

ORIGINAL ARTICLE

IMPROVING NEONATAL HEALTH OUTCOMES IN ETHIOPIA THROUGH AN INNOVATIVE AND SUSTAINABLE HEALTHCARE MODEL

Bogale Worku¹, Lillian Kidane², Kelemua Abera³, Anand Kumar³, Pinar Egeli³, Yohanne Kidolezi³

ABSTRACT

Introduction : Neonatal mortality continues to be a critical challenge in developing countries like Ethiopia. It is established that well-equipped healthcare facilities and skilled healthcare workers are vital for reducing neonatal mortality and improving health outcomes.

Approach : A hypothesis was proposed to improve neonatal health outcomes through an innovative model. It involved collaboration between, local and non-profit organizations, technology partners, skill development partners, and sustenance Monitoring & Evaluation (M&E) partners which were managed by GE Healthcare, under the active guidance of the Ethiopian Federal Ministry of Health (FMOH).

The model included setting up advanced technology within the Neonatal Intensive Care Units (NICUs), training the healthcare staff about the technology, and good clinical practices in new-born care (NICU solution). This hypothesis was evaluated using a pilot outcomes study, which covered four district level hospitals in Ethiopia for duration of six months.

Results: The pilot analysis demonstrated that the intervention resulted in significant improvement of clinical and skill outcomes. For example, neonatal mortality declined by 24% and overall neonatal health outcomes, at discharge, improved by 3.3%. There was an increase in throughput with the units handling more than double the number of new-borns, and, the number of new-borns referred to other hospitals decreased by half. The skills and competencies of the NICU staff improved following the initial training and periodic refreshment trainings during the pilot.

Conclusion: This partnership model had a positive impact on neonatal health outcomes. Such strategic partnerships focusing on improving neonatal health outcomes can be replicated and sustainably scaled up.

INTRODUCTION

Background: As the world transitions from Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs), neonatal mortality remains a global challenge.¹ Even after the commendable reduction in Infant Mortality Rate (IMR) by more than half (from 89 to 44 deaths per 1000 live births) between 1990 and 2015, Neonatal

Mortality Rate (NMR) has decreased by only 37% over the same period.² 2015 statistics show that almost one million neonates (~36% of all neonatal deaths) die on the day of birth and another one million die within the next six days after birth.^{3,4} The neonatal death projection for 2016 to 2030 is expected to be 50% of 69 million child deaths. This underscores the need for focus and care

¹ Ethiopian Pediatric Society, Addis Ababa, Ethiopia
Corresponding author: Bogale Worku bogaleworku@gmail.com

² GE Global Operations

³ GE Health Care

during the neonatal period (first 28 days of life) and calls for comprehensive and innovative action plans by all countries to attain the SDG target of reducing NMR to 12 per 1000 live births by 2030.⁵

Ethiopia has demonstrated its commitment in improving maternal and new-born health outcomes by implementing the National Newborn and Child Survival strategy.⁶ This policy helped the country achieve the MDG 4-IMR target, two years ahead of the 2015 deadline.⁷ In 2015, Ethiopia had a NMR of 27.7, which is comparatively better than many other African nations; however, it is still quite far from the SDG targets. To meet the challenge of achieving the SDG targets, Ethiopia is also trying to increase access to effective coverage of life-saving, high-impact neonatal and child health interventions through national-level plans such as Growth and Transformation Plan (GTP) and Health Sector Development Plans (HSDPs) IV. These plans focus on achieving the 2035 goal of reducing NMR to less than 10 per 1000 live births.⁸

