# Mentoring nurses to improve quality of delivery care at primary health centers: Evidence from Bihar, India

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## 【Abstract】

**<Introduction>**

Most maternal and neonatal deaths occur in low and middle-income countries (LMICs) despite remarkable increases in institutional deliveries. This suggests that improving the quality of delivery care in LMICs is needed. A novel mentoring program for nurses, embedded within the government health system, was launched in the Indian state of Bihar in December 2017. The program aimed at improving the quality of deliveries at primary health centers. This study examines the impact of this mentoring program.

**<Methods>**

Mentoring was provided at 439 primary health centers for at least 4 weeks in each facility. The evaluation was performed through direct observation of delivery with a structured questionnaire from October 2019 to March 2020. 101 deliveries were observed at 47 mentored facilities and 13 non-mentored facilities. A quasi-experimental post-test with matched comparison group design was used to estimate the impact of the mentoring program. Using standard checklist, quality actions by nurses were classified into five domains; initial assessment, management of second and third stage of labor, postpartum monitoring and counseling, infection prevention, and newborn care.

**<Results>**

The overall delivery quality score was significantly higher by 5% in the mentored facilities (40%) than in the non-mentored facilities (35%: p-value 0.045). In particular, the domains of the management in the second and third stages of labor and postpartum monitoring and

counseling had significantly higher accomplished proportions in the mentored facilities. Overall, nurses at mentored facilities achieved less than half the quality actions required for high-quality care.

**<Conclusion>**

The nurse mentoring program, which was embedded within the existing government health system and with minimal external support, improved the quality of care for deliveries, including practices and procedures that could be related to reducing maternal mortalities. For further improvement, making essential resources at health facilities and new techniques for mentoring are needed.

**【A summary of how your capstone project addresses the areas that you wanted to strengthen, as identified by your MPH Goals Analysis】**

As I wrote in MPH Goals Analysis, the areas I wanted to strengthen in the MPH program were the competency of 'Public Health Sciences' and the ability to write scientific papers, which include the skills to analyze the obtained data and use this result to improve population-level health. Thanks to Professor Rao's support at Capstone, fortunately, I had an opportunity to analyze the data that had just been collected about the effect of the nurse mentoring program involving the CARE, the Bill and Melinda Gates Foundation, and the government of Bihar, India. The result of this paper might have a great public health impact, as this mentoring program could become a model for future nurse education embedded in the existing government's health system in India. This was the analysis related to population-level health and was consistent with what I wanted to do.

Also, using the opportunity of Practicum, I was able to work as an intern at CARE India in

Bihar. CARE India provides technical support to this mentoring program. During this period, I was able to observe the monitoring process of this mentoring program in the CARE office. Also, I observed the delivery rooms and trained nurses in several public health facilities. The experience from directly observing the real situation with poor resources in public health facilities, and then to analyze the data about the program aimed at improving the quality of delivery care in those facilities will help me in the future. I hope this paper could contribute a little by giving CARE India some feedback about the program. Finally, I would like to take this opportunity to express my gratitude to Professor Rao and other team members who have taken care of me.

## 【Introduction】

Although maternal and neonatal deaths have declined significantly in recent decades[1], the world still has a high global maternal mortality ratio (211 per 100,000 live births) [2] and neonatal mortality rates (18 per 1,000 live births) [3]. This means that about 810 mothers and 7,000 newborns die every day worldwide [4, 5]. The majority of these maternal and neonatal deaths occur in low and middle-income countries (LMICs) [4, 5]. To achieve the Sustainable Development Goal by 2030 (70 per 100,000 live births and 12 per 1,000 live births, respectively) [6], more effective and vigorous interventions are needed.

Most maternal and neonatal deaths happen around the time of delivery and within seven days after delivery [7, 8], and they are largely preventable [9]. Therefore, increasing institutional deliveries is an important strategy adopted by many LMICs to reduce maternal and newborn deaths. This has led to an increase in institutional births worldwide, but unfortunately there has not been a proportionate decline in maternal and infant mortality [10]. An important

reason for this is because birth attendants at health facilities often do not perform practices that have been shown to reduce maternal and newborn mortality [11]. For that reason, improving the quality of care during delivery is now seen as critical in order to reduce mortality [10].

India presents a classic case where institutional deliveries have increased but maternal mortality has not proportionately decreased. Although maternal deaths in India had decreased by 68.7% from 1990 to 2015, the high maternal mortality ratio of 174 deaths per 100,000 live births in 2015, accounting for 15% of the world's maternal deaths, requires further improvement [1][12]. The Government of India has made policies such as Janani Suraksha Yojana (JSY), which provides cash incentives for institutional deliveries, to reduce home deliveries with the aim of improving maternal and neonatal mortality [13]. As a result, the institutional birth rate doubled from 39% in 2005 to 79% in 2016 [12]. However, the increase in institutional deliveries does not reflect the expected reduction in maternal and infant mortality in India as well as in other LMICs [14-16].

There are several ways to improve the quality of care during delivery, such as the provision of technical training, the introduction of supervision and feedback mechanisms, the use of checklists, and the introduction of coaching and mentoring [17-19]. Among these, solely providing short-term technical training or knowledge-based instruction with checklists have not been found to be adequate to improve patient care and outcomes [20, 21]. Mentoring, like coaching, includes a training component aimed at developing an individual's specific skills, but it is more relationship-oriented than coaching [22]. It's a process that gives learners the flexibility to learn interactively toward a common learning goal while giving them professional confidence [22]. Recently, on-site

clinical mentoring programs that involve relationship building and long-term engagement between mentors and mentees have been shown to be effective in improving nurses' knowledge and skills in essential obstetric and neonatal care [19, 23-25].

