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Improving quality of neonatal care practices in Nepal

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Abstract

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Despite the availability of cost-effective interventions, resource-poor countries are facing a high burden of preventable neonatal deaths, mainly due to low coverage and poor quality of care. The aim of this thesis was to evaluate the effect of a scaled-up neonatal resuscitation quality improvement (QI) package on newborn care practices in Nepal.

The studies were conducted in 12 second-level public hospitals in Nepal where the QI package was scaled up. The QI package was based on the Plan-Do-Study and Act (PDSA) approach with three major implementation strategies; facilitation, training, and audit and feedback. At baseline, readiness and availability of perinatal care services were evaluated using a cross-sectional design (Paper I). A pre-post study design was used to assess the effect of the QI package on the competency of health workers on neonatal resuscitation (Paper II). Prospective observational studies were conducted in four out of the 12 hospitals to assess the effect of QI package on neonatal resuscitation and early essential newborn care (EENC) practices (Paper III and IV).

At baseline, only five out of the 12 hospitals had all basic newborn care services under assessment and only 60% of the health workers had received training on neonatal resuscitation. After introducing the QI package, we observed an improvement in the knowledge and skills of health workers on neonatal resuscitation, which was maintained over time in all participating hospitals. In clinical practice, the proportion of clearing the airway increased among non-crying infants. We observed improved performance of health workers on the most crucial neonatal resuscitation action; initiation of bag and mask ventilation (BMV). The cumulative median time to first ventilation during the implementation period was 39 seconds less compared to the baseline. Overall, the rate of initiation of breastfeeding increased from 5% to 13%, and delayed cord clamping increased from 25% to 31%. The likelihood for a newborn to receive at least three of the four observed EENC practices increased threefold during the intervention period.

The QI package showed a positive impact in improving quality of newborn care and can be scaled up in other hospitals in Nepal and similar settings.

Keywords: neonatal mortality, quality improvement, neonatal resuscitation, early essential newborn care, delayed cord clamping, early initiation of breastfeeding, scale-up, Nepal

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To all newborn infants who did not survive
due to poor quality of care around birth.

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I. **Chaulagain DR,** Målqvist M, Wrammert J, Gurung R, Brunell O, Basnet O, KC A (2021). Service readiness and availability of perinatal care in public hospitals - a multi-centric baseline study in Nepal. *Submitted*.

II. **Chaulagain DR,** KC A, Wrammert J, Brunell O, Basnet O, Målqvist M (2021). Effect of a scaled-up quality improvement intervention on health workers' competence on neonatal resuscitation in simulated settings in public hospitals: A pre-post study in Nepal. *PLOS ONE*, 16(4).

III. **Chaulagain DR,** Målqvist M, Brunell O, Wrammert J, Basnet O, KC A (2021). Performance of health workers on neonatal resuscitation care following scaled-up quality improvement interventions in public hospitals of Nepal- a prospective observational study. *BMC Health Services Research,* 21: 362.

IV. Brunell O, **Chaulagain DR,** KC A, Basnet O, Målqvist M (2021). Effect of quality improvement interventions on early essential newborn care practices in public hospitals of Nepal- a multi-center observational cohort study. *Submitted.*

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Contents

Abbreviations

AAP	American Academy of Pediatrics
aOR	Adjusted Odds Ratio
ARR	Annual Rate of Reduction
BMV	Bag and Mask Ventilation
CHNRI	Child Health and Nutrition Research Initiative
COM-B	Capability, Opportunity, Motivation - Behaviour
CSPro	Census and Survey Processing System
DCC	Delayed Cord Clamping
DoHS	Department of Health Services
EENC	Early Essential Newborn Care
ENAP	Every Newborn Action Plan
EIBF	Early Initiation of Breastfeeding
HBB	Helping Babies Breathe
HBB-QIC	Helping Babies Breathe-Quality Improvement Cycle
HDI	Human Development Index
HP	Health Post
IMCH	International Maternal and Child Health
ISRCTN	International Standard Randomised Controlled Trial Number
KMC	Kangaroo Mother Care
MDG	Millennium Development Goals
MoHP	Ministry of Health and Population
MoSD	Ministry of Social Development
MToT	Master Training of Trainers
NENAP	Nepal's Every Newborn Action Plan
NePeriQIP	Nepal Perinatal Quality Improvement Project
NHFS	Nepal Health Facility Survey
NMR	Neonatal Mortality Rate
OSCE	Objective Structured Clinical Examination
PDSA	Plan-Do-Study and Act
PHCC	Primary Health Care Center
QI	Quality Improvement
SDG	Sustainable Development Goals

SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Sciences
SSC	Skin to Skin Contact
UHC	Universal Health Coverage
WHO	World Health Organization

Introduction

Background

With 2.4 million deaths of newborn infants worldwide in 2019, the global community continues to observe neonatal mortality as an unresolved global health agenda (1). Almost 47% of the total under-five deaths is constituted by neonatal mortality which occurs mostly in low-and middle-income countries (2,3). Around a third of these deaths occur on the first day and approximately three-quarters within 7 days of birth indicating the need for quality care during the critical periods, before and immediately after birth (2). Despite the availability of evidence-based care, resource-poor countries are continuously facing a high burden of preventable neonatal deaths, mainly due to lack or poor quality of care around birth (4–6). With the transition from Millennium Development Goals (MDGs) to the new global Sustainable Development Goals (SDGs), absolute targets have been set to reduce neonatal mortality (7). To achieve the global target of reducing neonatal mortality to 12 per 1000 live births by 2030 in low and middle-income countries, the Every Newborn Action Plan (ENAP) calls for concerted efforts to address the causes of neonatal deaths (8). Two of the five pillars of the ENAP aim to improve the quality of routine care immediately after birth (8). In this context, further reductions in neonatal deaths demand wider coverage and a massive improvement in the quality of care around the time of birth (9). Thus, the quest for ways to improve the quality of care around birth continues.

Recommended Newborn care practices

The period around childbirth is the most critical for saving the maximum number of maternal and newborn lives and preventing stillbirths (10). With increasing numbers of births in health facilities, more avoidable maternal and neonatal deaths are occurring in those facilities (9). To increase survival among newborn infants, WHO recommends essential newborn care practices after birth including neonatal resuscitation support for non-breathing infants

(11). The WHO defines essential newborn care as a comprehensive strategy to advance newborn health through evidence-based interventions during the time of pregnancy, during delivery, and soon after birth, and during the post-natal period. This newborn care package includes birth preparedness and complication readiness, four or more antenatal care visit, skilled care at birth, social support during delivery, immediate thermal care, timely initiation of breastfeeding, cord care, and check-up during the post-partum period (12). Amongst other essential newborn care components, this thesis focuses on quality improvement of routine care after birth for all newborns also referred to as early essential newborn care (EENC) including neonatal resuscitation for non-crying or non-breathing infants. The components of essential newborn care interventions included in the thesis form a part of the essential interventions for newborns recommended by the Lancet series 2014 to save newborn lives (13).

Early essential newborn care components

Early essential newborn care refers to the delivery of routine care for all newborns immediately after birth, to help them adapt to the new environment and avoid complications (9). To focus on quality-of-care measurement, the WHO has developed and released a list of global indicators for maternal and newborn care. One of the major indicators included in the list is "the proportion of all newborns who received all four elements of essential newborn care" (9,14). The four elements of essential newborn care include; i) immediate thorough drying, ii) immediate skin-to-skin contact, iii) delayed cord clamping, and iv) initiation of breastfeeding in the first hour of birth (15). Besides these, non-crying or non-breathing newborns require resuscitation support to establish breathing after birth (16).

Immediate and thorough drying

Immediate and thorough drying helps newborn infants to establish breathing and maintain body temperature (17,18). Immediately after birth, the baby's whole body should be dried with a dry towel. While drying, the baby should preferably be placed skin to skin on mother's chest or abdomen (11). When properly done, immediate and thorough drying acts as a stimulant for normal breathing for nearly 10 million newborns every year (18). Newborn babies, especially preterm and low birth weight, are at a higher risk of losing the required temperature (hypothermia) (19). Evaporation of amniotic fluid from

the skin may lead to hypothermia in newborns, which can be prevented by drying babies immediately and thoroughly after birth (17).

Skin to skin contact

Skin to skin contact (SSC) immediately after birth has been recognized as a trigger to establish breastfeeding immediately (20). It prevents loss of heat from the baby's body through conduction, which generally occurs when babies are kept on cold surfaces (17,20). Immediate SSC has been defined as placing the naked baby prone on the mother's bare chest after birth (20). SSC has been considered equally effective as conventional incubators in maintaining the body temperature (21). However, immediate SSC has been reported to be practiced at a sub-optimum level in several low and middle-income countries (22,23).

Delayed cord clamping

Delayed cord clamping (DCC) allows time for placental transfusion of blood and has the potential to increase the blood volume of newborn infants by up to 40% (24). DCC has demonstrated impact in increasing hemoglobin levels, decreasing the risk of iron deficiency anemia, increasing the ferritin levels, and improving cardiopulmonary adaptation among newborn infants (25–27). These valuable benefits have been found to extend even beyond the neonatal period (28). Following the recent evidence of the beneficial effects of DCC in newborns, WHO has recommended that the umbilical cord should be clamped between one to three minutes after birth (29,30). Early cord clamping (<1 minute after birth) should not be performed unless the newborn is not breathing and needs to be moved immediately for resuscitation care (29). However, the recommended delay in cord clamping is not yet commonly practiced in Nepal and similar settings (31,32).

Early initiation of breastfeeding

Breastfeeding has been seen as the cornerstone of child survival and development (9,33). Early initiation of breastfeeding (EIBF - initiation of breastfeeding within one hour after birth) has multiple benefits for newborns and mothers; it stimulates milk production, reduces the risk of heavy bleeding, fosters mother-child bonding, increases the duration of breastfeeding, and reduces neonatal deaths (34,35). The first milk, the colostrum, contains protective factors that protect the newborns from several pathogens (36). A meta-analysis of three large trials conducted in Ghana, India and Nepal reported that EIBF was associated with a 44% lower risk of neonatal mortality (37). Based on the

high-quality evidence, the WHO recommends that all mothers should be supported to initiate breastfeeding as soon as possible after birth, within the first hour after delivery (33). However, the rates of EIBF are globally low; 42% in 2017 indicating the need for concerted efforts to increase the coverage of this effective intervention (38,39).

