		
Fifty 30 days	0.83	(0.66, 1.05)		
Sixth 30 days	0.97	(0.64, 1.47)		

* IRR: Incidence Risk ratio; CI=confidence interval; LL=log likelihood; AIC: Akaike information criterion

3.2.5 Estimation of partograph use trends by 30-day interval

A generalized linear model was also used to predict the probability of partograph use over time by fitting dummy variables for each month after the training.

Model 2: $\ln(\text{Risk}) = \beta_0 + \beta_1 \times$ second 30 days after intervention (m2) + $\beta_2 \times$ third 30 days after intervention (m2) + $\beta_3 \times$ fourth 30 days after intervention (m4) + $\beta_4 \times$ fifth 30 days after intervention (m5) + $\beta_5 \times$ sixth 30 days after intervention (m6) + ε_t

Where, ln(Risk) is the probability of partograph use in t 30 days after the training. Factors m2 to m5 are binomial variables, indicating the period of time. For instance, in the third 30 days, first 30 days (m1), m2, m4, m5, and m6 are 0, and m3 is 1. β_0 estimates the proportion of partograph use right after the training. $\beta_{1\text{-}5}$ estimate the changes in proportion that occur with every 30 days after the training. The error term ε_t is the random error.

Partograph use dropped significantly in the third and fourth intervals after the training compared to the first 30 days (IRR=0.66, 95%CI: 0.50-0.87; IRR=0.66, 95%CI: 0.50-0.89; respectively; Table 6). The fifth and sixth 30 days had statistically similar levels of partograph use compared to the first 30 days (IRR=0.83, 95%CI: 0.66-1.05; PRR=0.97, 95%CI: 0.64-1.47; respectively).

3.2.6 Action line reached

Table 7. Numbers and proportions of action lines reached and actions taken in six LN study clinics, Masaka District, Uganda, August 23rd, 2017 – January 29th, 2018.

	Total partographs* (N)	Number of deliveries (n)	Percentage (%)	Standard Error	95% CI
Action line crossed	223	31	12	0.02	(0.08, 0.16)
Action taken	11	2	18	0.12	(0.03, 0.58)

* There were 47 missing values for action line cross and 20 missing values for action taken.

Among all used partographs, 31 reached action lines. According to the records, two actions (18%) were taken when an action line was reached: one was prepared for C-section and another was augmented with oxytocin.

3.2.6 Duration of labor and prolonged labor

Only 262 of 594 records had both admitted time and birth time recorded and thus were able to generate the estimated duration of labor. 46 records were removed since the duration of labor was shorter than 0 hours or longer than 80 hours, which were considered to be outside the range of a valid duration. Therefore, there were 226 records used for analysis.

From the histogram (Figure 10), the duration of labor approximated a Poisson distribution. Eighteen percent of the total births were prolonged labors (Figure 10, right of the red line), while, 82% of births were normal.

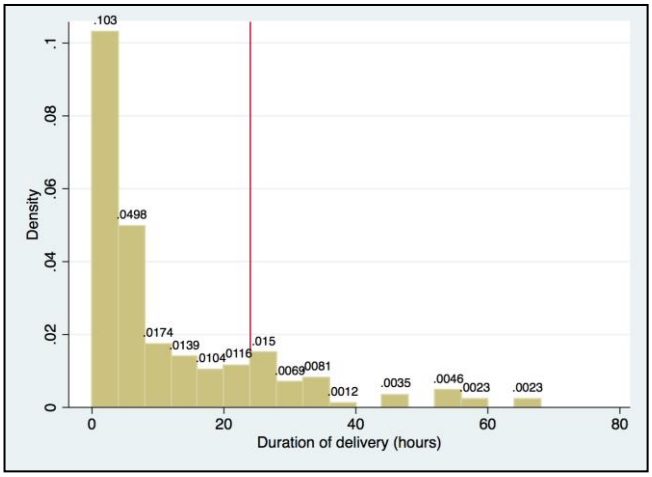


Figure 11: Distribution of duration of labor. N=226. The bin width = 4 hours. The red line indicates 24 hours labor, the threshold of prolonged labor using the WHO definition.

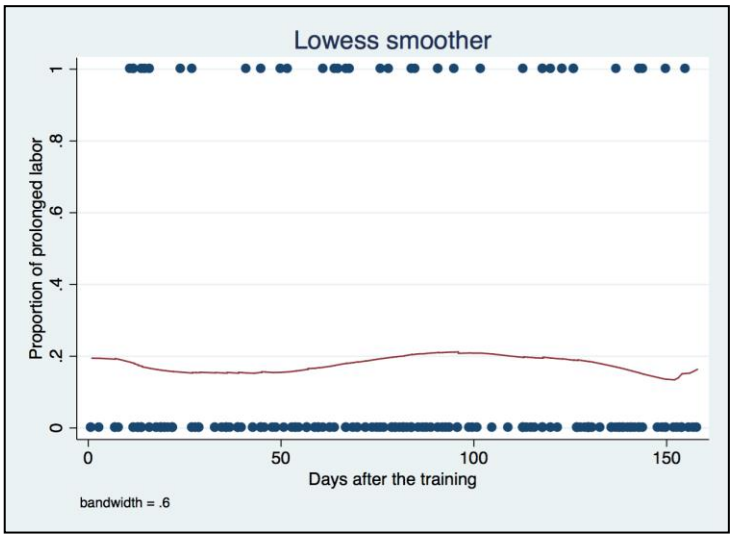


Figure 12: Trend of prolonged labor after the training. N=226.

From the loess curve (Figure 11), the trend of prolonged labor was relatively flat, indicating there was little change in the rate of prolonged labor over the study period.

3.2.7 Estimations of duration of labor and prolonged labor

It was thought that missing data for duration of labor might not be missing completely at random (MCAR). If MCAR cannot be assumed, then results of the analysis for prolonged labor may be biased by the missing data mechanism.

Generalized linear models were used to test the pattern of missing data for duration of labor (n=332) or impractical duration of labor (n=46) using measured covariates. A Directed Acyclic Graph (DAG) was used to identify potential confounders that might cause conditionally missing data for statistical tests. Potential confounders, including clinic (categorical), maternal age (continuous), first gravidity (binominal), full

gestation week (binominal; full gestation was defined as pregnancy for 37-40 weeks, according to LN training guide), types of deliveries (categorical; vaginal or CS), and birth outcomes (categorical; live birth, fresh still birth, or macerated birth), were tested individually. No factor was statistically significantly related with both missing records and time. Therefore, no measured factor was thought to lead to a significant bias in terms of missing data.

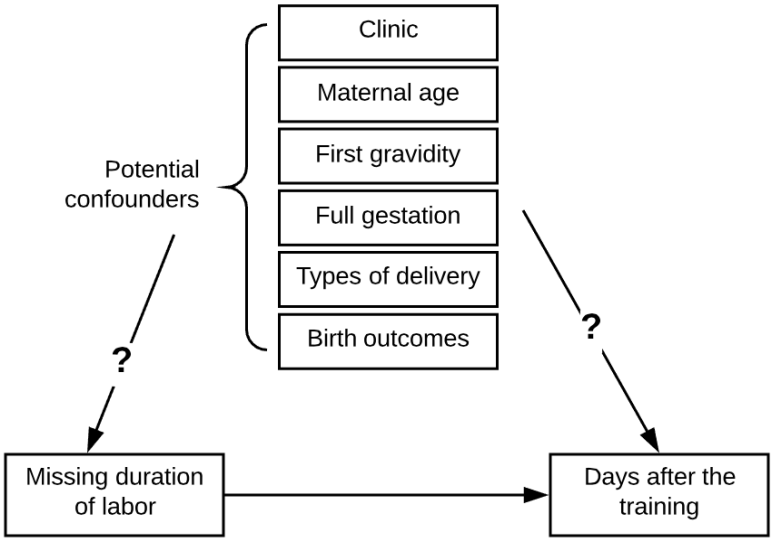


Figure 13: DAG of missing duration of labor and days after the training

To estimate duration of labor in days after the LN partograph training, we modeled:

Model 3: $Y_t = \beta_0 + \beta_1 \times$ **days after the training (time)** $+ \varepsilon_t$

Where, Y_t is the mean of labor length in t days after the training. *Time* is a continuous variable at day t from the training day. β_0 estimates the mean of duration of labor right after the training. β_1 estimates the changes in duration of labor that occur with each day after the training. The error term ε_t is the random error at day t.

To estimate the duration of labor when a partograph was used compared to when a partograph was not used, we modeled:

Model 4: $Y_p = \beta_0 + \beta_2 \times$ partograph $+ \varepsilon_p$

Where, Y_p is the mean of labor length when a partograph was used or not used to monitor labor. *Partograph* is a binomial variable, indicating whether a partograph is used (partograph=1) or not (partograph=0). β_0 estimates the mean of duration of labor when partograph is not used. β_2 estimates the changes in duration of labor that occur when a partograph is used to monitor labor. The error term ε_t is the random error.

Duration of labor did not change significantly throughout the time (RR=1.00, p = 0.561; Table 8). However, the duration of labor was significantly longer among deliveries monitored with a partograph than no partograph use (RR=4.39, p <0.001; Table 9).

To estimate probability of prolonged labor in days after the LN partograph training:

Model 5: ln(Risk) = $\beta_0 + \beta_1 \times$ days after the training (time) + ε_t

Where, ln(Risk) is the probability of prolonged labor in t days after the training. *Time* is a continuous variable at day t from the training day. β_0 estimates the proportion

of prolonged labor right after the training. β_1 estimates the changes in proportion occur with each day after the training. The error term ε_t is the random error at day t.