Need for New Partnership Model for Improving Neonatal Health Outcome

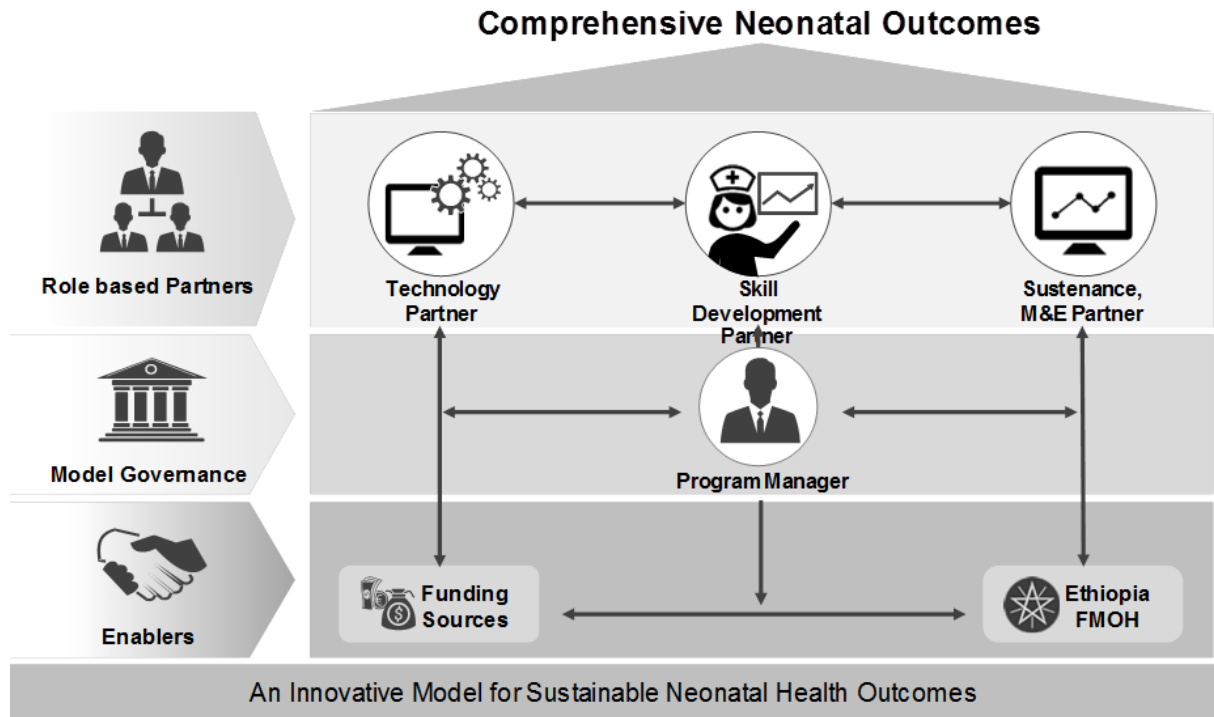
Limited resources in health facilities lack of timely access to end-to-end neonatal care and lack of consistent neonatal care delivery practices are some of the key challenges existing in neonatal care within emerging markets.⁹ Moreover, environments with limited resources often lack appropriate technology

for essential new-born care.¹⁰ Additionally, pre-term and complicated deliveries require expert and timely intervention to save the lives of both neonates and mothers, which is missing. It has also been established that most neonatal complications resulting in mortality are preventable with simple but timely interventions.¹¹

Most of the large-scale programs to reduce neonatal mortality in limited resource environments have faced scalability and sustainability challenges.¹² Invariably, misalignment of priorities and objectives among key stakeholders has led to long-term program implementation challenges. Such challenges underscore the need for new collaborative approaches to develop effective, sustainable, and scalable neonatal care programs.

To address the above, this project introduced a collaborative framework of strategic partners and stakeholders that included the Government, funding agencies, and national groups of healthcare professionals, NICU equipment suppliers, and local implementing partners. This innovative model involved a strategic collaboration between multi-disciplinary partners including local and non-profit organizations, technology partners, skill development partners, and sustenance M&E partners, which were managed by GE Healthcare, with the active guidance of the Ethiopian Federal Ministry of Health (FMOH). A schematic of this model is depicted below (Figure 1).

Figure 1. Innovative model for sustainable neonatal health outcomes



The model involved three partners with expertise in three key specific areas: technology, healthcare staff skills development and sustenance (medical technology management). The model was further supported by non-profit funding partners such as United States Agency for International Development (USAID), and approved by the Ethiopian FMOH. It was governed by a Program Manager to ensure seamless collaboration among the various partners. Each partner was an expert in its domain, accountable for a specific primary outcome, and all partners were jointly accountable for the success of the overall project.