Neonatal Resuscitation Care

Intrapartum hypoxic events, previously known as "birth asphyxia", account for an annual estimated 660,000 neonatal deaths worldwide (40). It may cause long-term consequences as cerebral palsy, epilepsy, and learning disabilities in surviving infants (41). Most of these intrapartum-related deaths can be prevented with early initiated simple and low-cost resuscitation support (42,43). Neonatal resuscitation has been defined as the set of interventions to support the establishment of breathing and circulation for newborn infants who require support to breathe at birth (44). Generally, 5-10% of all newborns require some degree of resuscitation support (tactile stimulation or clearing the airway or positioning), and approximately 3-6% require basic resuscitation support including assisted ventilation to establish breathing at birth (Figure 1) (45,46). Only less than 1% of neonates require advanced resuscitation with endotracheal intubation, medications, and ongoing inpatient specialized care (47). This thesis focuses on improving the quality of basic neonatal resuscitation care practices in hospital settings.

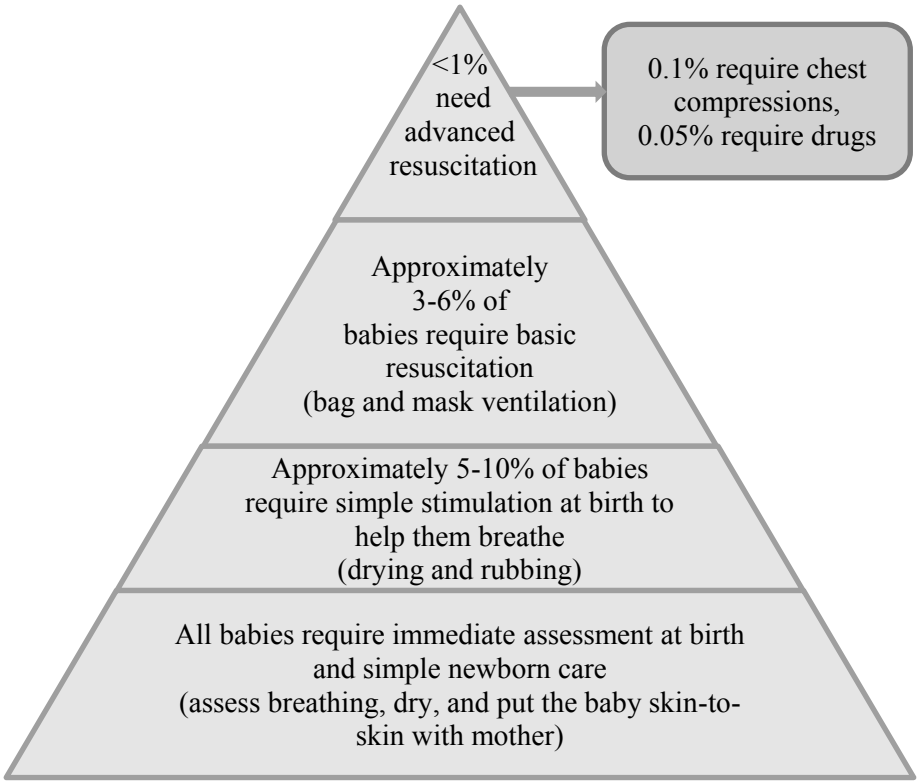

Figure 1. The estimation of the need for varying level of resuscitation support for newborns.

Helping Babies Breathe (HBB) - a neonatal resuscitation program

By improving health workers' competency, neonatal resuscitation program has the potential to reduce 30% of deaths in facility delivery among full-term infants having intrapartum-related events (46). According to studies, neonatal resuscitation training can decrease the risk of all stillbirths by 12%, fresh stillbirth by 26%, first-day neonatal mortality by 42%, seven-day mortality by 18%, and 28-day mortality by 14% (48). The Helping Babies Breathe (HBB), developed by the American Academy of Pediatrics (AAP), is a simulation-based neonatal resuscitation program designed especially for health workers in resource-limited settings (Figure 2) (49,50). The HBB emphasizes widespread basic neonatal resuscitation care because all newborn infants need immediate assessment and resuscitation support when required (49).

Based on the International Liaison Committee on Resuscitation Consensus on Science and Treatment Recommendations (ILCOR CoSTR), the HBB focuses on the initial steps of resuscitation that include drying of the baby, providing

warmth and additional stimulation to breathe, followed by bag and mask ventilation (BMV) when required (Figure 2) (49,51). Amongst other steps, the main emphasis of HHB protocol is on BMV which should be started within one minute of birth, known as 'the golden minute' (52). The HBB has demonstrated improvement in BMV in low-and middle-income countries (53,54). However, without ongoing training and continuous mentoring, HBB training alone is not sufficient to sustain and transfer simulated knowledge and skills into clinical practice (55,56). Several pre-post studies have demonstrated improvement in trainees' skills after HBB training but a significant decrease in knowledge and skills over time has also been reported (57–59). Transferring simulated knowledge and skills into clinical practice in a sustainable manner is another challenge (40,60). Health workers' anxiety and fear, difficulties assessing the infant's condition, and providing appropriate clinical response often delay the initiation of BMV (61). Also, some studies have reported no impact of the HBB program in reducing late neonatal mortality (3). Therefore, sustainable uptake, retention, and application of knowledge and skills on neonatal resuscitation and its impact on newborn survival is still a major question in resource limited-settings.

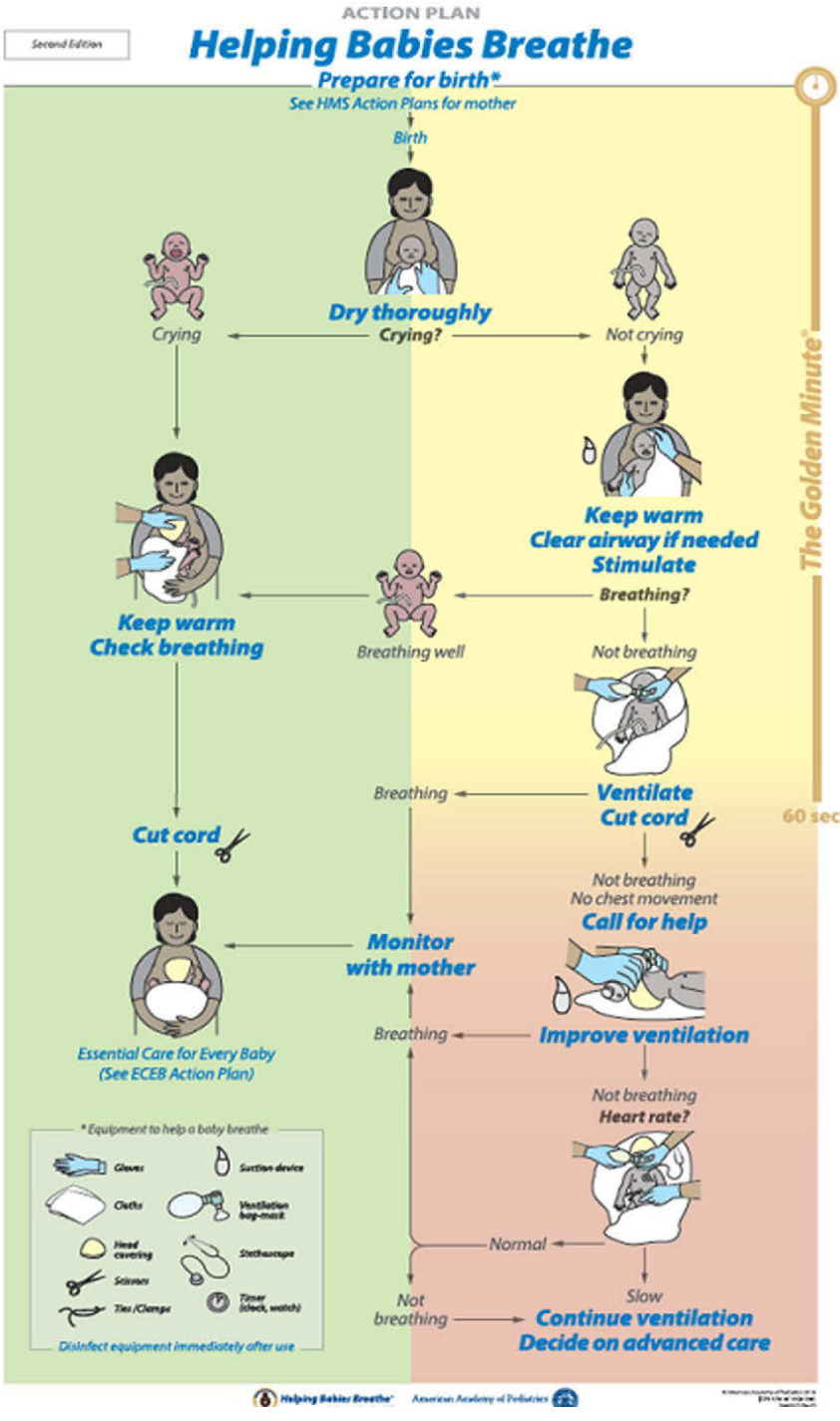

Figure 2. The Helping Babies Breathe action plan, second edition.