To estimate the probability when partograph was used compared to when partograph was not used:

Model 6: $\ln(\text{Risk}) = \beta_0 + \beta_2 \times \text{partograph} + \varepsilon_t$

Where, ln(Risk) is the probability of prolonged labor when partograph was used or not used to monitor labor. *Partograph* is a binomial variable, indicating whether a partograph is used (partograph=1) or not (partograph=0). β_0 estimates the proportion of prolonged labor when partograph is not used. β_2 estimates the change in proportion that occurs when a partograph is used to monitor a labor. The error term ε_t is the random error.

Table 8: Results from Modified Poisson regression models estimating duration of labors and probability of prolonged labor in six LN clinics by day after the LN partograph training Masaka District, Uganda, August 23rd, 2017 – January 29th, 2018. N=216.

	RR	95%CI	p-value	LL	AIC
Mean duration of labor					
Intercept	10.84	(10.03, 11.72)		-1836.99	17.03
time	1.00	(1.00, 1.00)	0.561		
Proportion of prolonged labor					
Intercept	0.16	(0.09, 0.29)		-100.43	0.95
time	1.00	(0.99, 1.01)	0.757		

* RR: Risk ratio; CI=confidence interval; LL=log likelihood; AIC: Akaike information criterion

Table 9: Results from linear regression models estimating mean duration of labor and proportion of prolonged labor by partograph use, Masaka District, Uganda, August 23rd, 2017 –January 29th, 2018. N=216.

	RR	95%CI	p-value	LL	AIC
Mean duration of labor				-1685.99	15.63
Intercept	3.01	(2.45, 3.70)			
Partograph use	4.36	(3.53, 5.38)	<0.001		
Probability of prolonged labor				-97.18	0.92
Intercept	0.03	(0.005, 0.23)			
Partograph use	5.97	(0.85, 41.89)	0.072		

* RR: Risk ratio; CI=confidence interval; LL=log likelihood; AIC: Akaike information criterion

From Table 8, probability of prolonged labor did not change significantly throughout time (RR=1.00, p = 0.757). Meanwhile, risk of prolonged labor was higher among deliveries monitored with the partograph than no partograph use but the difference was not statistically significant (RR=5.97, p=0.072; Table 9).

4. Discussion

4.1 Needs of partograph training

Before the LifeNet training intervention, the estimated proportion of partograph use was low at 19.8%. Among the six study clinics, two clinics did not use a partograph for a single delivery during the baseline data collection period. This proportion of partograph use was low, despite that monitoring labor with a partograph is suggested in the Uganda Clinical Guidelines 2016 as a standard procedure for midwives to prevent prolonged labor (MOH Uganda, 2016). The 19.8% partograph use, however, is similar to 17% of partograph use in the last week of SPA survey, reported in the Ugandan Service Provision Assessment Survey (SPA) in 2007 (MOH Uganda, 2008). This percentage of partograph use before the training was even higher than some previous research, as an audit study at Mulago Hospital in Kampala, Uganda, reported 3.57% of 7170 records had the partograph initiated in 2016 (Namwaya et al., 2017). Therefore, even though using the partograph to monitor labor is written in the Uganda Clinical Guidelines, the proportion of partograph use remains low in the six study clinics in Masaka, Uganda.

During the baseline period of the present study, both facility-level information and interviews reviled limited access to blank partographs in some clinics, which is at least one main reason that no partograph was used. This non-availability of partographs at facilities is consistent with other studies and reports from Uganda (MOH Uganda, 2008; Ogwang, 2009). Having a medical chart with partograph, and other supplementary

medical equipment available, is a necessary cause of using the partograph to monitor labors, and thus should be provided in all relevant health facilities.

However, having blank partographs available might not be sufficient for health providers to use the partograph. From the results, Clinic 2 had blank partographs as well as other medical instrument such as BP cuffs and fetal stethoscopes available throughout the baseline period (May 15th to July 17th, 2017), but no partograph was used to monitor any labor in this clinic before the LN intervention. This result indicates that having a partograph and other basic equipment and infrastructure available in a clinic did not always mean that the partographs would be used to monitor labor. This finding is consistent with Leslie et al.'s (2017) findings drawing on SPA data in eight LMICs, from 2007 to 2015, to assess whether the structural inputs of care predict clinical healthcare quality. Leslie found that the correlation between inputs, such as facility infrastructure and adherence to evidence-based care guidelines, was weak: health facilities provided widely varying healthcare quality with the same infrastructure level. Therefore, providing blank partographs, basic medical equipment, or necessary infrastructure might have limited influence on increasing partograph use if it is not done in concert with clinical training or other activities.

Meanwhile, this study found that some health providers had a misunderstanding of the recommended frequency with which to plot the components on the partographs and interpretation of the information from a completed partograph.

Although interviewed health providers were trained to use a partograph to monitor labor, lack of training or review about partograph use after school is probably a reason for health providers' misunderstanding. This agrees with Uganda SPA findings from 2007,, in which only nine percent of health providers had partograph training in the last year (MOH Uganda, 2008).

Many studies have observed improvement in partograph-related knowledge among health providers after partograph training. Nausheen (2010) assessed knowledge of the partograph among 100 health providers before and after a partograph workshop in Pakistan. Knowledge improvement was observed, as 87.8% of trained health providers got more than 80% correct in post-assessment, compared with just 14.9% of participants in the pre-test. A prospective controlled trial evaluated the effect of the Maternal Care Manual of the Perinatal Education Programme in South Africa in 1994. Midwives in a study town were trained to interpret the partograph and prenatal card, while midwives in two control towns were not given any training. This study found that the intervention group achieved 17.5% ($p=0.001$) higher marks in partograph interpretation after training than pre-training, whereas the control group did not change (Theron, 1999). Though with such a small number of clusters, this trial was able to distinguish the intervention effect from an effect that could be due to village level factors. Post-school training or workshops might be able to refresh partograph

knowledge among delivery health providers, and thus decrease misunderstandings about the partograph.

Considering the low proportion of partograph use, no blank partograph available in some clinics, failure to follow clinical guidelines in some clinics that were equipped with basic infrastructure, misunderstanding about the partograph among some health providers, and no post-school training, the LN intervention was warranted to improve uptake of partograph use and better healthcare practice.

4.2 The effectiveness of LN partograph training

The LN intervention significantly improved partograph use in six study clinics in Masaka District, Uganda. The overall percentage of partograph use was higher after the LN partograph training (46.8%) compared with pre-training (19.8%). Although the pre- and post-training data were collected through different methods (i.e., direct observation and medical chart review, respectively), these two methods often agree when evaluating health providers' performance,ed (Hermida, 1999; Miller Franco, 2002). Therefore, the change of partograph use in this study was less likely due to the disagreement between two data collection methods, but more likely resulted from the effect of the LN training.

Meanwhile, the sustained effect of the LN training on continued partograph use was durable across the six clinics throughout the five-month follow-up period. Sustaining this high partograph use after the training might be due in part, to the fact that other LN trainings continued for many months after the partograph training was

completed. Furthermore, additional review sessions were given to new employees in the six health centers who missed the scheduled training and to health providers who did not receive training at the initially scheduled time. The sustained improvement of partograph use resulting from continuous check or reviewing has also been reported in other studies. Fahdhy and Chongsuvivatwong (2005) conducted a cluster randomized controlled trial in Medan, Indonesia. Both intervention and control groups were trained for high-risk pregnancy management and only the intervention group received an extra partograph training and weekly supervision. This study observed 92.4% correctly completed partographs in the intervention group and significantly higher referral rate than in the control group (Adjusted OR=4.23, 95%CI: 2.10-8.71). The authors argued that the high rate of correctly completed partographs and more frequent action taken in the intervention group might have been a result of regular supervision and monitoring. A qualitative study described the health providers' perceptions of a childbirth healthcare quality improvement program in southern Tanzania in 2013. Some interviewed health providers said the follow-up supervision was useful to remind them what was learned during the training (Jaribu, et al., 2016). Considering that one interview participant in the present study indicated that supervision on partograph from the health officers was lacking before the LN intervention, the LN's regular engagement with health providers in these study clinics may be one reason partograph use improvement was found to be sustained throughout the study period.

4.3 Other factors related with partograph use

This study identified some potential factors that were associated with partograph use. First, informants said that heavy workload might be a reason for not using the partograph to monitor labor, as there were low staff-to-patient rate in each clinic so that a health provider had to take multi-responsibilities. In previous research, some studies found the heavy workload for health providers might hinder partograph use. Ogwang (2009) interviewed health providers in Rukungiri District, Uganda. Three respondents from hospitals said that a health provider had to manage more than three wards, including the labor ward and postnatal ward, so a health provider might stop monitoring labor with partographs when an emergency was coming. Lavender (2011) interviewed 51 student nurses in Nairobi, Kenya to gain the understanding of the realities of partograph use in the labor ward. The high number of mothers to take care of by one health provider was probably a reason not to use a partograph in the labor ward. Therefore, this heavy workload for limited numbers of health providers in each clinic might negatively impact partograph use.

Deliveries occurring at night might not negatively impact partograph use. This study found that the proportion of partograph use was not significantly different between daytime and nighttime deliveries before the LN training or after the training. This result is consistent with previous research. A prospective observational study assessed the association between partograph use and health providers' day and night

shifts in a teaching hospital in London, UK. No statistically significant difference was found between day and night shifts (Bailey, et al., 2015).