This model translated into the pilot project with a common goal - to deliver improved neonatal health outcomes and enhance the clinical skills of healthcare providers. More-

over, the pilot would serve as evidence to the Ethiopian FMOH for implementation of a sustainable neonatal health program, which could later be scaled to address gaps in access to quality neonatal health services across Ethiopia.

The pilot project was developed and implemented with Ethiopian Paediatrics Society (EPS) as the skills development, measurement and evaluation partner, GE Healthcare as the technology partner, and Infinity Advanced Technologies Solutions Plc. as the sustenance partner.

GE Healthcare was responsible for identifying and providing high quality, impactful and appropriate technology to cover the resource limitations. This included both GE and non-GE technologies.

Ethiopian Paediatrics Society owned the design of the clinical content and training structure. It was responsible for implementing these trainings through an integrated end-user training program for NICU staff. Ethiopian Paediatrics Society adapted the clinical training tools to the local Ethiopian context, trained the selected site staff, provided monthly refresher sessions, conducted evaluations, and collected data from the pilot sites. GE Healthcare also supported EPS in the data analysis and technology related components of the initial and monthly refresher trainings.

Infinity Advanced Technologies Solutions Plc. was responsible for the procurement, logistics, installation and provision of ongoing comprehensive service / maintenance of all the medical technology used for the pilot.

Funding was provided by USAID Health Enterprise Fund. This funding was part of Strengthening Health Outcomes through the Private Sector (SHOPS) project, led by Abt Associates.¹³ GE Ethiopia II, the legal entity of GE in Ethiopia, matched the funding by providing project management and execution resources. GE Ethiopia II, the grantee of the USAID grant was responsible for allocating and disbursing funds to each of the assigned partners in the pilot. The funds were allocated to each partner as per their operating cost structure.

Pilot Methodology

The objective of the pilot was to evaluate the viability of a multi-disciplinary partnership model aligned with the common goal of improving neonatal health outcomes. Neonatal health outcomes were assessed along key indicators, which included: changes in neonatal mortality and referrals, utilization of the NICU services, and effects on NICU staff skills.

The Ethiopian FMOH was approached to identify the sites for deploying the partnership model. As per the FMOH recommendation, four Ethiopian district level hospitals located in rural areas outside Addis Ababa were identified. These hospitals were at a distance of at least 100 kilometres from the nearest paediatric referral hospital. Two hospitals were located in Oromia region (Assela Hospital in Assela, and Adama Hospital Medical College in Adama), and two were located in SNNR region (Nigist Eleni Mohammed Memorial General Hospital in Hosana, and Hawassa University College of Health Sciences and Referral Hospital in Hawassa). The total number of neonates observed during the pre- and post-NICU intervention period was 1156 and 2402, respectively, and this data were collected in real time for one year (6-month before and 6-month data after the NICU intervention). This data were then retrospectively analysed to quantify the neonatal outcomes.

Pilot Feasibility Assessment and NICU Technology Solution

GE and EPS teams conducted two rounds of site assessments at each site. The assessments included identification of clinical needs, level of infrastructure, and NICU clinical practices base lining. Additional information assessed included statistics on NICU admissions, number of births, deaths, and birth complications. The additional technology to be deployed in the pilot was chosen to augment the existing NICU technology at these sites in consultation with EPS and Ethiopian FMOH.

The NICU technology solution at each pilot site included two radiant warmers (GE lullaby warmer, GE lullaby warmer prime), a bubble Continuous Positive Airway Pressure (CPAP) device, two high performance¹⁴ phototherapy devices (GE lullaby Light Emitting Diode (LED) phototherapy), neonatal monitor (GE Carescape V100), resuscitation support laryngoscope, and thermal support to transfer neonates from the Labour and Delivery Section to the NICU.

A continuous training program was designed to align with the HSDP IV¹⁵ which focused on scaling up the training of community and mid-level healthcare professionals. While EPS team developed a comprehensive neonatal care curriculum, GE Healthcare provided inputs to refine relevant aspects of the neonatal clinical sessions for seamless integration with the NICU technology being deployed as

part of the pilot. Ethiopian Paediatrics Society and GE co-developed the NICU staff skills assessment templates and questionnaires for assessing pre- and post-training skill levels pertaining to clinical information, equipment functionality and knowledge demonstration.