Health system gaps (bottlenecks) on newborn care

Effective implementation and scale-up of the evidence-based interventions require a functional health system in terms of six core components or building blocks; i) service delivery, ii) health workforce, iii) health information systems, iv) medical products, technologies v) financing and vi) leadership/governance (62,63). Health systems in low and middle-income countries, however, suffer from a varying degree of bottlenecks across these building blocks impeding the quality of maternal and newborn care (47,64). Analysis of the health systems of 12 countries from South Asia and Africa, including Nepal, revealed that the significant bottlenecks around basic newborn care were related to financing, service delivery, and health workforce. Health workforce, essential medical products and technologies, and service delivery were graded as having significant bottlenecks for neonatal resuscitation care (47). The Lancet series on newborn health 2014 revealed that there was an underlying shortage of skilled health workers in many high-burden countries (64). A multicenter study conducted in over 8000 health facilities from ten countries, including Nepal, indicated substantial gaps in the basic capacity to deliver health services (65).

The consequences of these gaps in health systems are reflected by high mortality rates; almost 5 million deaths were associated with low-quality health systems in 2016 in low-and-middle-income countries, with maternal and newborn causes constituting a large proportion (66). Worldwide, poor quality of essential maternal and newborn care contributes to nearly two million deaths of women and their newborns annually (6,67). To minimize these deaths by improving the quality of health services, a recent Lancet Commission has strongly recommended macro (health-system), meso (sub-national, health care organization), and micro (health workforce) level interventions in resource-limited settings (68).

Paradigm shift - quality improvement interventions for neonatal care.

In recent years, improvement in quality of services provided around the time of birth is receiving increased attention (69). The WHO has urged nations, especially low-income countries, to improve the quality of perinatal care to meet SDG targets 3.1 and 3.2 by 2030 (9). The Lancet series on newborn health (2014) highlights the need to focus on improving efficiency and quality in delivery of services since increasing coverage alone will not necessarily lead to the desired outcomes (64). A modeling study of a representative sample of 81 low-and middle-income countries indicated that delivering evidence-based interventions through a high-quality health system can reduce neonatal deaths by 28% (70).

Responding to the global call, several countries including Nepal are shifting the focus on quality improvement, and not merely on increasing the coverage of maternal and newborn care services (71–74). This paradigm shift for newborn care has begun to demonstrate positive results in the outcome of newborn care services in terms of improving care and reducing the level of mortality in developing countries (48,75–78).

The major characteristics of quality of care are safety, effectiveness, timeliness, efficiency, equity, and people-centeredness as defined by WHO and the Institute of Medicine (79). Sustained competency and motivation of health workers, functional health system, and availability of essential commodities on neonatal care are the foundations of quality newborn care services (49). QI interventions have the potential to improve the performance of health workers on EENC including neonatal resuscitation (6,67). For example, QI interventions including frequent skill practice, ongoing training, continuous monitoring, and professional support can sustain neonatal resuscitation knowledge and skills and improve neonatal survival (60,80). Simple and inexpensive interventions including supervised training were reported to be associated with retained and even improved HBB knowledge and skills in Peru (81). The QI interventions have demonstrated a reduction in intrapartum-related deaths and increased initiation of BMV within one minute in Nepal (82). There was a significant improvement from 39% to 73% in index scores of quality of essential newborn care practices after introducing a QI intervention in Tanzania (67). Therefore, QI interventions are indicated to improve neonatal care practices and to sustain and advance gains in neonatal care outcomes in resource-

poor settings. The QI interventions should however focus on the context and intervention-specific bottlenecks that are preventing the effective scale-up of those interventions (6,60).

Nepalese Context

Nepal, a federal democratic republic, is a landlocked country bordering China and India (83). After the adoption of the new constitution in 2015, Nepal has undergone administrative and structural changes during the last six years (84). After federalization, three tiers of government exist in Nepal; a) federal government, b) provincial government and c) local government. Nepal has an estimated total population of 30.4 million as of 2021 (85) and is one of the 48 least developed countries in the world with a per capita income of about US$ 850 (83). In 2019, the human development index (HDI) value of Nepal was 0.602, putting the country at the position 142 out of 189 countries (86). The life expectancy at birth of the Nepalese people has increased from 48 years during 1980-85 to 69 years during 2010-15 (87). As of 2017, 22 percent of the Nepalese population still live below the poverty line, among the highest in South Asia (83). The national economy is largely dependent on agriculture and remittances, accounting for nearly 28% and 25% respectively (88). The overall literacy rate stands at 65.9 percent with wide gender disparity; male (71.6%) and female (44.5%) (89).

Nepal has made steady progress in improving the overall health outcomes of its citizens during the last two decades (90). Despite this progress, the country is facing several health challenges including inequity, with wide variations in health care service availability, utilization, and health status across different socio-economic groups. The universal coverage and accessibility of quality basic health services to all people is still a daunting task in Nepal. Many people continuously face financial, socio-cultural, and institutional barriers in accessing basic health services (90). The complex topographical terrain of Nepal further widens the equity gap in availability, access, and utilization of services. Quality of care remains a challenge across basic inputs; deficit and absence of qualified health workers, stock-out of drugs and commodities, non-functioning equipment, and inadequate physical infrastructure (91).

Following federalization, the country's health system has also transitioned into a new health service delivery structure (84). The Ministry of Health and Population (MoHP) at the federal level is the leading entity for overall health-related policies, programming, and budgeting. The health programs are designed and implemented through the Department of Health Services (DoHS). At the provincial level, the health section of the Ministry of Social Development (MoSD) manages the health service delivery. The primary health service delivery outlets; district hospitals, primary health care centers (PHCC), and health posts (HPs) come under the administrative jurisdiction of the local governments (Municipalities). By endorsing the SDGs, Nepal is committed to achieving health-related targets by 2030 by ensuring equitable access and increased utilization of health services (92). To move towards universal health coverage (UHC), Nepal Health Sector Strategy has promulgated a basic health service package to be delivered free of cost to every citizen (90).

Even though there has been a large increase in the rate of institutional deliveries in Nepal; a 21 percentage point increase between 2011 and 2016, neonatal mortality remains an unfinished agenda (93,94). The current Neonatal Mortality Rate (NMR) in Nepal is 21 per 1000 live births (91). The Annual Rate of Reduction (ARR) for neonatal mortality in Nepal remained 4.0% between 2001 and 2016 with a wide disparity among the different socioeconomic groups; ARR of 6.3% among the wealthiest and 2% among the poorest quintile (95). The main causes of neonatal deaths included prematurity (30.8%), intrapartum related events (23.4%), and sepsis (18.4%) followed by congenital anomalies (13.4%), acute respiratory infections (5.6%), others (6%), and injuries (0.8%) (96). To achieve the SDG target of reducing NMR proportionately among all socio-economic groups, the inequity in NMR should be addressed through a multi-sectoral approach focusing on gaps in quality of care (91,95). Nepal is dedicated to improve quality of perinatal care, as part of the national newborn care program (93). Improving quality of care is one of the four strategic directions adopted by the Nepal Health Sector Strategy 2015-2020 to improve the overall health status of the population (90). However, further improvement in neonatal care outcomes cannot be achieved without improving structures, systems, and performance on neonatal care practices (91,97).

Development and scale-up of QI package in Nepal

Persisting gaps in the desired level of performance of health workers on essential newborn care warrant the continuous search for sustainable strategies and approaches to improve gains in neonatal care outcomes in low-income settings (46). A study conducted in a tertiary maternity hospital in Nepal in 2013 demonstrated that neonatal survival could be improved through a quality improvement intervention package; the implementation of the Helping Babies Breathe-Quality Improvement Cycle (HBB-QIC) resulted in improved health workers' performance on neonatal resuscitation and a reduction in intrapartum stillbirths and first-day neonatal mortality by 51 and 49 percent respectively (98,99). The study also reported an increased rate of BMV and increased initiation of ventilation within one minute of birth after the introduction of the QI interventions. Health workers practicing bag and mask skills, preparing for resuscitation before every delivery, using self-evaluation checklists, and attending weekly review meetings were more likely to retain neonatal resuscitation skills in the same hospital (99). However, the study could not demonstrate any changes in the first seven-day mortality, suggesting a need for improved neonatal care to maintain the gains (100). These results prompted efforts to scale up and test the adaptability of these QI interventions in other health facilities in the existing health system. Also, the persisting health system gaps across health facilities in Nepal demanded a rapid scale-up of the evidence-based QI interventions.

Primarily based on the findings of the studies in the tertiary maternity hospital and also incorporating recent evidence-based QI interventions in other settings, the MoHP developed a QI intervention package; Nepal Perinatal Quality Improvement Project (NePeriQIP). The QI package was developed with technical support from the study team. The QI package was based on the Plan-Do-Study and Act (PDSA) approach and comprised of three major implementation strategies; i) facilitation, ii) training, iii) audit and feedback (101,102). The QI package incorporated early essential newborn care components including neonatal resuscitation and infection prevention. The QI package was scaled-up in 12 second-level public hospitals in Nepal and evaluated through a stepped-wedge cluster-randomized design with intrapartum-related mortality as a primary outcome (103).

Plan-Do-Study and Act (PDSA) approach

Plan-Do-Study and Act is one of the methods, much-used globally, that aims to identify and act upon locally identified problems related to health services (104). The PDSA cycle is a structured approach, recommended by WHO, to solve health service-related problems in resource-limited settings (Figure 3) (9). This approach was previously found to lead to improvements in neonatal care outcomes in Nepal (99). The PDSA approach builds on the notion that institutionalization of a QI approach requires individuals and teams representing different roles and disciplines, jointly taking leadership for change management (104). The individuals and teams contribute to improvements aimed towards better health and survival during the perinatal period. This calls for a need to establish groups that systematically work towards improvement. Supporting the work of multi-professional groups requires a facilitator who guides the process and enables an environment in which everyone's voices are heard. Facilitation has been described as a technique by which one person, the facilitator, makes things easier for others to achieve desired outcome (102).