On the other hand, there are also challenges with these mentoring programs. In most mentoring programs, the implementing organization was not part of the existing government health system. As such there was the heavy reliance on external resources such as overseas donors [19, 23-25]. Another weakness of these externally driven programs is the difficulty to scale up ensuring program sustainability. To the best of my knowledge, there is no study that has successfully transitioned from an externally supported mentoring program to one that is embedded within the government health system for the purpose of scaling up and sustainability.

**● Objectives**

The study examines the impact of a nurse mentoring program on the quality of delivery care at primary health centers in the state of Bihar, India. This program, AMANAT Jyoti (AJ), aimed to create a sustainable mentoring program that operates within the resources available with the existing government health system without relying too much on external support. This program's design was seen an essential to improve the quality of delivery care at scale in a sustainable way.

**● Evolution of the AMANAT Jyoti (AJ) Program**

Indian policy guidelines recognize the importance of high-quality delivery care [26]. To improve the quality of nurse deliveries in perinatal care, CARE-India implemented an on-site

nurse mentoring program, called Apatkaleen Matritva evam Navjat Tatparta (AMANAT), in Bihar between March 2015 and January 2017 in collaboration with the Government of Bihar and Bill and Melinda Gates Foundation [27]. Bihar is the poorest state in India [28] and has one of the highest maternal mortality ratio and neonatal mortality rates (208/100,000 and 36.7/1,000) [29]. So, Bihar is a high priority state for national and international public health organizations. In the AMANAT program, nurses at mentored facilities received 7-9 weeks of direct mentoring in basic nursing procedures, infection prevention, basic obstetric and neonatal practices, management of complications like postpartum bleeding and preeclampsia during delivery, and communication skills [30, 31]. An evaluation study conducted in 2016 with a cross-sectional observational design found that the quality of delivery care in mentored PHCs had significantly improved compared to non-mentored PHCs [32]. Although the effects were lower than immediately after the completion of the mentoring program, the effects persisted one year after the end of the program [32].

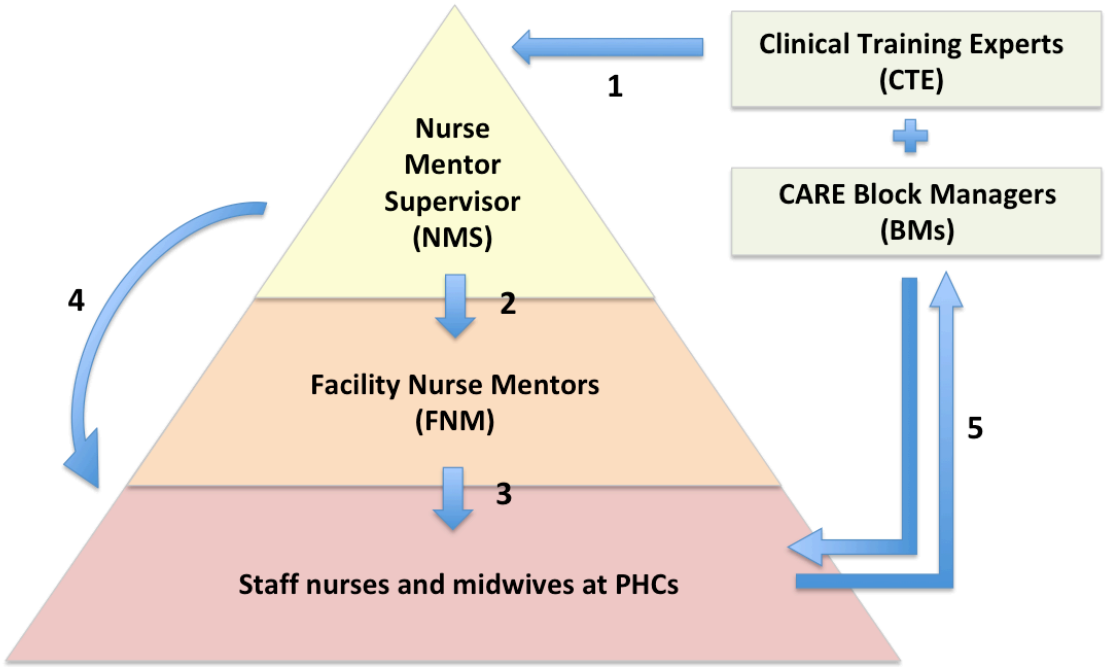
Based on the above results, the next step was to institutionalize and incorporate this resource-intensive and externally driven AMANAT program into the government's existing health system in order to increase sustainability and scale it up. Therefore, CARE created and implemented a new nurse mentoring program, called AMANAT Jyoti, at public health centers in Bihar. The new program was primarily implemented by nurses at government health facilities, using resources commonly available in government health facilities. In this paper, I investigate whether the AJ program improved quality of delivery care at primary health centers.

## 【Method】

**● AMANAT-Jyoti Program Model**

The AJ program was launched in December 2017 following the results of the AMANAT program with the aim of creating a sustainable nurse mentoring model in the public sector health system in Bihar. The program covers 439 primary health centers. The content of the program was adjusted according to whether or not the facilities had taken the AMANAT program in the past. In the AJ program, mentoring and supervision were conducted with multiple layers and roles. Initially, CARE employed 60 nurses, called Nurse Mentor Supervisor (NMS), who had the degree of Bachelor of Science in Nursing or Master of Science in Nursing. Clinical training experts (CTE) who are members of CARE trained NMSs for six weeks in the module content and supervision activities at a central training center (Figure 1-1).