This study also reviled the significant differences of partograph use among clinics. This finding might suggest the existing of clinic-level factors potentially related to the partograph use not measured in this study. However, the significant differences during pre-training period might be imprecise due to the wide ranges of estimation.

4.4 Duration of labor and prolonged labor after training

The results of the present study showed a significantly longer duration of labor among deliveries in which a partograph was used (RR=4.39, p <0.001). Meanwhile, the risk of prolonged labor was higher in the partograph use group than in the no partograph use group (RR=5.97, p =0.072), but the difference was not statistically significant. As the partograph is a tool to monitor, and thus prevent, prolonged labor, the mean duration of labor was expected to be shorter and the probability of prolonged labor would be lower among labors monitored using a partograph. Two main reasons might lead to this result. First, although the partographs were used to monitor more deliveries, interventions, including augmenting oxytocin and referring to higher-level health centers, were not given to mothers when the action lines crossed and altered abnormal deliveries. In this study, lack of action taken was observed during both pre- and post-training periods. The action taken when the action line was reached remained low: five total actions were taken among 212 deliveries during baseline, and two actions

were taken in total among 594 deliveries in phase two. Health providers in six study clinics used the partograph more frequently after the training but the intervention to abnormal deliveries remained the same level before and after the partograph training.

Previous studies about the effectiveness of the partograph have discussed this potential link among partograph use, active intervention, and decreased mean duration of labor or prolonged labor prevention. Javed (2007) studied 500 deliveries each before and after introducing the partograph at Jinnah Post Graduate Medical Center in Karachi, Pakistan. This prospective case-control study showed a significant reduction in duration of labor. The author argued that oxytocin was augmented earlier at the first sign of deviation from normal pattern according to the scientific monitoring. This early augment after partograph was introduced was argued as a main reason for shorter duration of labor. Another study randomized 400 high-risk labors into partograph monitoring group and no partograph group in Patna Medical College and Hospital at Bihar, India. The authors argued that the oxytocin augmentation was not significantly different between two groups and this same level intervention might resulted to the no decrease of labor duration (Rani et al., 2015). Partograph monitoring and active interventions were argued to be able to prevent prolonged labor (O'Driscoll et al., 1973). Fahdhy and Chongsuvivatwong (2005) recruited 40 midwives and gave high-risk labor management training and randomly trained 20 midwives to use partograph in Indonesia. This study found the odds of prolonged labor was not significantly reduced

(adjusted OR=0.40, 95%CI: 0.15-1.12). The authors argued that one reason for no reduce of prolonged labor in partograph use group could be that the control group had a higher rate of augmented labor (adjusted OR=0.38, 95%CI: 0.31-0.46), which would shorten the delivery process. Therefore, recognizing active intervention based on labor monitoring is important to understand the effectiveness of partograph as a monitoring tool to prevent prolonged labor.

Second, in this study, the results of the higher mean duration of labor and proportion of prolonged labor among partograph use group might be confounded by health providers' choices. Health providers may have been more likely to use the partograph selectively to high-risk mothers. RAs observed some health providers rushed to fill a partograph after issue a referral. This selective partograph use practice had not been reported in previous studies.

Another potential reason might be the deficient referral system in rural Uganda. A referral to another clinic could take two hours on a bumpy road, which is unlikely to help a mother in the emergency. Therefore, health providers might intend not to refer a mother even though they identified prolonged labor, which could be a possible reason that health providers do not start a partograph at the beginning.

4.5 Implications for policy and practice

This study identified a potential need for job-based partograph training among health providers working in health center-IIIs and -IVs in Masaka District, Uganda. The

trainings may be beneficial at two levels: the health provider level and the clinic. For the health provider level, training should be provided to refresh their knowledge of partograph use. Although delivery health providers were trained to use partographs in schools, the overall proportion of partograph use was low in previous research and in this study at 19.8% before the training in clinics. Considering some health providers had a misunderstanding of partograph use in their practices, partograph training might be helpful for health providers to refresh their knowledge and implement the knowledge in the clinical practices (Lavender et al., 2011). At the facility level, the blank printed partograph and other basic infrastructures, such as a blood pressure cuff, are necessary to monitor a delivery with a partograph. However, more resources were not found to be related with increased partograph use. Therefore, providing blank partographs and other resources as the only clinic-level intervention might not be helpful to improve the monitoring of labor with partographs.

This study provided evidence to support the effectiveness of LN partograph training module in improving partograph use. The components of the LN partograph training, including the partograph training lecture and provision of blank printed partographs to clinics, might have a positive influence on partograph use among trained clinics. The continuous engagement and reviewing with health providers may be leading to sustained partograph use after the training. Meanwhile, this study also suggested that the health providers' action taken when action line reached remained

very low, and thus the probability of prolonged labor did not improve. Therefore, next steps should focus relevant trainings on the appropriate response by the health providers to results of a completed partograph.

Heavy workload for health providers in the clinics might negatively impact partograph use. The heavy workload probably resulted from a low ratio of health providers to patient in these six clinics. This low staff-to-patient ratio is an institutional challenge that could be hard for a single organization to adequately address. This challenge requires higher-level intervention and a tremendous amount of time and resources to solve.

4.6 Implications for further research

This study indicated that the prolonged labor might not be prevented only through monitoring labor with partographs but also health providers' active interventions to mothers when the action lines reached. Further studies should measure and evaluate other health providers' interventions when the action lines on the partograph is reached, including augmenting oxytocin and referrals, as well as these factors' impacts of prolonged labor and other maternal health outcomes. Meanwhile, this study evaluated the impacts of LN partograph training for about five months. Future studies should explore the longer-term impact of training interventions to improve partograph use among health providers in these resource-limited settings.

4.7 Study strengths and limitations

One of the study strengths is its use of mixed methods. The qualitative data obtained from health provider interviews, highlighting causes underlying their behaviors, complements the quantitative data of the proportion of the partograph use. Together, the two methods demonstrate the impact of the partograph training and key factors that should have been addressed in the intervention.

Meanwhile, the direct clinical observation is a believed as the golden standard in collecting quality of care data. Hence, the observers were will-trained. Half of RAs are certified midwives, who have earned higher degrees in nursing and sometimes have more clinical experiences than health providers in the clinics. Therefore, these RAs would make valid decisions on if the health providers performed well or not.

There are several limitations in this study. First, the Hawthorne effect likely existed in the pre-training data collection period. Health providers might intentionally performed better when being observed, leading to an overestimation of partograph use before training. Therefore, the change of partograph use in this study is likely a conservative estimate.

During post-training data collection period, there might be information bias to due to variable misclassification when abstracting data from the medical chart. For instance, in this setting, many mothers came to the facility when they were in the second stage of labor, meaning they were ready to deliver and no need to monitoring the

process. Through data abstraction, these deliveries were likely categorized as "not monitored with a partograph."

Information from health providers is subject to bias introduced by the transcultural interaction. The interviewer and interviewees might have misunderstandings in both ways due to the different communication styles. Additionally, interviewees who learned and understood the importance of partograph use could probably respond in a most acceptable way instead of their opinions.

Meanwhile, as an observational study, unmeasured factors might confound the effect attribute to the LN training. For instance, if the delivery rate different over time by clinic, then, the change of partograph use might be due to the differential rate of delivery. This study, however, found no evidence that the rate of delivery change over time so that this could not confound the results. Also, this study has large number of missing data. However, missing data were not found to be a function of several measured factors, including clinic, maternal age, first gravidity, gestation week, type of delivery, and birth outcome. This does not preclude the possibility that additional unmeasured factors might be predictive of this missing data, and could, therefore, introduce bias into the study.

5. Conclusion

This study provides evidence that the LifeNet partograph training significantly improved health provider's partograph use in the six study clinics in Masaka District, Uganda, and led to a sustained improvement in partograph use for at least five months after the training. Post-school training and intervention in partograph use are needed among private health center-IIIs and –IVs. Active intervention when the action line is reached on a partograph is important to prevent prolonged labor, yet we found no change in actions taken pre- and post-intervention. Therefore, further partograph training for health providers should focus on enhancing action taken according to information obtained from a completed partograph.