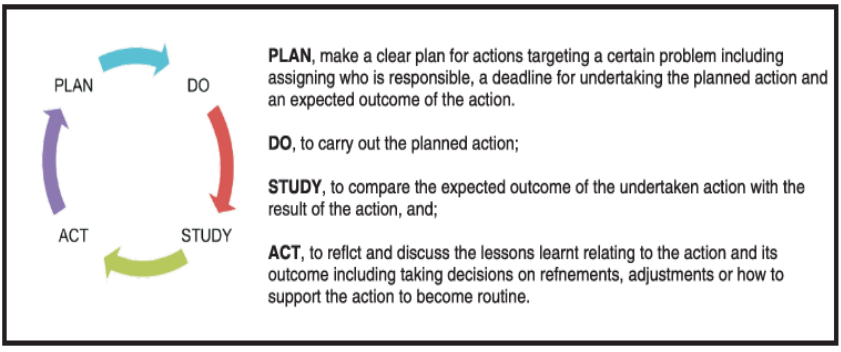

Figure 3. Plan-Do-Study-Act (PDSA) cycle

Implementation Strategies

The QI package utilized a combination of three different implementation strategies; i) facilitation, ii) process audit and feedback and iii) training. Each strategy had different components, some of which overlapped with different strategies (Table 1).

Table 1. Implementation strategies and corresponding quality improvement interventions/ activities.

Strategies	Strategy components	QI interventions/activities
1. Facilitation	PDSA cycles	• Unit meetings
	Holistic and task-oriented facilitation	• Unit meetings • Training sessions
	Regular supervision and support to facilitators	• Mentoring sessions for facilitators • Supervision of facilitators performance by mentors • Interaction sessions
	Needs-based in-house training	• Individual training of facilitators by mentors
	Experience sharing	• Interaction sessions
2. Training	Training of Trainers	• Training of facilitators and mentors
	In-service training of health workers	• Initial (basic) training of health workers • Refresher training after six months of basic training
3. Process audit and feedback	Readiness assessment	• Survey performed during preparatory phase • Dissemination of results
	Peer evaluation	• Skill checks with peer evaluation • Performance evaluation using checklists to be discussed with peers
	Self-evaluation	• Daily individual skill checks • Individual performance assessments after delivery
	Progress tracking	• Daily compilation of data displayed on scoreboards

Relating thesis with the main outcome of NePeriQIP study

The main outcome evaluation of the NePeriQIP has shown positive effects of the QI intervention package in reducing newborn mortality rates in study hospitals (77). After the introduction of the QI package, overall intrapartum-related mortality reduced to 8 per 1000 births during the intervention, compared to 11 per 1000 births in the control period. The early neonatal mortality rate in the hospitals reduced from 12.7 per 1000 live births during the control to 10.1 per 1000 live births during the intervention period (77). The studies included in this thesis were parts of the NePeriQIP study, and thus findings presented in the thesis relate to the main outcome of NePeriQIP evaluation.

Rationale

The progress in reducing neonatal deaths in Nepal has been slow in the last two decades indicating a need for rapid scale-up of the evidence-based newborn care interventions ensuring the quality to achieve SDGs related to neonatal mortality (94). By adopting Nepal's Every Newborn Action Plan (NENAP), Nepal is committed to achieving the target of NMR to 12 per 1000 live births by 2030 (91). Aligning with the global pledge to improve neonatal survival, newborn care program is being implemented as one of the high priority programs in Nepal (84). The Government of Nepal has been providing free antenatal, delivery and postnatal care services since 2005 to increase access and meet the demand for maternal and newborn care services (105). With this initiative, the coverage of maternal and newborn care interventions is increasing gradually, and at the same time, the concern for the quality of services is also growing rapidly (93,106).

Providing quality services for mothers and newborns remains a challenge because of the persisting gaps across all health system building blocks (90). The practice of life-saving evidence-based interventions for newborns is still not well institutionalized in Nepal (91). The major gaps in maternal and newborn care services were identified in health financing, workforce, essential medical products and technologies, and governance. Primary care facilities across the nation are struggling with the persistent absence of health workers, stock-out of drugs and commodities, poorly maintained infrastructure and equipment, insufficient opening hours, and insufficient control of hazardous waste and

basic infection practices (91). A low level of competency among health workers was identified in the management of pre-term newborns, neonatal resuscitation, and inpatient care for sick and small children (91). Overall health facility readiness to provide quality newborn care service was found to be low in a rural southern district of Nepal (107). Nepal Health Facility Survey (NHFS) revealed that only four out of 10 health facilities had carried out neonatal resuscitation and only three percent of PHCCs had performed all basic emergency obstetric signal functions at least once in the three months preceding the survey (108). The continuous search for better ways to improve the quality and sustain the gains of newborn care outcomes is crucial in this context.

Testing the effectiveness of the QI intervention package on improving newborn care practices will provide evidence for better implementation strategies for newborn care and survival. The studies included in this thesis attempt to test the effectiveness of QI intervention package on early essential newborn care in secondary level hospitals. This will add to our understanding of the applicability of QI intervention package in addressing health system gaps related to newborn care practices in Nepal and similar countries. The findings will inform better program design and implementation in resource-limited settings.

Furthermore, the studies included in this thesis aim to generate evidence on priority research areas beyond 2015 set by WHO and Saving Newborn Lives/ Save the Children using the Child Health and Nutrition Research Initiative (CHNRI) method (109). The studies focused on generating evidence on following priority research areas (109);

a) "How can health workers' skills in preventing and managing asphyxia be scaled up?" (ranked 2nd priority within the delivery domain)
b) "How can the quality of care during labor and childbirth be improved to reduce intrapartum stillbirth, neonatal mortality?" (ranked priority 9th within the delivery domain)

The findings presented in this thesis will have an impact on future research and intervention strategies for newborn care especially in Nepal and other resource-poor settings.

Conceptual framework

For systematic evaluation of the effect of the QI package, the conceptual framework for this thesis was developed based on the CHNRI model (Figure 4) (110). The CHNRI is an initiative of the Global Forum for Health Research aiming to develop a systematic method for setting priorities in health research investments and to apply it to global child health (111). Prior to the development of this model, the ongoing approaches of setting research investment priorities had been suffering from many shortcomings, which might have been responsible, partly, for existing high levels of mortality among children (112). These shortcomings led to the development of the CHNRI model in 2005 to improve impact of research in reducing childhood mortality (113).

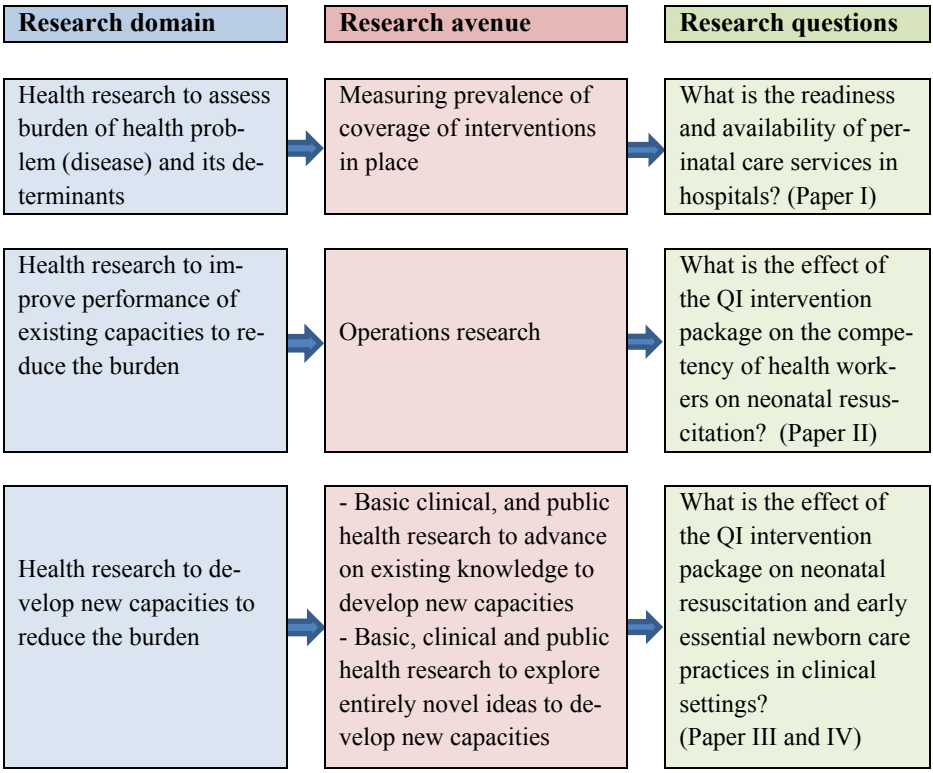

Figure 4. Conceptual framework based on the CHNRI model for improving neonatal resuscitation and early essential newborn care practices in public hospitals.

Aim and objectives

Aim

The aim of this thesis was to evaluate the effect of a scaled-up neonatal resuscitation QI intervention package on newborn care practices in Nepal.

Specific objectives

I. To assess the readiness and availability of perinatal care services in public hospitals in Nepal *(Paper I)*

II. To evaluate the effect of a scaled-up QI intervention package on the competency of health workers on neonatal resuscitation in simulated settings *(Paper II)*

III. To evaluate the effect of a scaled-up QI intervention package on the performance of health workers on neonatal resuscitation in clinical settings *(Paper III)*

IV. To evaluate the effect of a scaled-up QI intervention package on early essential newborn care practices in public hospitals *(Paper IV)*

Methods

Study design

The studies included in this thesis were part of the Nepal Perinatal Quality Improvement Project (NePeriQIP) (ISRCTN30829654) (103). The overview of methods for each paper included in the thesis is depicted in Table 2.

Table 2. Overview of methods for different papers

Paper	Study design	Participants	Analysis	Outcome
I	Descriptive cross-sectional	All study hospitals	Descriptive, color code categorization of hospitals, summarization of problems and root causes	Readiness and availability of perinatal care services
II	Pre-post	All health workers involved in perinatal care in participating hospitals	Wilcoxon signed-rank test, Kruskal Wallis test, Mc Nemar test, Logistic regression	Knowledge and skills on neonatal resuscitation
III	Prospective observational cohort	All non-crying newborns delivered by eligible women	Chi-square test, logistic regression	Additional stimulation, clearing the airway, BMV
IV	Observational before and after	All newborns delivered by eligible women	Chi-square test, multilevel logistic regression	Immediate and thorough drying, immediate skin to skin contact, delayed cord clamping, early initiation of breastfeeding

A cross-sectional design was used to assess the readiness and availability of perinatal care services in the hospitals (Paper I). A pre-post study design was used to evaluate the effect of the scaled-up QI package on resuscitation knowledge and skills of health workers (Paper II). A prospective observational cohort study design was used to evaluate the effect on performance of health workers on neonatal resuscitation in clinical settings (Paper III), and an observational before and after design was applied for assessment of EENC practices (Paper IV). The studies were conducted from April 2017 to December 2018.