**Figure 1** AMNAT Jyoti mentoring model




The primary role of NMSs was to train and supervise 701 nurses named Facility Nurse Mentors (FNMs) who were staff nurses or Auxillary Nurse Midwife (ANM) working in primary health centers. NMSs provided three weeks of training with FNMs in module content and supervisory activities at the district level health facilities (Figure 1-2). The primary role

of FNMs was to train staff nurses and midwives in module content at the health facility where they work (Figure 1-3). The end result of these layered training was that 701 trained FNMs who had the mentoring ability were embedded in each primary health center. Furthermore, the AJ program has designed to create a feedback loop without much dependence on CARE (a major difference from the earlier AMANAT program). For instance, Each NMS was responsible for 6 PHCs, and 2 NMSs were assigned to each district. NMSs periodically made supervision visits to the assigned health facilities for one week (Figure 1-4). NMSs used mobile applications on a tablet device to register the progress of the program and the results of direct observation of deliveries for concurrent assessments during each facility visit. Furthermore, NMSs, CARE Block Managers (BMs) and Clinical Training Experts (CTEs) were involved in various monitoring and supervision activities and got information from staff nurses and midwives at PHCs, forming a feedback loop by modifying the modules and training content as needed (Figure 1-5).

**● Content of the mentoring**

Mentoring from the FNMs to peer nurses and midwives at the PHCs were provided on a one-week basis for each module. As there are four modules in the AJ program, each mentored facility received a total of four weeks of mentoring, with some time interval between different modules. In a training week, three days were allocated to the module activities. Each day of the training week was allotted time for team rapport-building activities, ward and clinical rounds, thematic discussions, group activities, and summarizing and providing feedback on the day's activities. Pre-post testing for mentees was also conducted. AJ curriculum adopts adult learning principles with a focus on bedside training. Each module consists of six major topics and a few minor topics (Table 1). Modules 1 to 4 overlap in some themes, with each subsequent module containing more complex content. The AJ curriculum

was pilot tested and the modules were adapted to be implemented in the low-resource context of the PHC.

**Table 1** Modules of the AMANAT Jyoti program

| Module Number | Contents |
|---|---|
| **Module 1** | Assessment of the mothers in labor, Partograph, Respectful maternity care, Ward rounds, Conduction of labor, Essential neonatal care, Normal labor, Postpartum care and counseling, and Postpartum hemorrhage (PPH) |
| **Module 2** | Identification of high-risk pregnancies, Gestational hypertension disorders, Normal vaginal delivery of a healthy baby focusing on respectful maternity care and care for anxious mothers, Low birth weight baby, Kangaroo mother care, Neonatal resuscitation, Non-pharmacological management of postpartum hemorrhage, Situational Background Assessment Recommendation (SBAR), Intrauterine contraceptive devices, and Pre-eclampsia |
| **Module 3** | Breech delivery, Normal Singleton Vaginal Delivery (NSVD), Anemia, Sahli's method, Obstructed and prolonged labor, NSVD with PPH, Antenatal care, Preeclampsia, and Preterm delivery and steroid therapy |
| **Module 4** | Neonatal resuscitation, SBAR, Referral process and referral slip activities, NSVD and neonatal resuscitation, Antepartum hemorrhage (APH), Sepsis, Postpartum hemorrhage, Cord prolapse, and Pre-eclampsia |

● ***Evaluation design***

This process evaluation was conducted by Oxford Policy Management and Johns Hopkins University, which was independent of the regular program evaluations embedded in the AJ program. This study adopted a quasi-experimental post-test with matched comparison group design.

● **Data collection and sample size**

Data were to be collected from October 2019 to April 2020. The evaluation was performed by direct observation of delivery (DOD) by trained nurse-evaluators using structured paper questionnaires. The checklist questionnaire was developed based on the WHO guideline [10], WHO Safe Childbirth Checklist [33], the protocol made by the Ministry of Health and

Family Welfare in India [26], and the teaching materials used by CARE. The nurse-evaluators involved in data collection were basically newly recruited for this research. Their qualifications were mostly Bachelor of Science in Nursing and a few of them were Master of Science in Nursing. The role of these nurses was divided into enumerators and supervisors. Enumerators conducted data collection by direct observation of delivery and supervisors conducted unannounced inspections to assess the process and quality of data collection. The training methods for these nurses included tools, simulation, and field practice. The training was performed in three phases; initial training took place in September 2019; the second training for 4 days was in December 2019 because additional nurses were recruited; the third training for 10 days was in January 2020 because more nurses were recruited. The length of stay in each facility for enumerators to evaluate was planned for three days with the goal of observing two deliveries. No nighttime observations were conducted. In the mentored facilities, only those deliveries in which the mentee or mentor nurses performed were observed. In non-mentored facilities, all deliveries performed by any nurses working in the delivery room were observed. As delivery is prolonged, sometimes more than 12 hours, the whole process cannot be observed by a numerator. A delivery was considered a valid observation for this study if it included the initial or additional evaluations from the time of the admission to the first stage of labor, all three stages of delivery, and a minimum of 30 minutes of postpartum care.

The sample size calculation was designed to detect differences in the overall delivery quality score between the intervention facilities and the control facilities, based on the results of the past AMANAT study. It was designed to detect a 10-point difference in the overall delivery quality score with a 2:1 ratio of sample size for the mentored and non-mentored groups. With a power of 80% and $\alpha = 0.05$, 93 deliveries were calculated to be required. When adjusting

for a 20% non-response rate and a design effect (DEFT) of 2.0, the total number of deliveries was calculated to be approximately 232. This was rounded to 300. Assuming that two deliveries were observed per PHC, 150 PHCs need to be selected; 100 PHCs were selected from among mentored facilities and 50 PHCs were from the non-mentored facilities.