Appendix A

Direct observation form (DCO) (questions used in this study was highlighted)

Direct Clinical Observation

Clinic ID: |____|____| **Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|

Observation Date: |____|____| / |____|____| / |____|____|____|____| (DD / MM / YYYY) **RA ID:** |____|____|

Instructions: *Before observing the consultation, make sure to obtain informed consent from client. If the client is unable to provide consent for herself, her next of kin may give consent on her behalf. Consent must be obtained before conducting any observation. Also ensure the provider knows that you are there to observe, not to evaluate her/him or to be consulted on any client case.*

1. Do I have your permission to be present throughout your labour as you receive care and services today? .....|___|
   0 = No → **END observation.**
   1 = Yes
2. Person consenting .....|___|
   1 = Client herself
   2 = Next of kin

3. Time pregnant client admitted to facility..... |___||___|/|___||___|/|___||___||___| (DD / MM / YYYY) |___||___| : |___||___| (24hr)
4. Observation Start, Date and Time ..... |___||___|/|___||___|/|___||___||___| (DD / MM / YYYY) |___||___| : |___||___| (24hr)
5. Observation End, Date and Time..... |___||___|/|___||___|/|___||___||___| (DD / MM / YYYY) |___||___| : |___||___| (24hr)

Section 1: Initial Client Assessment

6. Was this section observed? .....|___|
   0 = No → **Skip to Section 2.**
   1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No 1 = Yes 8 = Do not know

INTRODUCTION AND HISTORY TAKING

7. Checks woman's HIV status (via card or asks woman) .....|___|
8. Is the woman's HIV status known? *Listen & record answer.* .....|___|

If Yes → Skip to Q10

9. Offers woman HIV test if status is unknown *[If known, mark 9=n/a].*.....|___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

0 = No **1 = Yes** **8 = Do not know**

EXAMINATION

10. Washes his/her hands with soap and water or uses alcohol hand rub before any initial examination .....|___|

11. Takes temperature.....|___|

12. Takes pulse.....|___|

13. Takes blood pressure .....|___|

14. Tests urine for presence of protein .....|___|

15. Performs the following steps for abdominal examination:

- **a.** Checks fundal height with measuring tape .....|___|
- **b.** Checks fetal presentation by palpation of abdomen .....|___|
- **c.** Checks fetal heart rate with fetoscope/Doppler/ultrasound .....|___|

16. Washes his/her hands with soap and water or uses alcohol rub before vaginal examination.....|___|

17. Gloves of any type (e.g., surgical, non-surgical, pre-packaged or not) used for the vaginal examination? .....|___|

If No/DK → Skip to Q20

18. Gloves used for vaginal examination were pre-packaged, surgical gloves .....|___|

If No/DK → Skip to Q20

19. Did any of the following practices occur related to the surgical gloves after they were opened and prior to examination?:

- **a.** Gloved hands touched bed &/or used to touch or lay down plastic sheet .....|___|
- **b.** Gloved hands touched antiseptic bottle while pouring.....|___|
- **c.** Gloved hands touched other non-sterile items not previously mentioned
  (Note: Touching sterile cotton or sterile kidney dish would not count here.) .....|___|
- **d.** Opened gloves left exposed for more than 10 minutes before use .....|___|
- **e.** Other practices that could potentially contaminate the gloves:
  (specify): _____ .....|___|

20. Informs the woman what will happen before conducting the vaginal examination .....|___|

21. Performs vaginal examination.....|___|

22. Informs pregnant woman of findings of vaginal exam.....|___|

23. Was this woman referred for a c-section? .....|___|

If No/DK → Skip to Q24

Why referred? *(Note: Ask provider if unknown.)*

- **a.** Obstructed labour .....|___|
- **b.** Pre-eclampsia/eclampsia.....|___|
- **c.** Placenta previa .....|___|
- **d.** Previous c-section scar.....|___|
- **e.** Fetal distress.....|___|
- **f.** Cord prolapse .....|___|
- **g.** Other, specify: _____.....|___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|/___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

24. Open-ended comments related to Section 1:

_____

_____

_____

_____

END SECTION 1: INITIAL CLIENT ASSESSMENT

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 2: Intermittent Observation of First Stage of Labour

25. Was this section observed? .....|___|
0 = No → **Skip to Section 3.**
1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No **1 = Yes** **8 = Do not know**

PROGRESS OF LABOUR

26. At least once, explains what will happen in labour to woman (and/or supporting person if present) .....|___|

27. At least once, encourages woman to consume fluids/food during labour.....|___|

28. At least once, encourages/assists woman to walk and assume different positions during labour.....|___|

29. Partograph used to monitor labour .....|___|

If no → **Skip to Q35**

30. Action line on partograph reached.....|___|

If no → **Skip to Q35**

31. Record time action line was reached.....|___||___| : |___||___|
24hr

32. Was any definitive action taken once reached the action line? .....|___|

If no → **Skip to Q35**

33. Record time action was taken.....|___||___| : |___||___|
24hr

34. What definitive action was taken?

- **a.** Consult with specialist.....|___|
- **b.** Refer to other facility for specialist.....|___|
- **c.** Prepare for assisted delivery .....|___|
- **d.** Prepare for c-section.....|___|

EXAMINATION AND PROCEDURES

35. Washes his/her hands with soap and water or uses alcohol hand rub prior to any examination of woman.....|___|

36. Gloves of any type (e.g., surgical, non-surgical, pre-packaged or not) used for the vaginal examination? .....|___|

If No/DK → Skip to Q39

37. Gloves used for vaginal examination were pre-packaged, surgical gloves .....|___|

If No/DK → Skip to Q39

38. Did any of the following practices occur related to the surgical gloves after they were opened and prior to examination?:

- **a.** Gloved hands touched bed &/or used to touch or lay down plastic sheet .....|___|
- **b.** Gloved hands touched antiseptic bottle while pouring.....|___|
- **c.** Gloved hands touched other non-sterile items not previously mentioned

Direct Clinical Observation

Clinic ID: |____|____| **Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|

Observation Date: |____|____| / |____|____| / |____|____|____|____| (DD / MM / YYYY) **RA ID:** |____|____|

(Note: Touching sterile cotton or sterile kidney dish would not count here.) .....|___|

d. Opened gloves left exposed for more than 10 minutes before use .....|___|

e. Other practices that could potentially contaminate the gloves:
(specify): _____ .....|___|

39. Explains procedures to woman (&/or support person) before proceeding.....|___|

40. Number of vaginal examinations .....|___|
[To the best of your ability, update the answer to this question during observation of the first stage of labour.)

41. Augments labour with oxytocin .....|___|

If No→ Skip to Q43

42. Oxytocin administered intravenously (IV) .....|___|

43. Performs artificial rupture of membrane.....|___|

44. Administers antibiotics .....|___|

PREPARATION FOR DELIVERY

45. Pre-packaged birth kit present (e.g., Mama Kit)? .....|___|

If No/DK→ Skip to Q47

46. Which components of the kit were used?—*come back to this question later if needed*

Cord clamp/cotton cord tie?.....|___|

Razor blade/scalpel? .....|___|

Soap?.....|___|

Gloves?.....|___|

Cotton/gauze?.....|___|

Plastic sheet for mother to lie on during delivery? .....|___|

47. Was this woman referred for a c-section? .....|___|

If No/DK→ Skip to Q48

Why referred for C-section?

a. Obstructed labour .....|___|

b. Pre-eclampsia/eclampsia.....|___|

c. Placenta previa .....|___|

d. Previous C-section scar.....|___|

e. Fetal distress.....|___|

f. Cord prolapse .....|___|

g. Other, specify: _____.....|___|

48. Has this woman completed the first stage of labour? .....|___|

[If first stage of labour is not yet complete, check answers in this section again 15-30 minutes later. Update as needed.]

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|/___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

49. Open-ended comments related to Section 2:

END SECTION 2: FIRST STAGE OF LABOUR

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 3: Continuous Observation of Second & Third Stage Labour

50. Was this section observed? .....|___|
0 = No → **Skip to Section 4.**
1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No **1 = Yes** **8 = Do not know**

PREPARATION FOR DELIVERY

51. Puts on clean protective clothing in preparation for birth (gown or apron) .....|___|

52. Washes his/her hands with soap and water or uses alcohol hand rub prior to any examination of woman .....|___|

53. Gloves of any type (e.g., surgical, non-surgical, pre-packaged or not) used for vaginal examination/delivery? |___|

If No/DK → Skip to Q56

54. Gloves used for vaginal examination/baby delivery were pre-packaged, surgical gloves .....|___|

If No/DK → Skip to Q56

55. Did any of the following practices occur related to the surgical gloves after they were opened and prior to use during examination/labour?:

a. Gloved hands touched bed &/or used to touch or lay down plastic sheet .....|___|

b. Gloved hands touched antiseptic bottle while pouring.....|___|

c. Gloved hands touched other non-sterile items not previously mentioned

(Note: Touching sterile cotton or sterile kidney dish would not count here.) .....|___|

d. Opened gloves left exposed for more than 10 minutes before use .....|___|

e. Other practices that could potentially contaminate the gloves:
(specify): _____ .....|___|

56. Mother is lying on disposable plastic sheet ..... |___|

57. Performs episiotomy if indicated (confirm with provider why it was indicated) .....|___|

58. Presentation of baby is cephalic (head first) .....|___|

DELIVERY

59. Record Date and Time of delivery .....|___||___|/|___||___|/|___||___||___||___| |___||___| : |___||___|
DD MM YYYY *24hr*

60. Second baby present? .....|___|

61. Administers uterotonic? .....|___|

If No→ Skip to Q67

62. Record time uterotonic given .....|___||___| : |___||___|
24hr

63. Timing of administration of uterotonic.....|___|

0 = Before any presentation of the baby

1 = At delivery of anterior shoulder
2 = Within 1 minutes of delivery of baby
3 = Within 3 minutes of delivery of baby
4 = More than 3 minutes after delivery of baby
8 = Do not know

64. Which uterotonic given? ..... |___|

1 = Oxytocin (note if it was properly refrigerated/stored in cold chain—IF NOT, describe in notes section)
2 = Ergometrine
3 = Syntometrine
4 = Misoprostol
8 = Don't know

65. Record dose of uterotonic given and units (e.g., IU, mg, mL, mcg) ..... _____
[If necessary, ask afterward.]

66. Route of uterotonic given ..... |___|

1 = Intramuscular
2 = Intravenously
3 = Oral
If Misoprotol, was tablet placed under the tongue? ☐ Yes ☐ No ☐ Don't' Know
4 = Other, specify: _____
8 = Don't know