Study settings

We conducted these studies in 12 public hospitals of Nepal (Table 3). The hospitals were selected with the criteria of having more than 1000 deliveries per year.

Table 3. Participating hospitals with annual estimated deliveries at baseline

Hospital	**Estimated Delivery (2016), n***
1. High-volume hospitals	
Western Regional Hospital	9427
Bharatpur Hospital	11318
Koshi Zonal Hospital	8355
Lumbini Zonal Hospital	9007
2. Medium-volume hospitals	
Mid-Western Regional Hospital	3139
Seti Zonal Hospital	5767
Rapti Sub-Regional Hospital	3280
Bheri Zonal Hospital	4276
3. Low-volume hospitals	
Bardiya District Hospital	1065
Nawalparasi District Hospital	1374
Nuwakot District Hospital	1438
Pyuthan District Hospital	1194

* Source: Annual Health Report, Department of Health Services, FY 2015/16

The participating hospitals were categorized into three different sizes based on the volume of annual deliveries; i) high-volume hospitals (> 8000 deliveries), ii) medium-volume hospitals (3000 - 7999 deliveries) and iii) low-volume hospitals (<3000 deliveries). The observation of clinical performance of health workers on neonatal resuscitation and EENC practices was done in the

four high-volume hospitals only, and Paper III and IV are based on observational data from those four hospitals. All of the four high-volume hospitals have a labor unit with basic neonatal resuscitation services led by skilled birth attendants and a specialized sick newborn care unit led by a pediatrician.

The intervention

The QI package, as described above, was introduced at different time points in hospitals according to the stepped wedge study design of NePeriQIP (103). Each wedge consisted of three hospitals (one high-volume, one medium-volume, and one low-volume). In collaboration with the central MoHP, we introduced the QI package in all participating hospitals in a similar fashion. At start, the hospital management team was oriented on the QI package. The hospital management then selected in-hospital QI facilitators from among the pediatricians, medical officers, and nurses. The number of facilitators depended on the size of the hospital; two from low-volume hospitals, three from medium-volume hospitals, and four from high-volume hospitals. External mentors were selected and recruited by the study team to support in-hospital QI facilitators in implementing the QI package in the hospitals. In-hospital QI facilitators along with the external mentors received a seven-day master training of trainers (MToT) on the QI package. Following the MToT, the QI facilitators assessed the readiness and availability of perinatal care services using a checklist in their respective hospitals. Based on the data of service readiness and availability assessment, a two-day bottleneck analysis workshop was organized at each hospital. After this, the health workers involved in perinatal care in each hospital received a three-day basic training on the QI package. The training consisted of the contents on EENC, HBB package, and quality improvement activities; daily bag and mask skill checks, self-assessment of preparation for resuscitation before every delivery, self-assessment for those requiring BMV, Plan-Do-Study and Act (PDSA) meetings, and use of scoreboards comprising major indicators on neonatal care. Each hospital was provided with the HBB job aid, self-assessment checklists, HBB mannequin set for skill checks, scoreboards, and weekly PDSA review meeting notes. After the basic training, the QI facilitators initiated weekly PDSA meetings involving health workers related to perinatal care. The health workers started daily skill checks on BMV using the mannequin. Health workers started self-assessment of preparation for resuscitation before every delivery and for those requiring BMV. In addition, the QI facilitators initiated updating the scoreboard

installed in the delivery room. Six months after the basic training, health workers received a one-day refresher training.

Study participants

Paper I - All 12 participating hospitals.

Paper II - The study participants included all health workers involved in perinatal care from 12 hospitals during the study period.

Paper III - Women in labor at ≥22 weeks of gestation who gave consent were eligible for the study. We enrolled all non-crying newborns delivered by eligible women for analysis.

Paper IV - All newborns delivered by the pregnant women who met the inclusion criteria and gave consent were included in the study. The criteria for inclusion were; a) women who delivered vaginally, b) fetus having heart sounds at admission and c) women with 22 or more weeks' gestation. Stillbirths, twins, newborn infants with malformations, and those receiving bag and mask ventilation were excluded.

Sample size

There was no a priori estimation of sample size. The participants for Paper II were selected by respective hospitals. For Paper III, all non-crying newborns delivered by the eligible women were included, resulting in 3031 non-crying infants for analysis. For Paper IV, all newborns delivered by the eligible women at four of the 12 hospitals were included, resulting in 28,688 newborns for analysis. The power calculation was done for the main outcome evaluation of NePeriQIP, intrapartum-related mortality, based on an estimated primary outcome level of 20/1000 births and an annual delivery rate of 60,000 births at the 12 hospitals combined. This power calculation would allow to demonstrate a reduction of intrapartum-related mortality of 14/1000 births or more (77).

Data collection and management

Paper I- Three different data collection tools were developed for this study; 1) an assessment checklist for service readiness and availability of perinatal care; 2) a format for causal/bottleneck analysis and onsite planning for perinatal care; 3) a form to collect secondary data from the medical records and registries. The tools were developed based on the indicators for assessing service readiness and availability outlined in the WHO's health system building blocks, and quality of care framework for maternal and newborn health (9). The tools were pretested in a tertiary maternity hospital in Kathmandu and were corrected based on the findings of the pre-test before its administration in the hospitals.

After receiving a one-day training on using the assessment checklist (Tool 1), the in-hospital QI facilitators were mobilized for the collection of data on readiness and availability of perinatal care in their respective hospitals. After filling the checklist for the service readiness and availability, a two-day bottleneck analysis workshop was organized in the respective hospitals. In-hospital QI facilitators and the representative of the study group (including Dipak Raj Chaulagain as a Project Coordinator) facilitated the workshop. The participants of the workshop were the health workers from the delivery unit, sick newborn care unit, emergency and pediatric departments including key managerial staff. During the workshop, participants worked in three groups to identify major problems related to perinatal care in the hospitals. The first group discussed and identified problems related to essential newborn care and neonatal resuscitation, the second group worked on kangaroo mother care (KMC) and breastfeeding, and the third group on infection prevention. The participants used the pre-developed format (Tool 2) to identify and list the problems. The major problems identified by each group were listed in the flip charts and presented in plenary for discussion. The final list of problems for each topic was finalized after the discussion in plenary. The respective groups then did root cause analysis for the identified problems; the 'five whys' method was used to explore the root causes for each problem (114). The root causes identified by each group were then presented in plenary for discussion on flip charts. At the end of the workshop, the research team collected the flip charts for compilation and analysis. The flipcharts have been securely stored in the central research office in Kathmandu. Secondary data on the neonatal care practices at the hospital were collected from the hospital registry by a team of independent data collectors using a form (Tool 3).

Paper II- A training registration and evaluation form (paper format) was developed for the data collection for this study. Trainees recorded responses to knowledge test and skill test [Objective Structured Clinical Examination (OSCE B)] in an individual training registration and evaluation form during the basic and refresher training. A standard set of 17 multiple-choice questions was administered to assess knowledge. The correct response to 14 out of 17 questions (≥ 82.35%) was set as the standard to pass the knowledge test. The OSCE B comprised of 18 skill-related questions out of which correct responses to 14 questions (77.7%) was required to pass the skills test. The cut-offs (standards) were set based on the cut-offs previously used by similar studies (58,59). Knowledge test responses were collected at three-time points; i) before starting the basic training (pre-basic), ii) at the end of basic training (post-basic), and iii) after six months during refresher training (pre-refresher). Skill test responses were recorded during basic and refresher training. The in-hospital QI facilitators and the external mentors did consistency checks. The data management officer at the central research office in Kathmandu entered data into electronic database SPSS.

Papers III and IV- Data were collected by a team of eight trained nurses with experience in nursing management and research. The data collectors worked on a rotation basis to ensure observations of all deliveries during the study period. The data collectors received a seven-day training on the data collection process before placement to the respective hospitals. A coordinator was assigned from among the data collectors to ensure a smooth data collection process at all hospitals. A Standard Operating Procedure (SOP) was developed to guide data collectors to ensure completeness, consistency, and accuracy of data. We collected data in paper formats, which were pretested in a tertiary level maternity hospital in Kathmandu and were corrected based on the pre-test results before administering it in the study hospitals. The data collection coordinator sent completed data collection forms on a weekly basis to the central research office in Kathmandu. After rechecking for completeness and consistency, and indexing the completed forms for respective hospitals, the data were transferred into electronic database, Census and Survey Processing System (CSPro), by a team of independent data entry officers. The forms have been safely stored at the research office in Kathmandu.

Statistical Analyses

Paper I- Descriptive data analysis was applied for data collected using Tool 1 (the checklist for assessment of service readiness and availability). We analyzed the status of service availability for newborn care, referral services, training of health workers on neonatal resuscitation, availability of essential equipment, infrastructure, information system, and governance for following newborn care services;

i) Early essential newborn care and neonatal resuscitation
ii) Kangaroo mother care

The findings were categorized for individual hospitals. The hospitals were assigned different color codes based on the fulfillment of the criteria under each assessment category. The hospitals meeting all the criteria under assessment were assigned a light green color, and those which did not meet all the criteria were assigned light blue color.

Regarding the data collected using Tool 2 (format for causal/bottleneck analysis for perinatal care), the major findings of the bottleneck analysis workshop, collected in flipcharts, were entered into Microsoft Excel for analysis. The data were analyzed to identify the most common problems and root causes. The findings were summarised in a table in terms of major problems and root causes. The findings represent the collective views of health workers that were documented and presented during the bottleneck analysis workshop after consensus in respective groups.