A total of 100 intervention PHCs were allocated proportionally to the nine divisions in Bihar based on the occupancy of the PHCs. Within each division, systematic sampling was used to determine the intervention PHCs. We defined the comparison group from PHCs not experiencing AJ training at the time of evaluation. Each control PHC was selected from the PHCs geographically close to the intervention PHC. A total of 50 control facilities were selected in order of priority followed: adjacent blocks in the same district as an intervention PHC, nearest blocks in the same district as an intervention PHC, adjacent district of an intervention PHC, and the nearest district of an intervention PHC. If there was more than one applicable PHC, the comparison PHC was randomly selected.

**● Analysis Plan**

We constructed an overall delivery quality score ranging from 0 to 100 that represented the percentage of all quality items/actions performed during delivery. A total of 55 items/actions have to be performed for high-quality delivery care based on international and national guidelines [10, 23, 30]. These 55 items were sorted into five domains; initial assessment on admission, the management of the second and third stages of labor, postpartum monitoring and counseling, infection prevention, and neonatal care. We also made the quality score of each domain from 0 to 100, as well as, the overall delivery quality score.

To match the imbalances in baseline characteristics between mentored and non-mentored

facilities, Coarsened Exact Matching (CEM) was performed. Facility indicators to match were from the WHO Service Availability and Readiness Assessment framework, including the number of deliveries for three months (service utilization), handwashing station in labor rooms (infection prevention), autoclave availability (infrastructure) and oxytocin (essential medicine) [34]. Also, the clustering effect caused by up to 2 deliveries observed at the same facility and the imbalance of the number of observed deliveries among divisions were taken into account in the analysis. We analyzed the overall delivery quality score and quality score for 5 domains by Wald test in logistic regression, adjusted for the nurse characteristics and residual confounding of facility-level characteristics. For individual items, since there were 0 or 100% completed proportions in both groups, we used Rao-Scott second-order corrected $X^2$ test to evaluate the difference in each individual item between mentored and non-mentored facilities.

**● Ethical considerations**

Verbal consent for participation in the study was obtained from the nurse and the mother at the time of the delivery. It was explained to the mother that she could stop observation at any time she wished. After verbal consent was obtained, it was signed and dated to record that permission. Individual identifiers were not collected so that no research subjects could be identified to share the results of the study.

**● Funding & Partnership**

The AJ program is funded by the Bill and Melinda Gates Foundation and supported by the Government of India and CARE India. The Christian Medical Association of India (CMAI) and Pronto International are implementing partners in CARE. CMAI is responsible for hiring and contracting NMSs for the AJ program. Pronto International supports the development of

simulation exercises and trains NMSs in simulation.

## 【Result】

**● Facility characteristics**

Because this survey was temporarily suspended in March 2020 due to the pandemic of COVID-19, this analysis evaluated 101 deliveries, about half of the 232 deliveries required to detect the statistically significant difference in the overall delivery quality score by 10 points. Of these deliveries, 80 deliveries were observed in 47 mentored and 21 deliveries in 13 non-mentored primary health centers. Table 2 shows the baseline characteristics of the mentored and non-mentored facilities before and after matching. The difference in facility-level characteristics between the two groups became smaller after matching.

**Table 2 :** The difference of the baseline facility-level characteristics between non-mentored facilities and mentored facilities

| Facility Characteristics | Before Matching | | | | | After Matching | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-Mentored | | Mentored | | P-value | Non-Mentored | | Mentored | | P-value |
| | N | Mean /% | N | Mean /% | | N | Mean /% | N | Mean /% | |
| The number of deliveries for three months | 20 | 450 (217) | 81 | 503 (209) | 0.31 | 19 | 536 (289) | 74 | 493 (214) | 0.47 |
| Oxytocin availability (%) | 20 | 55 | 81 | 61 | 0.58 | 19 | 62 | 74 | 62 | 1.00 |
| Autoclave availability (%) | 20 | 35 | 81 | 65 | 0.01 | 19 | 66 | 74 | 66 | 1.00 |
| Labor room has functional hand washing station (%) | 20 | 95 | 81 | 91 | 0.59 | 19 | 100 | 74 | 100 | - |

( Figures in parenthesis is SD )

**● Summary scores: Delivery Quality Score**

The summary scores for each of the five domains and the overall quality score for delivery care are shown in Table 3. The initial assessment domain was higher in the non-mentored

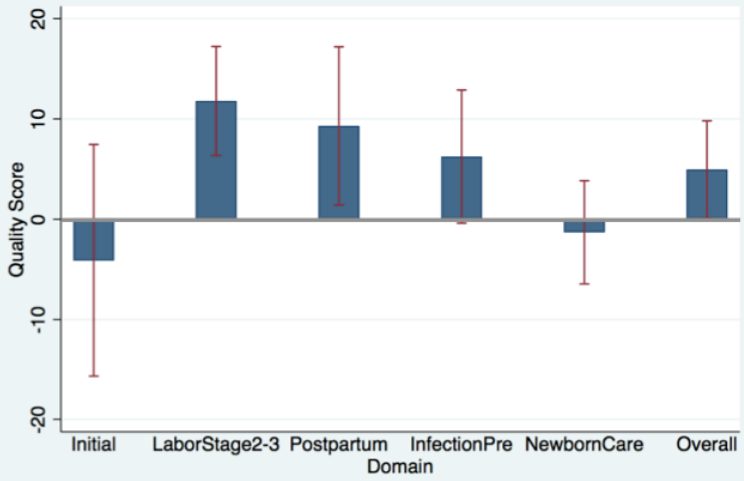
**Table 3**
Delivery quality score at mentored and non-mentored facilities

| Delivery quality score | Non-Mentored | | Mentored | | % Difference [95%CI] | P-value |
|---|---|---|---|---|---|---|
| | N (item) | % | N (item) | % | | |
| Initial assessment after admission | 168 | 44 | 624 | 39 | - 4.1 [-15.7, 7.5] | 0.486 |
| Management during second and third stages of labor | 247 | 32 | 958 | 43 | 11.8 [6.4, 17.2] | 0.000* |
| Postpartum monitoring and counseling | 190 | 19 | 740 | 28 | 9.3 [1.4, 17.2] | 0.021* |
| Infection prevention | 215 | 31 | 845 | 37 | 6.3 [-0.4, 12.9] | 0.065 |
| Newborn care | 209 | 49 | 814 | 48 | 0.97 [-6.4, 3.8] | 0.621 |
| Overall Quality Score | 1029 | 35 | 3981 | 40 | 5.0 [0.11, 9.8] | 0.045* |