67. Record time the cord was clamped..... |___||___| : |___||___|
24hr

68. Was a skilled birth attendant present at the delivery? (i.e., midwife, physician, obstetrician, nurse) ..... |___|

0 = No
1 = Yes

69. Performs uterine massage immediately following delivery of placenta ..... |___|

70. Was placenta examined for completeness ..... |___|

71. Was placenta delivered before administration of uterotonic ..... |___|

72. Did more than one health worker assist with the birth ..... |___|

73. Did mother give birth in lithotomy position (on back)? ..... |___|

74. Is a support person (companion) for mother present at birth inside the delivery room?..... |___|

75. Open-ended comments related to Section 3:

_____
_____
_____
_____

END SECTION 3: SECOND AND THIRD STAGE LABOUR

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 4: IMMEDIATE NEWBORN AND POSTPARTUM CARE

76. Was this section observed? .....|___|
0 = No → **Skip to Section 5**
1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No 1 = Yes 8 = Don't know

77. Provider properly conducts APGAR score at 1 minute .....|___|

78. Provider documents 1-minute APGAR score.....|___|

79. Provider properly conducts APGAR score at 5 minutes .....|___|

80. Provider documents 5-minute APGAR score.....|___|

81. Immediately dries baby with towel .....|___|

82. Ties or clamps cord:

Immediately/within 1 minute after birth .....|___|

2-3 minutes after birth .....|___|

83. Uses sterile cord clamp .....|___|

0 = No clamp used
1 = Sterile cord clamp used
2 = Cord clamp used, not sterile or sterility unknown

84. String used for cord.....|___|

0 = No string used
1 = Sterile string used
2 = String used, not sterile or sterility unknown

85. Cuts cord with sterile blade or sterile scissors .....|___|

86. Is the baby either breathing or crying? .....|___|

If no → Skip to Section 5

87. Places baby on mother abdomen "skin to skin" .....|___|

0 = No
1 = Yes→ **Skip to Q89**

88. If not placed skin to skin, wraps in dry towel .....|___|

HEALTH CHECK *(within first 5 minutes)*

89. Takes baby's temperature .....|___|

90. Takes mother's temperature.....|___|

91. Takes mother's pulse.....|___|

92. Takes mother's blood pressure.....|___|

93. Palpates uterus 15 minutes after delivery of placenta ..... |___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

FIRST HOUR AFTER BIRTH

94. Initiates breastfeeding within first hour.....|___|

95. Mother and newborn kept in same room after delivery .....|___|

96. Baby kept skin to skin with mother for the first hour after birth .....|___|

97. Provides tetracycline eye ointment 1% prophylaxis .....|___|

98. Administers Vitamin K to newborn.....|___|

99. Is the mother HIV positive? .....|___|

If No/DK → Skip to 101

100. Administers ARVS to newborn .....|___|

101. Administers antibiotics to mother postpartum if indicated .....|___|

If No/DK → Skip to 103

102. Why were antibiotics administered?.....|___|

1 = Treatment for chorioamnionitis
2 = Routine.prophylactic
3 = Third stage/postpartum procedure
4 = Group B Strep infection
5 = Premature rupture of membranes (PROM)
6 = Other (specify: _____)
8 = Don't know

CLEAN-UP AFTER BIRTH

103. Disposes of all sharps in a puncture-proof container immediately after use .....|___|

104. Disinfection of all reusable instruments .....|___|

105. Disposes of all contaminated waste in leak-proof containers .....|___|

106. Washes his/her hands with soap and water or uses alcohol hand rub .....|___|

CLEAN-UP AFTER NEWBORN RESUSCITATION

107. Was there a newborn resuscitation?.....|___|

If No/DK → Skip to Section 6

108. Disposes of disposable suction catheters and mucus extractors in a leak-proof container or plastic bag ...|___|

109. Disinfection for bag, valve and mask.....|___|

110. Disinfection for reusable suction devices .....|___|

111. Washes his/her hands with soap and water or uses alcohol hand rub .....|___|

112. Open-ended comments related to Section 4:

_____

_____

_____

_____

END SECTION 4: Immediate Newborn and Postpartum Care

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 5: CHECKLIST FOR NEWBORN RESUSCITATION

113. Was this section observed? ..... |___|

0 = No → **Skip to Section 6.**
1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No **1 = Yes** **8 = Don't know**

114. Record time resuscitation started ..... |___||___| : |___||___| *24 hr*

115. Clears the airway by suctioning the mouth first and then the nose ..... |___|

116. Stimulates baby with back rubbing ..... |___|

117. Does newborn start to breathe or cry spontaneously [Observe] **(if YES, go back to Section 4.)** ..... |___|

118. Ties or clamps cord immediately ..... |___|

119. Uses sterile cord clamp ..... |___|

0 = No clamp used
1 = Sterile cord clamp used
2 = Cord clamp used, not sterile or sterility unknown

120. String used for cord ..... |___|

0 = No string used
1 = Sterile string used
2 = String used, not sterile or sterility unknown

121. Cuts cord with sterile blade or sterile scissors ..... |___|

122. Places the newborn on his/her back flat on a clean, warm surface or towel ..... |___|

123. Places the head in a slightly extended position to open the airway ..... |___|

124. Places mask on the newborn's face so that it covers the chin, mouth and nose (but not eyes) ..... |___|

125. Checks the seal by ventilating two times and observing the rise of the chest ..... |___|

126. Is newborn's chest rising in response to ventilation? ..... |___|

If yes → Skip to 134

127. Checks the position of the newborn's head ..... |___|

128. Checks mouth, back of throat and nose for secretion, and clears if necessary ..... |___|

129. Checks the seal by ventilating two times and observing the rise of the chest ..... |___|

130. Is newborn's chest rising in response to ventilation? ..... |___|

If yes → Skip to 134

131. Repeats suction of mouth and nose to clear secretions, if necessary. ..... |___|

132. Checks the seal by ventilating two times and observing the rise of the chest ..... |___|

133. Is newborn's chest rising in response to ventilation? ..... |___|

If newborn's chest is not rising after two attempts to readjust, observer should call supervisor to intervene. If no one competent in resuscitation is available, observer may choose to intervene.

Direct Clinical Observation

Clinic ID: |____|____| **Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|

Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY* **RA ID:** |____|____|

134. Ventilates at a rate of 30 to 50 breaths/minute .....|___|

135. Checks heartrate of newborn after 1 minute of ventilation with visible check movements .....|___|

136. Conducts assessment of newborn breathing after 1 minute of ventilation .....|___|

137. Condition of newborn at assessment .....|___|

1 = respiration rate 30-50 breaths/minute and no chest in-drawing
2 = respiration rate <30 breaths/minute with severe in-drawing
3 = no spontaneous breathing

138. Additional heartrate monitoring after more than 1 minute .....|___|

139. Record time that resuscitation actions ended (or time of death if baby died)..... |___||___| : |___||___| *24 hr*

140. Was the resuscitation successful? .....|___|

141. Arranges transfer to special care either in facility or to outside facility .....|___|

142. Did you as the observer call for help or intervene during the resuscitation to save the life of the newborn?|___|

143. Open-ended comments related to Section 5:

_____

_____

_____

_____

_____

END SECTION 5: NEWBORN RESUSCITATION --- *RETURN TO SECTION 4 HEALTH CHECK*

Direct Clinical Observation

Clinic ID: |____|____| **Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|

Observation Date: |____|____| / |____|____| / |____|____|____|____| (DD / MM / YYYY) **RA ID:** |____|____|

161. Delivery method noted on partograph or medical chart? ..... |___|

162. Birthweight noted on partograph or medical chart? ..... |___|

163. Was action line on partograph reached? ..... |___|

If No/DK → Skip to 168

For questions 155-176, examine partograph &/or chart for information. If the information is not in the chart or partograph, but the observer knows the information or recorded info in a previous section, s/he should fill in their own answer. If the information from the partograph or chart differs from the observer's information, ***use the observer's information.***

0 = No 1 = Yes 8 = Don't know *or otherwise indicated*

164. Record time action line was reached ..... |___||___| : |___||___| *24 hr*

165. If action line reached on partograph, was any definitive action taken? ..... |___|

If No/DK →Skip to 168

166. Record time action was taken ..... |___||___| : |___||___| *24 hr*

167. What definitive action was taken? ..... |___|

1=consult with specialist
2=refer _
3=assist delivery
4=c-section prep
5=other, specify: _____

168. Age of woman ..... ____ years

169. Gravidity (# of pregnancies) of the woman ..... _____

170. Parity (# of pregnancies carried to viable gestational age) of the woman ..... |___| + |___|
(PRIOR TO THIS DELIVERY)

171. Time of admission to labour ward ..... |___||___| : |___||___| *24 hr*

172. Centimetres dilated upon admission to labour ward ..... _____cm

173. Type of delivery ..... |___|

1=spontaneous vaginal
2=assisted
3=C-section

174. Time of birth ..... |___||___| : |___||___| *24 hr*

175. Birthweight in grams *(Note: convert to grams if recorded in kilograms)* ..... ____ g

176. Gestational age at birth in weeks *(Note: record # of weeks or 8 in second box for DK)* ... _____weeks or |___|

177. Did the mother have blood loss more than 500mL *(Note: NOT based on your observation)*? ..... |___|

178. Was she diagnosed with postpartum haemorrhage? ..... |___|

179. Did the mother develop a fever of 38 C or higher during labour? ..... |___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 6: OUTCOME & REVIEW OF DOCUMENTATION

This section should be completed for all clients.