Regarding the data collected using Tool 3 (form to collect data from medical records and registries), descriptive statistics were used to analyze the baseline performance of health workers on neonatal care. This paper focused on four representative newborn care indicators to assess the baseline performances of individual hospitals; i) BMV among newborn infants with APGAR <7, ii) early initiation of breastfeeding among newborns before transfer to post-natal ward, iii) counseling of mothers on breastfeeding and, iv) skin-to-skin contact immediately after birth.

Paper II- Wilcoxon Signed Rank test was performed for paired comparison of knowledge and skill scores between; i) pre-basic and post-basic, ii) post-basic and pre-refresher, and iii) pre-basic and pre-refresher test. Kruskal Wallis test

was performed for comparison between hospitals by size and between individual hospitals. McNemar test of proportions was used to test the paired differences in pass rates on knowledge questionnaire and OSCE B according to the size of the hospitals and for the overall group. A logistic regression model was used to assess the association between Health Workers' background characteristics and two dependent variables; i) change in neonatal resuscitation knowledge level over time and, ii) change in neonatal resuscitation skill over time.

Paper III - Chi-square test was performed for comparison of outcome variables between control and intervention period. Odds ratio with 95% confidence interval and p values were calculated for each outcome variable, comparing control and intervention period. Logistic regression analysis was performed to adjust three possible confounding variables (preterm birth, assisted breech delivery, and meconium-stained amniotic fluid at birth) that were different between the control and intervention period. A time plot was created to show cumulative monthly average time taken to initiate first ventilation on BMV.

Paper IV - Chi-Square test was used for the comparison of outcome variables between control and intervention period. Multilevel logistic regression was performed to display crude and adjusted odds ratios with 95% confidence intervals for each outcome variable. In the first model, socio-demographic variables were adjusted for, and in the second model, maternal and neonatal characteristics were included. In the final model, adjustments were made for hospitals also.

The Statistical Package for the Social Sciences (SPSS) version 25.0 was used for all analyses in all studies. A p-value less than 0.05 was considered statistically significant.

Ethical Consideration

Ethics approval was obtained from Nepal Health Research Council (ref 26-2017) before starting the data collection process for all studies. Written informed consent was obtained from the management committee of all hospitals for participation in the study before introducing the QI package. The QI package was developed by the central MoHP after several rounds of discussion

with experts from the local and international levels. Guideline for the implementation of the QI package was finalized by organizing a two-day workshop at Kathmandu and was endorsed by the MoHP. Before initiating the data collection process, a standard operating procedure (SOP) was developed to ensure accuracy and consistency, as well as to ensure ethical integrity of the data collection process. The data collection team used this SOP to ensure integrity during collection, and the study team used it for monitoring the process.

All methods for data collection were performed complying with relevant guidelines and regulations according to the declaration of Helsinki (115). For Paper I, secondary data were collected from the hospital registries with approval from the respective hospital management committee. Informed verbal consent, approved by the respective hospital management committee, was obtained from all health workers participating in the bottleneck analysis workshop. For Paper II, verbal informed consent was obtained from all health workers before starting basic and refresher training. The training registration and evaluation form, which was used to evaluate trainees' knowledge and skills, was used for the documentation of their consent. The participants filled and signed the training registration and evaluation form after agreeing to participate in the study. Written informed consent was obtained from the mothers of all participating newborn infants before starting the observation (Paper III and IV). Participation in the study was voluntary and participants were informed about the option to withdraw from the study at any time without any need for explanation.

Paper III and IV involved the observation of clinical actions of health workers by our trained data collectors; that imposed possibility of interference on the routine work of health workers. To minimize this effect, the data collectors were clearly instructed, during the training, not to interfere with any of the routine clinical work of health workers in the hospital. Before initiating data collection, the hospital management and the health workers were well informed about the presence of our data collectors for observation. Also, the health workers were ensured about the confidentiality of the observed behaviors.

The stepped-wedge design of the study itself is bound to some debatable ethical issues (116). First, there is an ongoing debate on the classification of the study as research or non-research (117). The underlying objective of a systematic and robust evaluation of the effectiveness of QI package on neonatal

care outcomes qualified NePeriQIP as a research and was registered as a clinical trial (103). Second, there is an ethical concern on delayed rollout of the intervention to the control group; especially with appropriate randomization process (116). The hospitals in our study were randomly allocated to one of the four wedges (clusters) using block randomization. One cluster was randomized to cross from control to intervention period at a three-month interval. The randomization sequence was generated prior to the start of the study, but the hospitals did not have prior knowledge of when the intervention would be rolled out. Also, the data collection team and the hospital management team were unaware of when the hospital was in a control or intervention period.

All data collected for this project have been kept confidential, and have been used only for study purposes. All participants were anonymized for analysis and dissemination of results.

Results

The main findings of the four papers in this thesis highlight the potential of a QI package in improving the competency and clinical performance of health workers on EENC practices, including neonatal resuscitation, in hospitals in resource-poor settings.

Health system gaps in newborn care

The categories of assessment of the hospitals were; availability of basic newborn care services, training on neonatal resuscitation, referral services for newborn care, availability of equipment, information system, and the governance system (Paper I). The hospitals meeting all of the criteria under assessment were coded light green color and, and those which did not meet all the criteria were assigned light blue color. The assessment of hospitals reflected gaps in most of the categories under assessment (Figure 5). Only five out of the 12 hospitals had all basic newborn care services under assessment. KMC service was not available in seven hospitals, and one hospital was lacking sick newborn care service (Paper I).

Neonatal resuscitation training

Only two of the hospitals had all health workers working perinatal care services trained on neonatal resuscitation. Overall, only 60% of the health workers involved in neonatal care had received training on neonatal resuscitation. The proportion of health workers receiving training ranged from 20% to 100% (Paper I).

Category of assessment	Categorization of hospitals (by hospital numbers)											
	1	2	3	4	5	6	7	8	9	10	11	12
Availability of newborn services												
Referral services												
Training on neonatal resuscitation												
Health workers' availability												
Equipment availability												
Infrastructure (electricity, water supply)												
Information system												
Governance												

	Met all criteria of assessment
	Did not meet all criteria

Figure 5. Categorization of hospitals based on the fulfillment of criteria under assessment

Availability of equipment for basic newborn care

Overall, only 72% of the equipment required for basic newborn care was available in the hospitals. The percent availability of the required equipment was as low as 48% (in two hospitals) to as high as 86% (in three hospitals) (Paper I).

Performance of hospitals on selected newborn care indicators

Only 3.2% of the newborns with APGAR <7 at one minute after birth received BMV. The proportion of BMV among newborns with APGAR <7 at one minute ranged from none in two hospitals to 9% in one hospital. Overall, only 8% of the mothers were found to initiate breastfeeding immediately, within one hour, after birth and around 73% of the newly delivered mothers received counseling on breastfeeding. Around 41% of the mothers kept their newborns in skin-to-skin contact immediately after birth (Paper I).

Root causes behind the major problems related to essential newborn care and neonatal resuscitation

The major root causes identified by the participants during the bottleneck analysis workshop for early essential newborn care including neonatal resuscitation were; lack of training, lack of positive attitude of health workers, lower level of motivation, overburden of duty due to the inadequate number of staff, unavailability of required equipment, poor infrastructure, weak supervision and monitoring, and poor governance mechanism (Paper I).

Competency of health workers on neonatal resuscitation

Changes in knowledge and skills on neonatal resuscitation

There were altogether 798 participants in the basic training and 702 in the refresher training (Paper II). Out of the total, only 380 trainees were included in the knowledge evaluation and 286 were enrolled for skill evaluation for neonatal resuscitation. In the final analysis, with the intention to perform a paired comparison, we included those health workers who participated in knowledge and skill evaluation during both the basic and refresher training. This loss to follow up of health workers who participated in basic training was due to their unavailability in refresher training mainly because of their transfer to other hospitals. We observed improved knowledge and skills among the trainees after introducing the QI intervention in the hospitals. The overall knowledge test score increased from 14.2 (pre-basic) to 15.9 (post-basic) during the basic training ($p<0.001$) (Table 3). The improvement in knowledge test scores was recorded in all sizes of hospitals. Increased knowledge test score was observed in all hospitals, except one. The post-basic knowledge test score was above the set standard of >14 in all hospitals. The overall skill score was found to be above the set standard of >14 (16.98± SD 1.79) during the basic training (Paper II).

Deterioration of knowledge and skills over time

We found deterioration in the level of knowledge and skill which was acquired during the basic training over time. The overall knowledge test score of the trainees decreased from 15.9 (post-basic) to 15.3 (pre-refresher) ($p<0.001$). The deterioration in the level of knowledge was recorded in all sizes of hospitals. However, at the individual hospital level, the reduction in knowledge test

scores was observed only in four hospitals. The overall skill test score deteriorated over time to 16.4 ± SD 2.0 during the refresher training. The most notable deterioration in skill score was observed in high-volume hospitals (Paper II).

Maintenance of knowledge above the set standard

Even though both knowledge and skill of the participants deteriorated over time, it was maintained above the standard to qualify them to perform neonatal resuscitation. The pre-refresher knowledge test score was maintained above the set standard (>14) in all participating hospitals, and the overall knowledge score was higher during the pre-refresher test compared to the pre-basic test ($p<0.001$) (Paper II). Similarly, the skill test score was maintained above the standard (>14) in all hospitals during refresher training (Paper II).

No association of the background characteristics of trainees on the deterioration of knowledge and skills.

We performed logistic regression analyses to detect associations between background characteristics with the level of knowledge and skills on neonatal resuscitation. In the univariate logistic regression, being male and having no experience of resuscitating newborns in the past were found to be two factors associated with deteriorated or unimproved knowledge levels over time. But, the association of these characteristics was not confirmed when adjusted for other background characteristics. Likewise, previous experience of attending deliveries in the past was found to be associated with deteriorated or unimproved skill scores in the univariate logistic regression, which was not confirmed when adjusting for other background characteristics (Paper II).