* p-value < 0.05

facilities (44%) than mentored facilities (39%) but there was no significant difference. The domain of the management in the second and third stages of labor was significantly higher by 12% in the mentored facilities (43%) than in non-mentored facilities (32%). The domain of postpartum monitoring and counseling was also significantly higher by 9% (Figure 2) in mentored facilities (28%) than in

**Figure 2**
Difference in the quality score between the mentored minus non-mentored facilities with 95% confidence interval



non-mentored facilities (19%). The domain of the infection prevention was not significant but higher by 6% in the mentored facility (37% vs. 31%). In the newborn care domain, there was little difference between the two groups. In summary, the total quality score was significantly higher by 5% in the mentored facilities (40%) than in the non-mentored facilities (35%: p-value 0.045). From the next section, I'll describe the individual items in each domain.

**● Domain 1: Initial assessment**

Assessing the mother's vital signs at the time of admission is essential for the early detection of preeclampsia and infections. Blood pressure assessed was 18% higher in the non-mentored facilities than in the mentored facilities (82% vs. 64%) (Table 4). Body temperature was never measured in the non-mentored facilities and was measured at 13% in the mentored facilities. There was no significant difference in pulse rate checked and fetal heart rate measured between the two groups. Urinalysis helps identify pre-eclampsia by detecting the protein urea, which was significantly higher in non-mentored facilities.

**Table 4**
Initial assessment after admission at mentored and non-mentored facilities

| Observed items | N | Non-Mentored (%) | N | Mentored (%) | P-value |
|---|---|---|---|---|---|
| **Blood pressure checked** | 19 | 82 | 67 | 64 | 0.336 |
| **Pulse checked** | 19 | 35 | 67 | 39 | 0.817 |
| **Temperature checked** | 19 | 0 | 67 | 13 | 0.178 |
| **Vaginal Examination conducted** | 19 | 87 | 67 | 87 | 0.996 |
| **Abdominal examination conducted** | 19 | 39 | 67 | 40 | 0.932 |
| **Blood test conducted** | 18 | 28 | 74 | 19 | 0.565 |
| **Urine test conducted** | 18 | 24 | 74 | 4 | **0.036*** |
| **Fetal Heart Rate(FHR) checked** | 19 | 67 | 67 | 66 | 0.929 |
| **Partograph Initiated** | 18 | 24 | 74 | 14 | 0.457 |

* p-value < 0.05

Blood tests help identify anemia, but it was performed at low proportions with no difference between the two groups. Similarly, vaginal and abdominal examinations were not different between the two groups. Although the partograph is important in understanding the process of labor, the usage of partograph was low in both groups, 14% in the mentored facilities and 24% in the non-mentored facilities.

**● Domain2: Management in the second and third stages of labor**

The second and third stages of labor in which the labor process is dynamically proceeding and the fetus and placenta are delivered are important stages to reduce maternal and neonatal deaths. Assessment and description of the amniotic fluid volume was 12% higher in the mentored facilities (Table 5). Contractions were rarely assessed in either group. Measurement of the fetal heart rate, a means of assessing the reassuring fetal status, was higher by 14% in the mentored facilities. Perineal support during delivery to prevent perineal

**Table 5**
The monitoring and management of 2nd and 3rd stages of labor at mentored and non-mentored facilities

| Observed Items | N | Non-Mentored (%) | N | Mentored (%) | P-value |
|---|---|---|---|---|---|
| Amniotic fluid assessed and documented | 19 | 11 | 74 | 23 | 0.303 |
| Contractions assessed | 19 | 4 | 74 | 0 | 0.066 |
| Fatal heart rate assessed | 19 | 5 | 74 | 19 | 0.078 |
| Support provided to perineum during delivery of head | 19 | 33 | 74 | 30 | 0.781 |
| Fundal pressure was not applied during labor | 19 | 74 | 74 | 85 | 0.233 |
| Checked for presence of second twin | 19 | 12 | 74 | 19 | 0.589 |
| Uterotonic administered | 19 | 100 | 74 | 95 | 0.335 |
| Uterotonic administered within 1 min | 19 | 49 | 70 | 79 | 0.059 |
| Uterus assessed for bleeding | 19 | 65 | 74 | 70 | 0.658 |
| Uterine massage initiated | 19 | 62 | 74 | 88 | 0.084 |
| Placenta kept in tray and examined | 19 | 0 | 74 | 5 | 0.328 |
| Placental Membranes examined | 19 | 5 | 74 | 35 | 0.003* |
| Umbilical cord examined | 19 | 0 | 74 | 18 | 0.080 |

* p-value < 0.05

tears was not significantly different between the two groups. Only 30% was done even in the mentored facilities. Fundal pressure during labor, which has insufficient evidence of beneficial effects [35] and has possible harmful effects [36, 37], was 11% lower in the mentored facilities. Administration of uterine contractions just before or after delivery prophylactically is known as an active management of the third stage of labor to minimize postpartum hemorrhage. The WHO guideline recommends the administration of oxytocin within 1 minute of delivery [10, 33]. Oxytocin was administered at a high proportion in both groups (95% mentored and 100% non-mentored facilities). On the other hand, the administration within 1 minute was higher in the mentored facilities than in the non-mentored facilities by 30% (79% vs. 49%). In addition, uterine massage was also higher in the mentored facilities by 26%. The investigation of the placenta, placental membranes, and umbilical cord after placental delivery can be helpful in understanding the etiology of complications during the pregnancy. The investigation of the placenta membrane was significantly higher in mentored facilities.