144. Record outcome for the mother ..... |___|

1 = Recuperates at same facility
2 = Referred to specialist, same facility
3 = Goes to surgery, same facility
4 = Referred to other facility
5 = Death of mother
8 = don't know

145. Record outcome for the newborn or fetus ..... |___|

1 = Goes to normal nursery
2 = Referred to specialist, same facility
3 = Referred, other facility
4 = goes to ward with mother
5 = Newborn death
6 = Fresh stillbirth (fetal heartrate detected at admission)
7 = Macerated stillbirth (no fetal heartrate at admission)
8 = don't know

Review partograph and medical chart for completeness. For questions 137-154, base responses on what is recorded on the partograph and medical chart, even if the recorded information differs from what the observer saw.

0 = No 1 = Yes 8 = Don't know 9 or 99 = Not Applicable

146. Was APGAR score documented? ..... |___|

If No/DK → Skip to 150

147. Record the documented 1-minute APGAR score *(Note: Record 99 if N/A or not documented)* ....|___||___| **/ 10**

148. Record the documented 5-minute APGAR score *(Note: Record 99 if N/A & not documented)* .....|___||___| **/ 10**

149. Record the documented 10-minte APGAR score *(Note: Record 99 if N/A & not documented)* ....|___||___| **/ 10**

150. Was newborn resuscitation documented? ..... |___|

151. Was the partograph used to monitor labour? ..... |___|

If No/DK → Skip to 168

152. Fetal heartrate plotted at least every half hour ..... |___|

153. Cervical dilation plotted at least every four hours ..... |___|

154. Descent of head plotted at least every four hours ..... |___|

155. Frequency and duration of contractions plotted at least every half hour ..... |___|

156. Maternal pulse plotted at least every half hour ..... |___|

157. BP recorded at least every four hours ..... |___|

158. Temperature recorded at least every two hours ..... |___|

159. Observer: Did you see provider create a partograph after delivery ..... |___|

[with information that should be entered during labour?) [Indicate "don't know" if partograph use was not observed]

160. Birth time recorded on partograph or medical chart? ..... |___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

180. Was she diagnosed with chorioamnionitis during labour? .....|___|

181. Were antibiotics administered to mother at any time? .....|___|

If No/DK → Skip to 184

182. When were antibiotics administered?.....|___|
1=1st stage
2=2nd stage
3=3rd stage
4=postpartum

183. Why were antibiotics administered?.....|___|
1=Prevent Strep B infection
2=Prevent pre-term labour
3=Ruptured membranes
4=General prophylaxis
5=Other, specify: _____

184. Is the mother HIV+? .....|___|

185. Was newborn given ARVs? .....|___|

186. Open-ended comments related to Section 6:

_____
_____
_____
_____
_____

END SECTION 6: OUTCOME & REVIEW OF DOCUMENTATION

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

SECTION 7: OBSERVATION OF POSTPARTUM HEMORRHAGE

187. Was this section observed? ..... |___|
0 = No → **END OBSERVATION. RECORD TIME IN Q5.**
1 = Yes

Record whether the provider carried out the following steps and/or examinations. Some of the steps may be carried out simultaneously or by more than one provider.

0 = No 1 = Yes 8 = Don't know *or otherwise specified*

188. Record time complication started ..... |___||___| : |___||___|
24 hr

Immediate Care

189. Monitors bleeding ..... |___|

190. How much bleeding was there (mL) *(Note: According to provider)* ..... _____mL

191. Performs uterine massage ..... |___|

If No/DK → Skip to 194

192. Time massage performed ..... |___||___| : |___||___|
24 hr

193. Minutes after complication began that massage was performed ..... |___||___|

194. Gives oxytocin ..... |___|

If No/DK → Skip to 199

195. Record dose (in IU) ..... _____IU

196. Is route of administration IV through ringer's lactate or normal saline? ..... |___|
0 = Not administered through IV
1 = ringers lactate
2 = normal saline

197. Time oxytocin given..... |___||___| : |___||___|
24 hr

198. Minutes after complication began that oxytocin was given ..... |___||___|

199. Other uterotonic given ..... |___|

If No/DK → Skip to 203

200. Which other uterotonic was given? ..... _____

201. Time other uterotonic given..... |___||___| : |___||___|
24 hr

202. Minutes after complication began that other uterotonic was given..... |___||___|

203. Performs abdominal exam for uterine contraction ..... |___|

If No/DK → Skip to 206

204. Time abdominal exam performed..... |___||___| : |___||___|
24 hr

205. Minutes after complication began that abdominal exam was performed ..... |___||___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

206. Examines the vagina and perineum for lacerations and or cervical tear ..... |___|

If No/DK → Skip to 209

207. Time vaginal and perineum exam performed ..... |___||___| : |___||___|
24 hr

208. Minutes after complication began that vaginal and perineum exam was performed ..... |___||___|

209. Examines the placenta for completeness ..... |___|

If No/DK → Skip to 212

210. Time placenta exam performed ..... |___||___| : |___||___|
24 hr

211. Minutes after complication began that placenta exam was performed ..... |___||___|

212. Starts IV fluids ..... |___|

If No/DK → Skip to 215

213. Time IV fluids started ..... |___||___| : |___||___|
24 hr

214. Minutes after complication began that IV fluids were started ..... |___||___|

Immediate Care

215. Performs uterine exploration ..... |___|

If No/DK → Skip to 218

216. Time uterine exploration performed ..... |___||___| : |___||___|
24 hr

217. Minutes after complication began that uterine exploration was performed ..... |___||___|

218. Performs uterine mechanical evacuation ..... |___|

If No/DK → Skip to 221

219. Time uterine mechanical evacuation performed ..... |___||___| : |___||___|
24 hr

220. Minutes after complication began that uterine mechanical evacuation was performed ..... |___||___|

221. Performs manual removal of the placenta ..... |___|

If No/DK → Skip to 224

222. Time manual removal of placenta performed ..... |___||___| : |___||___|
24 hr

223. Minutes after complication began that manual removal of the placenta was performed ..... |___||___|

224. If questions 215-221 were performed, were elbow-length sterile gloves wore for each procedure? ..... |___|

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

225. Perform aortic compression ..... |___|

If No/DK → Skip to 228

226. Time aortic compression performed ..... |___||___| : |___||___| *24 hr*

227. Minutes after complication began that aortic compression was performed ..... |___||___|

228. Uses balloon or condom tamponade ..... |___|

If No/DK → Skip to 231

229. Time tamponade performed ..... |___||___| : |___||___| *24 hr*

230. Minutes after complication began that tamponade was performed ..... |___||___|

231. Uses uterine sutures/cutgut ..... |___|

If No/DK → Skip to 234

232. Time sutures/cutgut used ..... |___||___| : |___||___| *24 hr*

233. Minutes after complication began that when uterine sutures/cutgut were used ..... |___||___|

234. Performs cardiac resuscitation ..... |___|

If No/DK → Skip to 237

235. Time cardiac resuscitation performed ..... |___||___| : |___||___| *24 hr*

236. Minutes after complication began that cardiac resuscitation was performed ..... |___||___|

237. Sends to surgery for hysterectomy ..... |___|

If No/DK → Skip to 240

238. Time sent to surgery for hysterectomy ..... |___||___| : |___||___| *24 hr*

239. Minutes after complication began when sent to surgery for hysterectomy ..... |___||___|

240. Performs blood clotting time test ..... |___|

If No/DK → Skip to 243

241. Time blood clotting time test performed ..... |___||___| : |___||___| *24 hr*

242. Minutes after complication began that blood clotting time test was performed ..... |___||___|

243. Checks haemoglobin/haematocrit ..... |___|

If No/DK → Skip to 246

244. Time haemoglobin/haematocrit checked ..... |___||___| : |___||___| *24 hr*

245. Minutes after complication began that haemoglobin/haematocrit was checked ..... |___||___|

Direct Clinical Observation

Clinic ID: |____|____| **Client ID:** |___|___|___|___|___/___/___|___|___|___|___|___|___|

Observation Date: |____|____| / |____|____| / |____|____|____|____| (DD / MM / YYYY) **RA ID:** |____|____|

246. Requests blood grouping and cross matching ..... |___|

If No/DK → Skip to 249

247. Time blood grouping and cross matching requested ..... |___||___| : |___||___| (24 hr)

248. Minutes after complication began that blood grouping and cross matching was requested ..... |___||___|

249. Gives blood products ..... |___|

If No/DK → Skip to 253

250. Number of units ..... _____

251. Time blood was given ..... |___||___| : |___||___| (24 hr)

252. Minutes after complication began that blood was given ..... |___||___|

253. Gives antibiotics ..... |___|

If No/DK → Skip to 257

254. Which? ..... _____

255. Time antibiotics given ..... |___||___| : |___||___| (24 hr)

256. Minutes after complication began that antibiotics were given ..... |___||___|

257. Gives additional dose of oxytocin ..... |___|

If No/DK → Skip to 262

258. Record dose ..... _____

259. Is route IV? ..... |___|

260. Time additional dose of oxytocin was given ..... |___||___| : |___||___| (24 hr)

261. Minutes after complication began that additional dose of oxytocin was given ..... |___||___|

262. Gives additional dose of other uterotonic ..... |___|

If No/DK → Skip to 266

263. Which other uterotonic? ..... _____

264. Time additional dose of uterotonic given ..... |___||___| : |___||___| (24 hr)

265. Minutes after complication began that additional dose of other uterotonic was given ..... |___||___|

266. Is the woman's condition stable? *(Note: According to provider)* ..... |___|

267. End time of observation ..... |___||___| : |___||___| (24 hr)

268. What is the woman's diagnosis? ..... |___|

1=atonic uterus
2=laceration
3=incomplete expulsion of placenta
4=placenta attached
5=coagulopathy