Clinical performance on neonatal resuscitation

Bag and mask ventilation (BMV)

Altogether 3,031 non-crying newborns were enrolled for analysis from the four hospitals. After introduction of the QI package in hospitals, we observed improved performance of health workers on the most important action of basic neonatal resuscitation; initiation of BMV to non-crying infants. The proportion of non-crying newborns who were initiated on BMV was higher during the intervention period (aOR 1.28, 95% CI-1.04-1.57, p=0.016) compared to

the control. It increased from 16% during control to 20% during the intervention period (Paper III). The ventilation-time plot depicted that the cumulative median time to initiate ventilation, as of the last month of data collection, was 39.5 seconds less compared to the baseline period (Figure 6).

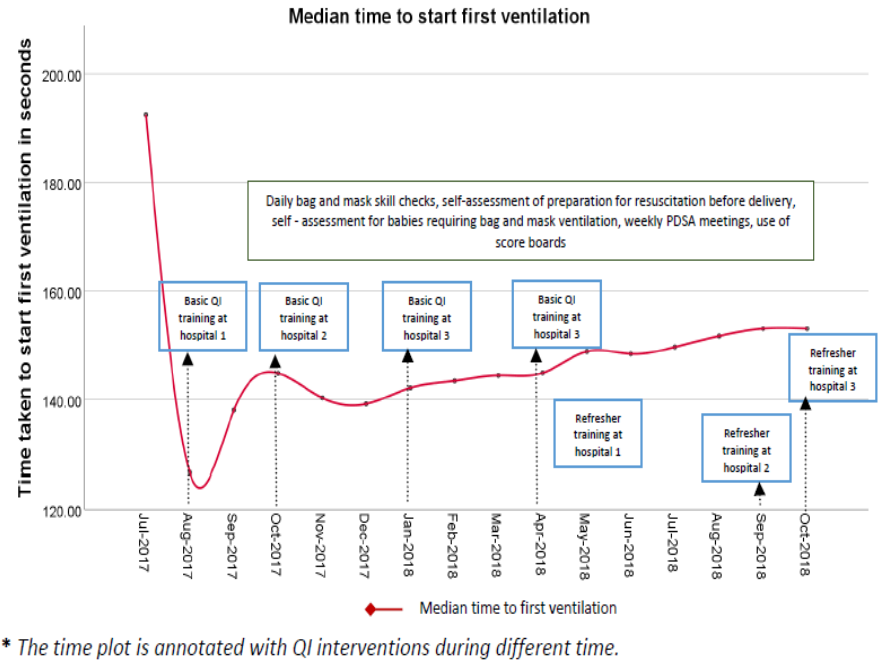

Figure 6. The monthly cumulative median time to first ventilation among newborns initiated on BMV

However, we observed no changes in the following variables before and after the introduction of QI interventions (Paper III);

i) initiation of BMV within 1 minute (OR 0.83; 95% CI, 0.51 - 1.33),
ii) selection of correct mask for ventilation (OR 0.99; 95% CI, 0.96 - 1.03)
iii) ventilation at the rate of 30-50 breaths per minute (OR 0.92; 95% CI, 0.80 - 1.06),
iv) rising of chest after each ventilation (OR 1.03; 95% CI, 0.95 - 1.13)
v) repositioning the head if no rise in chest (OR 0.98; 95% CI, 0.85 - 1.13), and
vi) assessment of heart rate after one minute of ventilation (OR 0.91; 95% CI, 0.80 - 1.04)

Clearing the airway of non-crying newborns

There was an improvement in the performance of health workers on clearing the airway (wiping or suctioning of the mouth and nose) among non-crying infants after introducing the QI package. Clearing the airway of non-crying infants increased from 68 % during the control to 71% during the intervention period (aOR 1.23; 95% CI, 1.03-1.46, p=0.017) (Paper III).

Effect on early essential newborn care

Performance in delayed cord clamping (DCC)

After introducing the QI package, the rate of DCC increased in three of the four hospitals, resulting in an overall increase from 25% to 31% (p<0.001) (Table 4). When adjusted for hospitals, the likelihood for a newborn to receive DCC increased two-fold during the intervention period (aOR 2.22; 95% CI, 2.06-2.38) (Paper IV).

Table 4. Early essential newborn care. Chi2-test for group differences in the total sample, four hospitals combined.

EENC components		**Total N, (%)**	**Baseline N, (%)**	**Intervention N, (%)**	**p-value**
Delayed cord clamping	Yes	7,524 (28.2)	2,657 (24.6)	4,867 (30.7)	
	No	19,150 (71.8)	8,145 (75.4)	11,005 (69.3)	<0.001
Early initiation of breastfeeding	Yes	2,770 (9.7)	557 (5.0)	2213 (12.7)	
	No	25,808 (90.3)	10,594 (95.0)	15,214 (87.3)	<0.001
Immediate thorough drying	Yes	27,630 (96.7)	10,835 (97.2)	16,795 (96.4)	
	No	948 (3.3)	316 (2.8)	632 (3.6)	<0.001
Immediate skin to skin contact	Yes	17,540 (61.5)	9,499 (85.2)	8,041 (46.1)	
	No	11,038 (38.6)	1,652 (14.8)	9,386 (53.9)	<0.001

Early initiation of breastfeeding (EIBF) practices

The practice of EIBF improved after the introduction of the QI package in all four hospitals. Overall, the rate of EIBF increased from 5% in the control to 13% in the intervention period (p<0.001) (Table 3). After adjusting for hospitals, we observed an increased likelihood for a newborn to receive EIBF during the intervention period (aOR 3.63; 95% CI, 3.22 - 4.09) (Paper IV).

Immediate thorough drying and skin to skin contact (SSC)

Most of the newborns were thoroughly dried immediately after birth, both during the control (97.2%) and intervention (96.4%) period. But, immediate SSC dropped in two of the participating hospitals during the intervention period compared to control, and remained on a similar level in other two. No neonates were found to be kept skin to skin for at least one hour as recommended by the WHO guidelines (Paper IV).

The composite score (three out of four observed EENC)

We found a small proportion of newborns receiving all four EENC, 1.4% during the control and 3.1% during the intervention period. A composite score of newborns receiving all or at least three out of the four observed EENC was calculated. The rate of newborns who received at least three out of the 4 observed EENC improved in all hospitals after introducing the QI package. When adjusting for the different hospitals, the likelihood for a newborn to receive at least three of the four observed EENC increased three-fold (aOR 2.80; 95% CI, 2.57-3.05) (Paper IV)

Discussion

The main results presented in this thesis indicate the potential of multi-faceted QI interventions in creating an environment for better care for newborns around the time of birth. After introducing the QI package in hospitals, we have seen improvements in knowledge and skills of health workers on neonatal resuscitation, which transferred into better clinical practice on resuscitation; especially initiation of BMV and clearing the airway among non-crying newborn infants. Similarly, we saw improvement in most of the observed early essential newborn care practices after the introduction of the package. The improvements in competency and clinical performance can be related to the reduced intrapartum-related mortality and early neonatal mortality in hospitals, as demonstrated by the main outcome paper of NePeriQIP study (77). The results came out from the large-scale multi-center studies in Nepal. Therefore, our findings will have an impact on future research and interventions for newborns, especially in Nepal and other resource-poor settings.

Capability, Opportunity and Motivation - Behavior

Improvement of quality of care is a major concern worldwide in the Sustainable Development Goals era (69). Previous studies have demonstrated the impact of QI interventions on improving quality of newborn care practices (67). The QI package was designed and scaled up in hospitals to improve the quality of care around birth mainly by addressing the existing health system gaps through different QI interventions. Our studies revealed the potential of this package in improving different important aspects of neonatal care which are discussed below. The Capability, Motivation, Opportunity - Behaviour (COM-B) framework was adopted to understand and explain the effect of QI interventions on behavior of health workers (Figure 7) (118). According to the framework, capability, opportunity, and motivation interact to generate desired behavior that in turn influences these components (119). This model was adopted with the notion that a given intervention might change one or more components in the behavior system. For our study, the behavior of health

workers was described as appropriate newborn care practices following the existing guidelines.

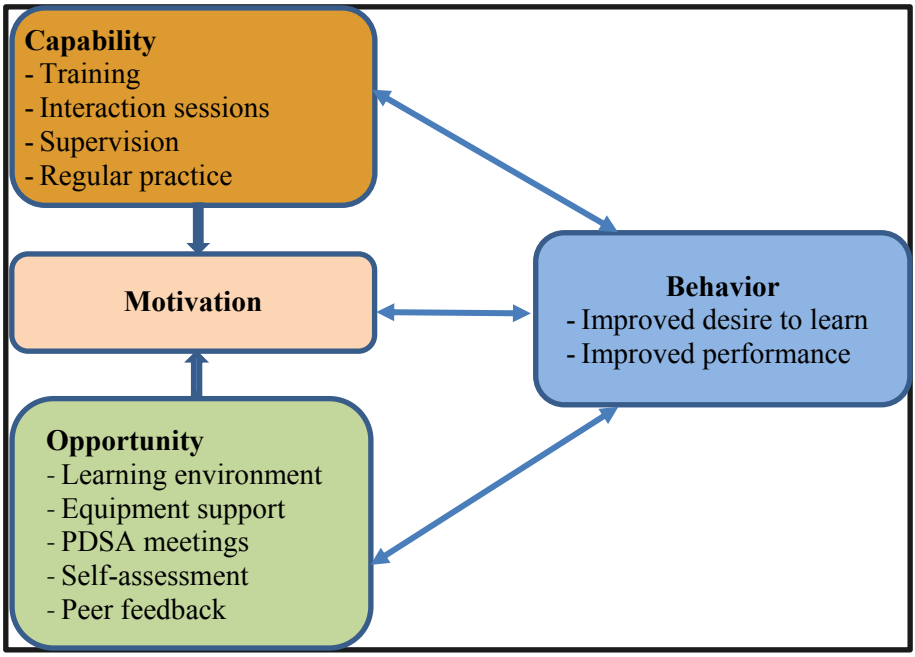

Figure 7. Interaction of QI activities with different components of the COM-B system.