**● Domain 3: Postpartum observation and counseling**

The maternal and neonatal vital monitoring in the postpartum period is essential for the early detection of various lethal complications related to delivery. Maternal vital monitoring was performed at higher proportions in the mentored facilities compared to the non-mentored facilities: blood pressure (67% vs. 39%), pulse (45% vs. 9%), and body temperature (11% vs. 0%) (Table 6). On the other hand, fetal vital signs were rarely measured in both groups. Abdominal examination to check the hardness of the uterus and vaginal examination to check for postpartum bleeding were performed at lower proportions in the mentored facilities than in the non-mentored facilities: abdominal examination (55% vs. 72%) and vaginal examination (50% vs. 69%). Postpartum instructions for mothers were performed at higher

proportions in mentored facilities than in non-mentored facilities: bleeding/cramping response (15% vs. 0%), breast-feeding education (30% vs. 14%), and KMC/skin-to-skin care education (7% vs. 0%).

**Table 6**
Postpartum observation and counseling at mentored and non-mentored facilities

| Observed Items | N | Non-Mentored (%) | N | Mentored (%) | P-value |
|---|---|---|---|---|---|
| Blood pressure checked soon after delivery | 19 | 39 | 74 | 67 | 0.058 |
| Pulse checked soon after delivery | 19 | 9 | 74 | 45 | 0.018* |
| Temperature checked soon after delivery | 19 | 0 | 74 | 11 | 0.229 |
| Newborn's respiratory rate checked soon after delivery | 19 | 0 | 74 | 3 | 0.387 |
| Newborn's temperature checked soon after delivery | 19 | 9 | 74 | 8 | 0.919 |
| Vaginal Examination conducted | 19 | 69 | 74 | 50 | 0.128 |
| Abdominal Examination conducted | 19 | 72 | 74 | 55 | 0.208 |
| Mother given instructions about bleeding/cramping | 19 | 0 | 74 | 15 | 0.119 |
| Mother received breast-feeding education or encouragement | 19 | 14 | 74 | 30 | 0.231 |
| Mother received KMC/skin-to-skin education or encouragement | 19 | 0 | 74 | 7 | 0.242 |

* p-value < 0.05

**● Domain 4: Infection prevention**

Aseptic manipulation in labor is fundamental to prevent infections. Painting of vagina/vulva with the antiseptic solution was performed at a higher proportion in mentored facilities by 20% (Table 7). Handwashing before delivery was higher in the mentored facilities at 58% and in the non-Mentored facilities at 37%. The proportion of sterile gloves used during delivery and the cord cut with a sterile scissor/blade were very low in both mentored and non-mentored facilities (sterile gloves; 3% vs. 5%, sterile scissor/blade; 3% vs. 0%). Not only aseptic manipulation during the delivery but also proper waste management is an important element for infection prevention. The percentage of used needles properly disposed in

puncture-proof containers or hub cutter containers to prevent needlestick incidents was higher in mentored facilities than non-mentored facilities (22% vs. 12%). Also, the percentage of instruments placed in a bleaching solution was significantly higher in the mentored facilities

**Table 7** Infection prevention steps during labor and delivery at mentored and non-mentored PHCs

| Observed Items | N | Non-Mentored (%) | N | Mentored (%) | P-value |
|---|---|---|---|---|---|
| Painting of vagina/vulva with antiseptic solution | 19 | 14 | 74 | 34 | 0.127 |
| Hands washed with soap and water before delivery | 19 | 37 | 74 | 58 | 0.260 |
| Hands washed with soap and water after delivery | 19 | 85 | 74 | 85 | 0.968 |
| Sterile Gloves used for delivery | 19 | 5 | 74 | 3 | 0.474 |
| Sterile pad/cloth used during Support provided to perineum | 6 | 0 | 31 | 3 | 0.385 |
| Cord cut with sterile scissor/ blade | 19 | 0 | 74 | 4 | 0.247 |
| Placenta disposed in a yellow colored bin | 19 | 76 | 74 | 55 | 0.239 |
| Dispose used needles and syringes in puncture proof container or use a hub cutter | 19 | 12 | 74 | 22 | 0.467 |
| Dispose soiled dressing materials in yellow color bin | 19 | 73 | 74 | 57 | 0.372 |
| Decontamination of used gloves in bleaching solution followed by red bin | 19 | 15 | 74 | 28 | 0.465 |
| Place the instruments in bleaching solution | 19 | 30 | 74 | 72 | 0.019* |
| Using bleaching solution for disinfection of the labor table and surroundings | 19 | 12 | 74 | 8 | 0.669 |

* p-value < 0.05

by 42%. But, there was no significant difference in the other items related to waste segregation. The usage proportion of bleaching solution for the delivery table and its surroundings was also low at around 10% in both facilities.