An initial three-day clinical and equipment training workshop was planned and conducted at Adama Hospital Medical College. Nineteen NICU staff from all the four pilot sites attended the session. The topics covered in the training program included risks of pre-term delivery (i.e., gestational age <37 weeks), risk factors, clinical management, role of nutrition, and breast feeding management. The workshop also included sessions on essential neo-natal care and its standardisation, diagnosis and management of perinatal asphyxia, neonatal jaundice, neonatal apnoea, and hyaline membrane disease.

In addition, a detailed hands-on session was conducted for using the NICU solution equipment. A few examples of the topics covered were: how to operate the equipment, manage alarms, and clinically correlate the equipment indicators with the new-born conditions. Ethiopian Paediatrics Society and GE team members conducted monthly visits to all the sites for six months to monitor, assess, re-train, and suggest improvements in clinical practice and equipment usage. After six months, a final skill assessment of both clinical and equipment knowledge was conducted through a theoretical exam and

equipment knowledge was conducted through a theoretical exam and a practical demonstration by the NICU staff at each of the pilot sites.

Data Collection and Analysis

A list of key measurable outcomes were defined and validated with stakeholders, which included EPS and GEHC, prior to initiating the pilot. The key measurable outcomes that were agreed upon were - clinical indicators on neonatal mortality, overall new-born outcomes, improvement in the overall health, and decrease in complications of the neonates.

Data were extracted from completed data collection templates and encoded by skilled data entry clerks. Ethiopian Paediatrics Society and GE Healthcare teams collected daily and monthly data on the use of the equipment and neonatal health indicators. Ethiopian Paediatrics Society was responsible for organising the infield collection and coding of the data. Additional data were taken from manual log register entries, individual inpatient records, and skill assessment reports. Following the cleansing, editing, and checking the data for overall consistency, data were entered, integrated, and analysed by GE Healthcare in collaboration with EPS.

Certain variables such as weight of neonates (birth weight and discharge weight) were converted into single data (grams) units. Categorical variables such as gestational age, antenatal care (ANC) visits, and gravida

were converted into standardised numerical coded variables. Birth date, discharge date, and date of admission based on the Ethiopian calendar were converted into Gregorian calendar dates.

Neonatal birth weight data were the prime criteria used for data validation purpose. The following data were excluded from the analysis: exceptionally low or exceptionally high birth weight (considered as outliers), length of stay (LOS) outlier data, null data (captured as blanks) and missing values for more than five variables.

Datasets were first de-identified to remove patient names and gender related bias. Independent sample t-test was used to compare pre-versus-post time frames. The paired sample t-test was used to compare the pre- and post-training skill assessment data.

In most of the NICU cases, antibiotics (due to prevalence of sepsis), was the main intervention. Hence, the analysis was performed for potential outcomes and benefits in two scenarios - excluding and including antibiotics. The data were analysed in Microsoft Excel version 2010 using Statistical Analysis for Excel pack. This data were validated and approved by EPS.

Results

Post NICU intervention, a significant increase of 108% (from 1156 to 2402 newborns) was observed in NICU throughput across the four pilot sites. Three of the four sites showed more than 80% increase in

NICU admissions (Table 1). While a greater number of neonates were treated during the post intervention period, the number of neonates referred to other hospitals decreased by 50%. The increase in overall throughput and the reduction in referrals can be attributed to the efficiency of the intervention.

Post NICU intervention, the timely availability and usage of advanced technology led to an overall 3.3% (from 85.3% to 88.1%) improvement in health status of neonates at the time of hospital discharge. In addition, neonatal mortality decreased by 24% (from 8.2% to 6.2%) of NICU admitted neonates (Table 1).