Direct Clinical Observation	
Clinic ID: |____|____|	**Client ID:** |___|___|___|___|___/___|___|___|___|___|___|___|
Observation Date: |____|____| / |____|____| / |____|____|____|____| *DD MM YYYY*	**RA ID:** |____|____|

269. At what stage of labour and delivery did the complication occur?.....|___|
1=at delivery
2=postpartum
3=after discharge

270. Were the woman's legs raised at any time point after PPH began? .....|___|

271. Open-ended comments related to Section 7:

_____

_____

_____

_____

END SECTION 7: OBSERVATION OF POSTPARTUM HEMORRHAGE

--END--

Appendix B

Facility checklist

Daily Facility Checklist

Clinic ID: |____|____| **RA ID:** |____|____|

Observation Date: |____|____| / |____|____| / |____|____|____|____| (DD / MM / YYYY) **Start Time:** |___||___| : |___||___| (24 hr)

Instructions: *This checklist is to be completed every day. Record an "8" for don't know responses.*

SUPPLIES AND EQUIPMENT

1. Number of Delivery Kits Present (*If none, record 00.*)
- a. Pre-packaged sterile birth kit ..... |___||___|
- b. Pre-assembled sterile birth kit from in-house supplies ..... |___||___|

2. No prepped birth kits. Staff must collect in-house supplies ..... |___|
0 = No
1 = Yes

For those items below, is there at least one of these items and is it functional? 0 = No 1 = Yes

BASIC
3. Soap ..... |___|
4. Gloves ..... |___|
5. Sterilization procedures functioning (autoclaving, bleaching, boiling) ..... |___|
6. Type sterilization procedures used today
7. Sterilized scissors or blade ..... |___|

INFRASTRUCTURE
8. Running water ..... |___|
9. Functioning toilet ..... |___|
10. Functioning refrigerator (electric &/or solar) ..... |___|
11. Record any loss of electricity in the past 24 hours. If none, record a "0: ..... |___|

Electricity Outage	Approximate Start Time *(24 hr clock)*	Approximate End Time *(24 hr clock)*

GENERAL
12. Filled oxygen cylinder with cylinder carrier and key to open valve ..... |___|
13. Ultrasound ..... |___|
14. Blood pressure cuff ..... |___|
15. Stethoscope ..... |___|
16. Fetal stethoscope ..... |___|
17. Clinical oral thermometer ..... |___|
18. Rectal thermometer for newborn ..... |___|
19. IV materials (catheter for IV line (16-18), infusion stand, IV cannulae) ..... |___|
20. Urinary catheters ..... |___|
21. Adult ventilator bag and mask ..... |___|
22. Newborn resuscitation mask ..... |___|
23. Partographs ..... |___|
- a. Type of partograph *(mark all that apply)*:
  - 1 = LifeNet ..... |___|
  - 2 = MOH ..... |___|
  - 3 = Other (specify: _____) ..... |___|

TESTS
24. Blood sugar testing sticks/equipment ..... |___|
25. Uristix (dip stick for protein in urine) ..... |___|
26. HIV rapid testing kit ..... |___|
27. Syphilis test ..... |___|

28. Was a skilled birth attendant not accessible when needed (e.g., delayed, unreachable, etc..) ***[If yes, SKIP to 30]*** ..... |___|

29. Please briefly describe situation, delay, and solution:

_____ _____

_____ _____

Daily Facility Checklist

Clinic ID: |____|____| **RA ID:** |____|____|

Observation Date: |____|____| / |____|____| / |____|____|____|____| **Start Time:** |___||___| : |___||___|
DD MM YYYY *24 hr*

PHARMACY
0 = No 1 = Yes

30. Any current stock-outs? ..... |___|
a. Which drugs/medicines? _____
_____

31. Oxytocin (injection) ..... |___|

32. Antibiotics? ..... |___|
a. Penicillin ..... |___|
b. Ampicillin ..... |___|
c. Gentamicin ..... |___|
d. Metronidazole ..... |___|
e. Cephalosporin ..... |___|
f. Other (specify: _____) ..... |___|

33. Anticonvulsants? ..... |___|
a. Magnesium sulphate ..... |___|
b. Diazepam ..... |___|
c. Phenobarbital ..... |___|
d. Phenytoin ..... |___|
e. Other (specify: _____) ..... |___|

34. Antihypertensives? ..... |___|
a. Hydralazine ..... |___|
b. Labetalol ..... |___|
c. Methyldopa ..... |___|
d. Other (specify: _____) ..... |___|

35. ARVs ..... |___|
a. NVP ..... |___|
b. AZT ..... |___|
c. 3TC ..... |___|
d. Other (specify: _____) ..... |___|

36. Vitamin K (for newborns) ..... |___|

37. IV fluids ..... |___|

38. Blood for transfusions ..... |___|

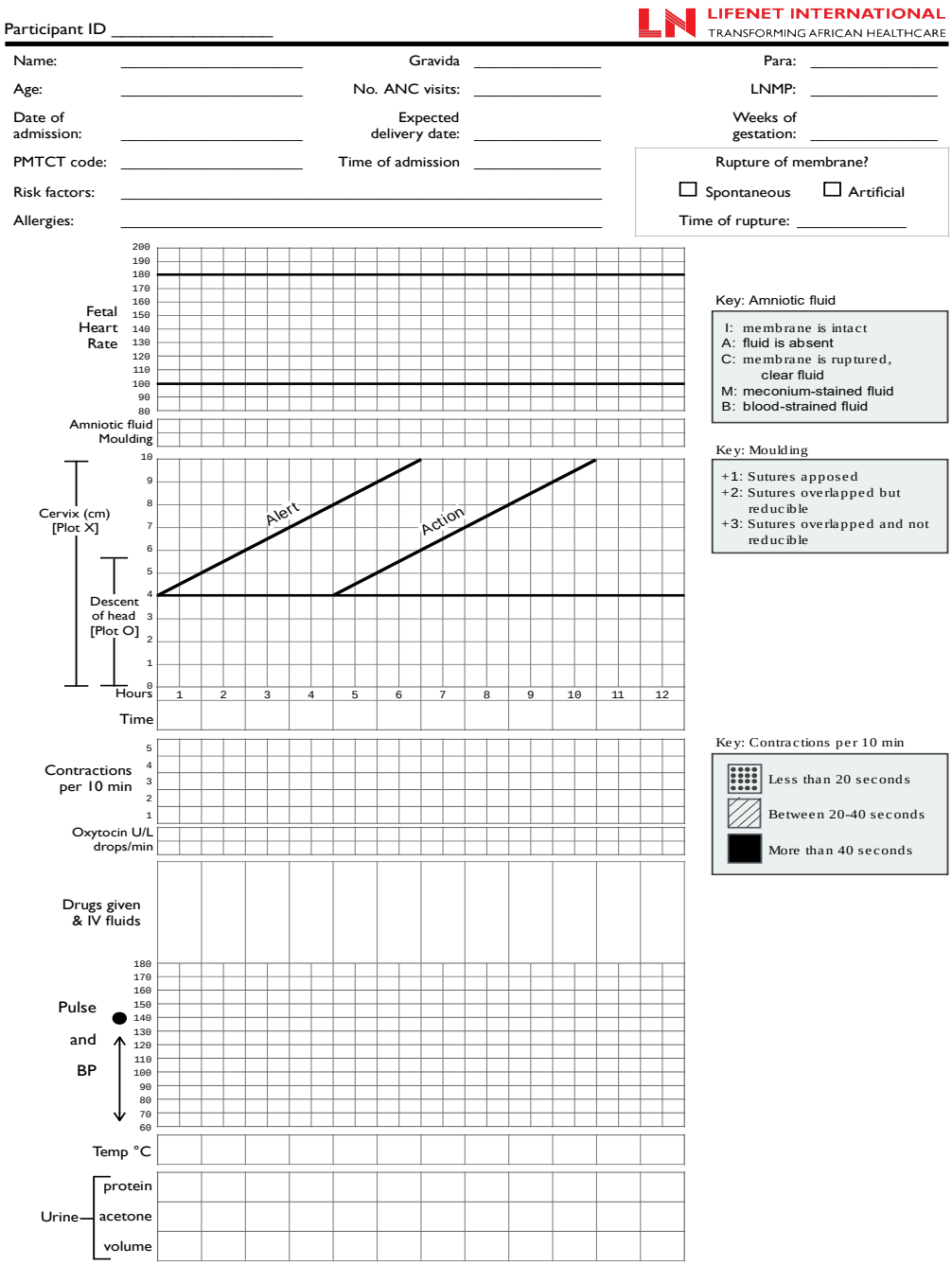
39. Pharmacy contains any expired drugs? ..... |___|
a. List: _____

40. Is the drug inventory register up-to-date (within the last 7 days)? ..... |___|
0 = No drug inventory register
1 = The drug inventory register is present, but not up-to-date
2 = The drug inventory register is up-to-date

41. Describe any circumstances affecting the facility's functioning *(laboratory, pharmacy, admin, supplies, etc…)*
_____
_____

Appendix C

Medical chart form



Participant ID _____

LIFENET INTERNATIONAL
TRANSFORMING AFRICAN HEALTHCARE

DELIVERY

Time: _____ Type: _____ Status: _____

Sex: _____ Weight: _____

Instrument used to cut umbilical cord: ☐ Razor blade from birth kit ☐ Razor blade from elsewhere ☐ Non-sterilized Scissors ☐ Sterilized scissors