**● Domain 5: Newborn care**

The newborns checked for the cord around the neck was low in both facilities. In contrast, almost all newborns were immediately placed on the mother's abdomen and assessed for breathing/crying at birth (Table 8). Since newborns tend to lose body heat immediately, newborns are recommended to be wiped with a dry towel and be covered with a towel or clothes. In this study, both were assessed whether they were done with clean towels or

clothes. Both mentored and non-mentored facilities had a low implementation for both items: dried 5% vs. 12% and covered 7% vs. 8%. Umbilical cord clamping recommended to be performed after more than 1 minute of labor except in situations where resuscitation is required. This procedure was performed in most cases at both facilities (96% in mentored and

**Table 8**
Newborn care at mentored and non-mentored facilities

| Observed Items | N | Non-Mentored (%) | N | Mentored (%) | P-value |
|---|---|---|---|---|---|
| **Provider checked for cord around the neck of newborn** | 19 | 10 | 74 | 8 | 0.798 |
| **Newborn immediately placed on the mother's abdomen** | 19 | 92 | 74 | 95 | 0.705 |
| **Newborn assessed for breathing/crying at birth** | 19 | 100 | 74 | 95 | 0.312 |
| **Newborn dried using a towel/cloth immediately** | 19 | 12 | 74 | 5 | 0.330 |
| **Newborn covered using a clean towel/ cloth** | 19 | 8 | 74 | 7 | 0.865 |
| **Cord checked for pulsation before clamping** | 19 | 36 | 74 | 46 | 0.550 |
| **Cord clamped delayed at least 1 min after birth** | 19 | 100 | 74 | 96 | 0.397 |
| **Baby's eyes wiped with sterile wet gauze** | 19 | 0 | 74 | 3 | 0.374 |
| **Skin to skin care initiated after birth** | 19 | 8 | 74 | 4 | 0.562 |
| **Newborn weighted just after delivery** | 19 | 91 | 74 | 93 | 0.756 |
| **Breastfeeding initiated after birth** | 19 | 84 | 74 | 72 | 0.358 |

* p-value < 0.05

100% in non-mentored facilities). On the other hand, wiping baby's eyes with sterile wet gauze had hardly been done. Similarly, skin-to-skin care was implemented at a lower rate in both groups. Weighing of newborns immediately after delivery and initiation of breastfeeding within 24 hours of delivery were performed at high proportions in both facilities without significant differences.

## 【Discussion】

Our analysis found that the overall quality score of delivery in mentored PHCs was significantly higher than that in non-mentored PHCs by 5%. Importantly, the mentored

facilities showed significantly higher quality scores in the management of the second and third stages of labor, and postpartum monitoring and counseling. Quality actions in these areas associated with reduced maternal mortality by reducing postpartum hemorrhage because the leading cause of maternal death worldwide is postpartum hemorrhage (27%) [38] In terms of the actions related to reducing postpartum hemorrhage, the active management that is an administration of uterine contractions just before or after delivery prophylactically can reduce postpartum hemorrhage [39]. Specifically, the WHO guideline recommends the administration of oxytocin within 1 minute of delivery [10, 33]. This item was 30% higher in mentored facilities than in non-mentored facilities. Also, uterine massage after delivery was 26% higher in mentored facilities. In addition, the instruction to mothers about bleeding/cramping before discharge was 15% higher in mentored facilities. Furthermore, monitoring the mothers' vital signs immediately after delivery is important for early detection of a variety of life-threatening complications including postpartum hemorrhage. Blood pressure and pulse checked immediately after delivery were 28% and 36% higher in the mentored facility. Further, placental membranes and umbilical cord examined are significantly higher in the mentored facility, which can give information about the etiology of complications during the pregnancy and risks for future pregnancies [40].

On the other hand, the overall delivery quality score of 40% in the mentored facility means more than half of the recommended procedures were not performed. In particular, some items had very low implementation. The reason for this was not purely due to the AJ program, but several factors need to be considered. The first factor is the lack of the necessary resources to provide sufficient quality care in primary health centers (PHCs). In the infection prevention, for instance, if the facility does not have an autoclave, the item "sterile pad/cloth used during support provided to perineum" would not be met regardless of the nurse's knowledge/skill.

That is because basically the instruments would not be considered to be sterile without using an autoclave. Similarly, if the facility does not have sterile gauze, the item "wipe the newborn's eyes with sterile gauze" would not be met. In fact, among all the deliveries in this study, the availability of autoclave and sterile gauze were only 61% and 67%, respectively (APPENDIX 1). For vital monitoring, blood pressure apparatus, thermometers, and the Doppler for checking the fetal heart rate were available only for 53%, 30%, and 11% of deliveries, respectively (APPENDIX 1). In other words, even if the AJ program improved the nurses' knowledge and skills, nurses in the mentored facility could not check more vital signs than these percentages of resource availability. These results indicate that it’s necessary to stock the essential resources in PHCs to maximize the effects of the mentoring program.

The second factor was a shortage of nurses. In some PHCs, multiple procedures had to be performed by one nurse at a time, making it difficult to perform some items such as keeping sterile procedures and writing partograph. Third, we need to consider the timing of the mother's visit. Some mothers visited the facility directly when they were in the 2nd stage of labor, and others visited the facility once and then returned home and visited again when they were in full dilation. Therefore, the implemented actions in the domain of the initial assessment, such as checking the vital sign, blood tests, and urine tests from admission to the 1st stage of labor, was low.

There were also issues with changing the scoring methods during the survey. For example, postpartum abdominal examination and vaginal examination were initially defined as being performed after finishing all delivery procedures. At the beginning of the study, since more mentored facilities were observed than non-mentored facilities, the completed percentages of these items in mentored facilities became low. But, the definition was changed during the

course of the study, to recording these examinations after the delivery of the placenta (not after all delivery procedures). So, in general, the implementation percentage of these items in the mentored facilities was lower than in the non-mentored facilities.