Table 1: Patient inflow, neonatal mortality and improvement in neonatal health across pilot sites

Pilot sites	Neonatal Inflow (n)		Neonates with "Improved" health status (%)		Neonatal deaths (%)	
	Pre	Post	Pre	Post	Pre	Post
All sites	1156	2402	85.3	88.1	8.2	6.2
Adama	439	1184	90	91	5	4
Assela	266	487	80	87	10	8
Hawassa	188	408	83	86	14	11
Hosaena	263	323	84	84	8	8

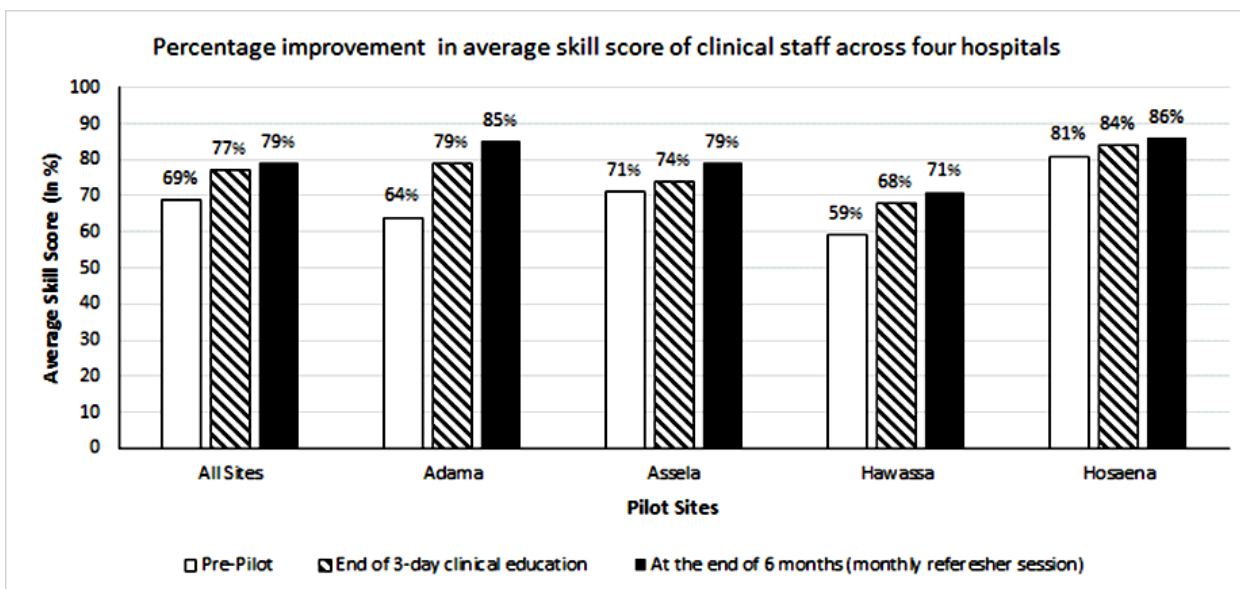
Total sample size across sites: Adama - 1623, Assela - 753, Hawassa - 596, Hosaena - 586, and Overall - 3558

Post NICU intervention, the overall average LOS shortened significantly by more than a day (from 8.3 days to 7.2 days) indicating faster recovery. The average LOS shortened regardless of the need for antibiotics, although, 90% of neonates still received antibiotics. The shortening of LOS can be attributed to the impactful technology in conjunction with the appropriate clinical education. Further, in-depth analysis of NICU effectiveness as per neonatal complications (singular cases: one complication only) revealed a significant reduction in LOS by three days among neonates diagnosed specifically with only jaundice cases. GE Lullaby LED

Phototherapy improved clinical performance through faster degradation of bilirubin compared to other phototherapy devices at the sites.

The reduction in mortality rate and improvement in neonatal health status seemed correlated to the improved skills and knowledge of NICU staff. The average skill assessment scores of NICU staff improved from 69% to 77% after a three-day end-user training program. After the six monthly monitoring visits, the average skill assessment score further improved to 79%. This improvement in the average skill assessment score was consistent across the four sites (Figure 2).