Obstetrical History:

_____
_____
_____
_____

Medical / Surgical History:

_____
_____
_____
_____

Clinical Notes:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Participant ID _____

LIFENET INTERNATIONAL
TRANSFORMING AFRICAN HEALTHCARE

BABY

Sex: ☐ Male ☐ Female ☐ Pre-term (<37 weeks) ☐ Full term (39 - 40 weeks) ☐ Post-term (>42 weeks)

Gestational age: _____ Birth weight (Kg): _____

Apgar:	1 min.	5 min.	10 min
	HR _____	HR _____	HR _____
	RR _____	RR _____	RR _____

Did the baby require resuscitation? ..... ☐ Yes ☐ No

Cord clamped at: ☐ <1min ☐ 1-3 min ☐ > 3min

- If yes, did this occur in labor room? ☐ Yes ☐ No

Initiation of breastfeeding? (within one hour) ☐ Yes ☐ No

Immediate skin-to-skin contact provided ☐ Yes ☐ No

Successful latch? ☐ Yes ☐ No

Baby dried immediately ..... ☐ Yes ☐ No

Formula required? ☐ Yes ☐ No

Physical assessment: _____

_____

_____

Any congenital anomaly (specify) _____

Birth injury ..... ☐ Yes ☐ No If yes, specify: _____

Tetracycline eye ointment given ..... ☐ Yes ☐ No

Injection Vitamin K administered ..... ☐ Yes ☐ No If yes, dose: _____

Tests administered _____

_____

_____

Vaccinations done ..... ☐ BCG ☐ OPV

Specify ARV's given to baby (if applicable) _____

Treatment given _____

_____

DISCHARGE SUMMARY

Condition of mother .....

BP _____

HR _____ Temp. _____

O_2 _____ RR _____

☐ Discharged in good health

☐ Maternal death

☐ Discharged in poor health

- Type of morbidity: _____

☐ Referred

If referred, - where? _____

- why? _____

Condition of baby .....

HR _____

Temp _____

RR _____

☐ Discharged in good health

☐ Newborn death

☐ Inevitable abortion

☐ Discharged in poor health

- Type of morbidity: _____

☐ Referred

If referred, - where? _____

- why? _____

Participant ID _____

LIFENET INTERNATIONAL
TRANSFORMING AFRICAN HEALTHCARE

COUNSELING / TEACHING

Danger signs	☐ Yes	☐ No	Immunization for baby	☐ Yes	☐ No
Nutrition	☐ Yes	☐ No	Family spacing	☐ Yes	☐ No
Breastfeeding	☐ Yes	☐ No	Follow up	_____	

OUTCOME OF LABOR: MOTHER

Register # _____

Delivery date _____ Time _____

Type of delivery ..... ☐ Vaginal ☐ C-Section ☐ Assisted, with vacuum ☐ Assisted, with forceps

Other _____

Outcome ..... ☐ Live birth ☐ Fresh stillbirth ☐ Macerated stillbirth

If death, cause of death: _____

Time of delivery of placenta and membranes: _____ ☐ Complete spontaneous ☐ Complete assisted

- Abnormalities _____ ☐ Incomplete
- Blood loss measurement _____ - Interventions _____

Postpartum Hemorrhage (PPH) ..... Mother experienced PPH? ☐ Yes ☐ No

Oxytocin administered AFTER delivery to prevent PPH? ☐ Yes ☐ No

Post Delivery Vital Signs

Time	BP	HR	RR	Temp	SaO_2

Physical Assessment _____

Tests administered _____

Treatment given _____

FOLLOW UP CONTACT INFORMATION

Read to mothers during discharge:

A representative from LifeNet International may contact after one month by phone to check on the health status of you and your baby. If you are willing to be contacted, please provide your phone number and that of your next of kin.

Mother's Contact: _____ Next of Kin: Name _____

Phone Number _____

Staff Name _____ Staff signature _____

28-DAY PATIENT FOLLOW-UP ASSESSMENT

Attempt:	**Date of Attempt** *(DD_MM_YYY)*	**Successful Contact?**	**Spoke to?**
1st Call	___ / ____ / ____	**___ YES ____NO**	**___ Mother ___ Family member**
2nd Call	___ / ____ / ____	**___ YES ____NO**	**___ Mother ___ Family member**
Last Call	___ / ____ / ____	**___ YES ____NO**	**___ Mother ___ Family member**
If family member contacted, with whom did you speak? _____			

[**NOTE**: Patient will be called on the phone or contacted in person at least 28 days past her delivery date to respond to questions about her health and the health of her baby. If the mother died during this time, the interviewer will ask to speak to another adult member of the household or relative who can answer on their behalf. No consent is being obtained—this data is entered into the Patient Medical Chart (post-discharge section) and thus is considering medical record data.]

Introduction: "Hello, my name is [NAME] and I am calling from [HF NAME] to follow-up on your recent pregnancy and delivery at our clinic. Do you have a few minutes for me to ask you some questions? This is completely voluntary and you do not have to answer if you do not want to.
[If YES, proceed.] The questions I am going to ask you today are about your health and your baby's health during the 28 days after delivery.

1. Since you delivered your baby on [DATE OF DELIVERY], have you had any health problems?
   ___ YES ____NO

   If yes, can you describe these health problems?
   [If mother has any current concerns, encourage her to visit the health facility]

2. Since you delivered your baby on [DATE OF DELIVERY], has your baby had any health problems? **___ YES ____NO**

   If yes, can you describe these health problems?
   [If mother has any current concerns, encourage her to visit the health facility]

3. Fill in this table based on any illnesses, injuries or death outcomes within 28 days postpartum—add maternal and child death data to the Medical Chart.

28-day Outcomes	**"X" if yes**	**Specify type/cause if known**	**Visited health provider?**
Maternal Death (*date of death)* ___DD ____MM ____YYYY			
1st Maternal illness/injury			
2nd Maternal illness/injury			
Child Death (d*ate of death)* ___DD ____MM ____YYYY			
1st Child illness/injury			
2nd Child illness/injury			
3rd Child illness/injury			

Appendix D

LifeNet Uganda Study – Semi-structured Interviews Guide for Health Providers

Date:

Clinic Code:

Introduction:

Thank you for participating in this interview. My name is Yixuan and I am a health researcher at Duke University in the United States.

First, did you have a chance to review and sign the informed consent form?

[Make sure this is signed before proceeding]

Today, I would like to ask you some questions about your expectation/experiences working with LifeNet. As you know, LifeNet began partnering with your clinic in April. One of the goals of this partnership is to help improve the quality of care in your clinic and also to improve the health of your patients. As part of this process, LifeNet will be performing several clinical training sessions, in addition to the administrative trainings that you have already taken. Your feedback on your experiences with this process will help us to better understand how LifeNet can best meet these goals.

The interview contains two parts, and this is the first/second part. Just to remind you, this interview is totally voluntarily and you can choose to stop the interview at any time, for any reason. And please let me know if you have any questions, or need me to repeat any of the questions that I ask today. There are no right or wrong answers to my questions. It is most important that you feel comfortable in sharing your honest opinions.

Do you have any questions for me before we get started?

[Now turn on the audio recorder and let the participant know that you have turned it on. Keep it visible to the participant the whole interview]

Finally, before we get started, please let me know if any time you would like me to pause or stop the audio recording device

Are you ready to start?

Background

1. I'd like to begin with some questions about you and your job
    a. What is your position at this clinic? (Probe: medical, management)
    b. How long have you been working in this position?
    c. What are your major responsibilities in this position?

2. What was your clinical experience prior to coming to this clinic?
    a. Probe: if this participant was at another health clinic, ask them to describe their duties. If they were in school. Have them describe their degree, training, etc.

3. What other clinical training programs, except LifeNet medical training, have you taken part in, if any?
    a. If yes:
        i. How long has it been since you took these training? Are they still on going or they have ended? Which organization facilitated them?
        ii. What topics were covered in these trainings?
        iii. Do you think these trainings changed your clinic practice behaviors? If yes, how?

Questions [For LN clinical providers before the training (Late May)]:

Objective 1: To assess health providers' expectations to the medical training program

4. What were your expectations before this LN medical training program began?

5. What benefits, if any, do you think there will be from participating in the LN medical training program? (Probe: for self, for others)
    a. What specific skills do you expect to refresh/learn through the program, if any?
    b. How do you think these skills will help you in practice?

6. What would make you think it may be unnecessary to participate in the LN medical training program? (Probe: for individuals, for health facilities)

7. How much effort do you expect to put into when participating the medical training program? (Probe: time, attendance, extent of activation in teamwork, sharing with others)

Objective 2: To understand the health providers' perspectives and past experiences with using medical charts

8. Thinking back to your last few deliveries, what did you document for those deliveries, if anything?
    a. If nothing documented, why not?
    b. If documented:
        i. Who fills out the document?
        ii. What device was used to complete the document (Probe: medical chart, partograph)
        iii. When did you complete the charts (during or after delivery)?
        iv. What information was included in the documentation?
        v. To what extent the chart is completed? If not completed, why not?

9. Do you routinely use/complete a partograph/medical chart during delivery?

10. Is the partograph/medical chart helpful? (Probe: for monitoring mother and baby health condition, taking records for further referral, tracking what is/isn't done). If so, when is it helpful?

11. What are the barriers to use the partographs/medical charts? (Probe: when mother comes to clinic in emergency circumstance, no-need for monitoring, not trained how to fill the charts, it doesn't help my clinic practice, etc.)

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