We also need to examine the low scores caused purely by the quality of mentoring of the AJ program. Considering that the third leading cause of maternal death is pregnancy-related sepsis [38], items related to infection prevention should be performed at higher proportions in mentored facilities. One example of this was the use of sterile gloves. Even though 21% of deliveries in mentored facilities were not available for sterile gloves (APPENDIX 1), the appropriate use of sterile gloves, 3%, was too low in mentored facilities. There were several reasons for this; the inappropriate wearing method making the glove unsterile, touching the unsterile areas with the glove to perform multiple jobs, and the preference of using washed gloves instead of sterile gloves. Unless sterile gloves were properly used, no matter how much sterile equipment was available, sterile delivery would not be maintained. Similarly, the achieved proportions of 'newborns dried using clean towel' and 'newborn covered using fresh towel' were very low because nurses didn't use clean towels washed in their facilities but used towels and clothes brought by mothers and her family members. Also, items, such as skin-to-skin care and vital monitoring soon after delivery, should be improved more to reduce neonatal mortality.

In order to change bad practices, not only providing the correct knowledge but also mentee's behavioral change is needed. One possible reason for the dilution of the mentoring effect was the multi-layered training system in the AJ program. The AJ program used the method of the training of trainers (TOT) multiple times in order to deliver mentoring at a large number of facilities, as well as, to create nurses with mentoring ability in the primary health centers for

sustainability. This might have reduced the quality of the mentoring program. For example, in the first layer, CTEs used simulations to instruct NMSs in responding to abnormal deliveries, but there was a possibility that simulations weren't used for mentees at the facility level. The second possible reason for the weakened effect was due to the friction between mentors and mentees. In the AJ program, some challenges related to the interpersonal relationship have arisen especially when mentors with less experience as nurses taught mentees with more experience as nurses. In addition to the mentor-mentee relationships, the challenges related to insufficient support from the Medical Officers and nursing staff in the facilities has been reported. We are currently conducting a qualitative study to investigate this impact.

There are several limitations to this study. The first limitation is the small sample size at this moment. Originally, all sampling was to have been completed by April 2020. But, due to the COVID19 outbreak, the survey was suspended in March 2020. Therefore, the current evaluation was performed in 101 deliveries, about less than half of the 232 deliveries required to detect a 10-point statistical difference. In general, this small sample size was unlikely to be adequate to detect statistically significant difference between groups. However, the fact that the overall quality for delivery care at the mentored facilities was significantly higher than non-mentored facilities, even with this small sample size, indicates the strong utility of this program. When the survey resumes, we will analyze it again with the original calculated sample size.

Another limitation is that the baseline characteristics of the intervention and control groups may not be identical because of the quasi-experimental study design. Therefore, we conducted Coarsened Exact Matching (CEM) to match the baseline characteristics of

mentored PHCs and non-mentored PHCs on several elements. However, as the sample size decreases with increasing the number of matching elements, we focused on the elements that are considered to be most necessary for matching. The other limitation is the equal weighting of all items in our quality score. Clinically, some items are more important than others. For example, administering oxytocin within one minute after delivery, which has been shown to reduce postpartum bleeding, is clearly more important than putting the placenta into the yellow dustbin. However, since it was difficult to assign relative weights based on the importance of the item for all items, a uniform weighting was used. Finally, it was impossible to be completely blind to enumerators about the assignment of the intervention arm. Enumerators were not informed but might notice the mentored status of their observing PHCs.

High-quality delivery care is critical to ensure safe and healthy delivery and to reduce maternal and neonatal mortality. In addition to the past mentoring program called AMANAT, the achievement of the statistically significant higher quality of delivery care in facilities with the mentoring program embedded within the framework of an existing government health system was an important advance. However, the 5% quality improvement observed between mentored and non-mentored facilities suggests that the AJ program did not have a strong impact on reducing maternal and neonatal mortality.

The following are some of the considerations for further scaling up of this program in the future. First, to maximize the effectiveness of the mentoring program, all PHCs need to be equipped with the necessary equipment and supplies for the high quality of delivery care, such as oxytocin, sterile glove, sterile gauge, and the thermometer. Second, it’s necessary to adjust the workload to allow nurses working in the delivery room to do their jobs with high

quality, such as placing more nurses in PHCs with many deliveries or assigning jobs that can be done by non-nurses to other positions like Accredited Social Health Activist (ASHA). The third is to conduct a study to prove that the quality improvement of delivery care leads to a reduction in maternal and neonatal deaths. Although the current AJ program and the previous AMANAT program acknowledged higher quality of care in deliveries at mentored facilities, they did not directly examine whether maternal and neonatal mortality rates improved as a result of the intervention. Fourth, it is necessary to consider the cost-effectiveness of the mentoring program, using the reduction in maternal and neonatal deaths as an outcome. This is likely to be needed in the future to make the program more government-led instead of relying on external resources.

## 【Conclusion】

The nurse mentoring program embedded in the framework of an existing government health system with small external support in Bihar, India has improved the quality of care for deliveries, including procedures that could be related to reducing maternal mortality. On the other hand, since even the mentored facilities achieved less than half of the items required for high-quality care, there is considerable scope for further improvements. Increasing the availability of essential resources for carrying out quality deliveries in primary health centers can be helpful in increasing the effect of nurse mentoring.

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# 【Appendix】

**APPENDIX 1**

Resource availability among 101 deliveries in non-mentored and mentored facilities (non-matched)

| Category | Items | Average (%) | Non-Mentored (%) | Mentored (%) |
|---|---|---|---|---|
| Vital Monitoring | Blood Pressure Apparatus | **53** | 55 | 53 |
| | Thermometer | **30** | 40 | 27 |
| | Doppler for Fetal Heart Rate | **11** | 30 | 6 |
| Infection Prevention | Sterile Glove | **79** | 80 | 79 |
| | Sterile Gauze | **67** | 70 | 67 |
| | Autoclave | **61** | 35 | 67 |
| Laboratory | Urine Test | **75** | 80 | 74 |
| | Blood Test | **93** | 95 | 93 |