Figure 2: Percentage improvement in average skill score of clinical staff across four hospitals



The NICU staff evaluation of the training program demonstrated high effectiveness of the program. 79% of the NICU staff found the training program “effective” or “very effective” in enhancing their technical skills. Eighty-nine percentages of the NICU staff was “likely” or “very likely” to recommend this training program to their colleagues, or other healthcare workers. Additional analysis revealed that there was an overall increase of 6% points in ANC visits during the NICU intervention post-period. This increase can be attributed to the promotional activities conducted by Ethiopian FMOH. In concurrence with the NICU solution intervention, we see more institutional practice and better documentation with greater record keeping compliance for capturing ANC visits. Overall, the pilot benefits measured by the reduction in neonatal mortality and improved health outcomes were consistent across the four sites.

Discussion and Conclusion

Governments of many developing nations are facing the challenge of providing access to comprehensive quality neonatal care for the susceptible neonatal population. Results from this pilot indicate that there is an emergent need to conceptualise, innovate, implement, and extend such neonatal healthcare interventions to achieve improved neonatal health outcomes.

The post-NICU intervention results indicate that an innovative and sustainable healthcare model that leverages appropriate technology, trainings, and stakeholder partnership in multiple sectors, can be highly successful in fulfilling the objective of improving neonatal health outcomes. The pilot results showed a significant reduction in neonatal mortality. Moreover, a significant reduction in LOS of neonates in NICU and improved neonatal health conditions at the time of discharge was observed. The NICU solution seemed

instrumental in increasing admissions while reducing the number of referrals to other hospitals due to neonatal complications. The improved outcomes can also be attributed to the availability of appropriate technology and skilled clinical staff. The equipment provided in the pilot was designed to reduce neonatal complications in a limited-resource environment. The pilot also underscored the need for end-to-end and continuous NICU staff training programs as a critical component to enable overall improvement of neonatal health outcomes. The technology and continuous training program increased the confidence of physicians, and other healthcare staff in managing neonatal complications.

In limited resource settings, such as Ethiopia, most neonates have low and disproportionate coverage of comprehensive and skilled clinical interventions. As of 2011, 89.7% births in Ethiopia took place in home settings, 8.7% in public hospitals, and 1.2% in private hospitals. Critically, Ethiopia has only 8% coverage of NICU infrastructure in public hospitals, which is insufficient to manage around 2.34 million neonatal population susceptible to complications.⁽¹⁾¹⁶, , , These multiple limiting factors to neonatal care access require a systematic approach for achieving scalable national-level neonatal care programs.

Ethiopian FMOH has demonstrated focus by outlining the “National Newborn and Child

Survival Strategy” with a NMR goal of 11/1000 by 2020. The strategy focuses on covering gaps with equitable coverage and development of neonatal care across regions. This strategy acknowledges the need to scale up existing high impact interventions such as early postnatal care and skilled birth attendance. The implementation of this strategy has boosted the child survival efforts in the country through improved coordination, partnership, resource mobilization and scaling up of high impact interventions. In 2015, FMOH came up with a five-year plan aimed at enhancing and channelizing human and financial resources to build a robust healthcare infrastructure and improve accessibility of related services to communities (Health Sector Transformation Plan 2020).¹⁵, The development and implementation of innovative and sustainable partnership models, as demonstrated by this pilot, is vital for the sustainable success of such plans. In this context, comprehensive and national-level neonatal care intervention programs require a strong partnership between federal or local governments or Ministries of Health, local healthcare professional organizations, the private sector, and non-profit organizations. Sustainable partnerships of this kind seem to create a win-win situation for the achievement of program goals. The key components of this approach, such as comprehensiveness, governance, funding, project and quality management, integrated training, and

equipment maintenance have created a strong proposition to FMOH to replicate such partnerships. This innovative model has helped to provide Ethiopia FMOH with a unique option of a flexible and scalable program for improving neonatal health outcomes.

Limitations of the Study

The pilot had a few limitations. These limitations are limited laboratory infrastructure to perform regularly routine bilirubin measurements (to assess and compare the rate of bilirubin reduction), omission of NICU ad-

setup while pre- and post-NICU data were collected across the entire NICU. This could attenuate the real impact, had this been the sole technology within the NICU. Nonetheless, the results of this pilot not only supported the success and feasibility of such shared accountability collaborations, but also demonstrated that a blend of appropriate technology and interwoven clinical training, with regular monitoring and support could bring about a sustainable improvement in neonatal health outcomes.

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