Capability - Improving competency

Capability has been defined as the individual's physical and psychological capacity to engage in the required activity (118). Physical capability includes the physical strength, skill or stamina to engage in a particular behavior whereas psychological capability is the capacity to be engaged in the necessary thought process; reasoning, comprehension etc. (120).

In our study, having necessary knowledge and skills was crucial in developing capability to be engaged in providing better care for newborns in study hospitals. Training was one of the core activities bundled in the QI package which helped to improve the physical and psychological capability of in-hospital QI facilitators and health workers for newborn care practices. A seven-day MToT helped to improve knowledge and skills of QI facilitators not only on essential newborn care components but also on QI approach and facilitation techniques.

The basic and refresher training organized for health workers enhanced knowledge and skills of health workers on early essential newborn care including neonatal resuscitation. Besides these, the in-hospital QI facilitators and health workers were supported by external mentors to enhance their knowledge and skills. Further, the health workers practiced bag and mask ventilation on mannequin daily to retain their skills in neonatal resuscitation.

The finding of our study that the knowledge and skills on neonatal resuscitation can be improved through QI intervention package is similar to several other studies in different settings. For example, knowledge scores on neonatal resuscitation increased from 57% to 80%, and skill scores from 43% to 88% after HBB training in Zambia (54). Other studies have demonstrated that when HBB training is accompanied by QI interventions, the likelihood of uptake and retention of neonatal resuscitation among health workers is higher (58,59,81,121). The findings of our study reiterated this fact, indicating the need to scale up QI interventions in other health facilities. Even though the knowledge and skills deteriorated over time in our study, it was well maintained above the standard among health workers in all of the participating hospitals compared to the baseline performance; indicating their capacity to retain the level of competency required to perform neonatal resuscitation whenever needed. Even though the deterioration was observed as a whole, the average skill score during the refresher training in our study (16.4) was higher than the deteriorated level of skill of midwives in rural Ghana (14.6) (59). This maintenance of the level of knowledge and skill above the standard can probably be attributed to the multifaceted interventions bundled in the QI package.

Opportunity - Addressing health systems gaps

Opportunity has been defined as all the factors outside the individual that play a role in motivating behavior change. It is sub-categorized as the physical (environmental influences such as time, resources, locations, cues, and physical affordance) and social opportunities (interpersonal influences, social cues, and cultural norms) (119).

WHO suggests that to deliver quality health services, health system should be functional in terms of six building blocks; i) service delivery, ii) health workforce, iii) health information system, iv) medical products, technologies v) financing and vi) leadership and governance (63). Gaps in one or more of the

building blocks lead to care of sub-optimum quality resulting in higher preventable mortality (47). The gaps we have observed in most of the health system building blocks are obstructing the opportunity of health workers for better performance on newborn care in hospitals in Nepal. At baseline, gaps in the health system were leading to a lower level of performance on neonatal care which was reflected by the status of some of the newborn care indicators used for the assessment of readiness and availability; low level of performance of BMV, SSC and EIBF practices. The finding is similar to previous studies related to readiness and availability of perinatal care services in different countries. Analysis of 12 countries that account for the majority of global maternal and newborn deaths reflected major bottlenecks in health financing, health workforce, and health service delivery (6). The quantitative findings in our study were triangulated by the collective views of health workers related to perinatal care in participating hospitals; the most common problems and root causes identified by the health workers were related to training, equipment, and infrastructure.

Our study hospitals were supported with the required set of logistics and equipment; mannequin sets, scoreboards, HBB job aids, self-assessment checklists, peer evaluation checklists, and PDSA meeting notes. The hospital management provided a conducive learning environment for QI facilitators and health workers. The health workers had an opportunity of self-assessment of bag and mask skills and self-evaluation of the performance on delivery services. The weekly PDSA meeting in the hospitals provided an opportunity to health workers to share their experiences, problems related to newborn care services. This meeting platform also provided them an opportunity to share their problems with hospital authorities in a systematic way. The health workers had an opportunity to get their performances evaluated by peers, and received feedback for improvement. This working environment provided both physical and social opportunities to motivate health workers to change their behaviors in terms of providing better services.

Motivation - Transferring skills into clinical practices

Motivation has been defined as all those brain processes that energize and direct behavior; it includes habitual processes, emotional responding and analytical decision making (122). Motivation has been subdivided as reflective motivation (self-conscious intentions, planning and evaluation) and automatic

motivation (emotional reactions, desires, impulses, inhibitions, reflex responses and habits) (119).

With enhanced knowledge and skills, coupled with a conducive working environment in the hospital, the health workers involved in perinatal care units were found to be motivated to change their behavior. During training and interaction sessions, the health workers reflected their desire to change in terms of better care practices. Besides routine care, the QI package introduced in the hospitals demanded extra responsibilities from health workers like filling out the assessment checklists, scoreboards, participation in PDSA meetings, reporting of QI activities etc. There was no provision of any extra financial incentives for being involved in those activities. However, health workers expressed their commitment to be engaged in those QI activities without any extra financial incentives. They were ready to take this responsibility as their routine work, which reflected their automatic motivation.

Previous studies have reported that the simulated knowledge and skills on neonatal resuscitation are more likely to be transferred to clinical practices when neonatal resuscitation training is linked with QI interventions (67,99). In our study, the improved and sustained level of knowledge and skills after the introduction of the QI package transferred adequately into clinical performance on EENC including neonatal resuscitation in hospitals. Especially, the proportion of the initiation of BMV, clearing the airway of non-crying newborns, EIBF and DCC increased in public hospitals. This can be attributed to the reflective and automatic motivation developed among health workers, after introducing QI interventions, to perform better for newborn care.

Behavior - Improving neonatal care

The COM-B model has demonstrated that human behavior results from the interaction between personal physical and psychological capabilities, by utilizing physical and social opportunities through reflective and automatic motivators (123,124). Similar to this, the findings of our study indicated that interventions/activities bundled in the QI package interacted with different components of the COM-B system and helped health workers to change their behaviors for better performances on newborn care practices (Figure 7).

Based on the evidence, WHO strongly recommends EENC for all newborns and neonatal resuscitation support to non-breathing infants to further reduce

morbidity and increase survival (11,125). Our findings reflect the changes in behavior of health workers on early newborn care practices including neonatal resuscitation. The improved uptake and retention of knowledge and skills on neonatal resuscitation reflect their desire for continuous learning. The improved performance on initiation of BMV, clearing the airways, delayed cord clamping and early initiation of breastfeeding reflect their changed behavior in routine care practices in the hospitals.

Initiation of BMV is the most crucial action in saving the lives of non-crying newborns (49,55). Our findings differ from the systematic review and meta-analysis which reported no changes in the proportion of BMV before and after HBB training (53). Our finding also differs from a study in Tanzania which reported a decreased proportion of BMV after HBB training (126). However, an increased proportion of BMV after HBB training was reported in Sudan, similar to our findings (78). Different interventions included in the QI package might have resulted in an increased initiation of BMV and clearing the airway in our study.

Even though there are multiple benefits of EIBF, it is practiced only by less than 45% of mothers worldwide (35,127). The struggle to improve this effective, cost-free, and evidence-based practice has continued for several years (39,128). Our study demonstrated that the EIBF practices could be improved by introducing a QI package in public hospitals in resource-poor settings. The proportion of EIBF in our study, both during the control and intervention periods, is higher than that reported by Reema et al. in South India (1.4%), and by LC Mullany et al. in Nepal (3.4%) (128,129). Regarding DCC, the recommended delay in cord clamping is not found to be commonly practiced in Nepal and other settings (31,32). Globally, continuous efforts are being made to increase the rate of DCC (130,131). In this context, our findings indicate the potential of QI interventions in course of increasing this evidence-based practice.

The increase in the composite score (three out of four observed EENC practices) in all study hospitals reflects the positive impact of the QI package in overall EENC practice in public hospitals. Similar findings were reported by a study in Gaza where quality improvement interventions; clinical coaching together with regular self-assessments and action by hospital teams improved care during delivery (132).

Need of further research

Our study results revealed the need for research to search for ways for further improvement in some of the crucial newborn care components. First, further studies are required to explore ways to improve the timing of first ventilation to non-crying newborns in resource-poor settings. Among those newborns who require BMV, it should ideally be started within the first minute of birth (Golden minute) because the delay in starting ventilation increases the likelihood of mortality (43). Even though the QI package reduced the time taken to initiate ventilation in our study, it was still more than one minute. The cumulative median time taken by the last month of data collection (153 seconds) is far from the ideal time. Also, we could not observe changes in the proportion of initiation of BMV within one minute before and after the introduction of the QI package. The inadequate number of health workers in the delivery room might have affected this performance. Further studies should focus on how to improve initiation of BMV within the first minute of birth considering the existing contextual factors (number of health workers available, work culture, motivation of health workers etc.).

Immediate and thorough drying and immediate SSC are essential components of thermal care for newborns immediately after birth (11). Even though the immediate thorough drying was at a satisfactory level both during the control and intervention period, the SSC dropped during the intervention period in two of the hospitals in our study. Anecdotal evidence, based on discussions with health workers in those hospitals, indicated that the health workers continued their habitual practice of wrapping the newborn in a towel instead of putting them skin to skin. This might, to some extent, be explained by increased awareness among health workers after the introduction of the QI package, which made them perform what they thought was good quality care. Although the basic training on QI included the content on SSC, there was little emphasis on this topic compared to other contents like BMV and breastfeeding. We assume that the little emphasis given to SSC during training led to an increase in those habitual practices of wrapping newborns in towels resulting in the dropped level of SSC. Immediate SSC has been reported to be practiced at a sub-optimum level in several other resource-poor countries (22,23). Further studies, focusing on the specific contextual factors, are required on how to improve this evidence-based practice in resource-poor settings.

Overall, further studies are required to search for ways to sustain the positive impacts of the QI package on newborn care practices in Nepal and similar settings.

Methodological considerations

Stepped wedge design of the study

The QI package was introduced at different time points in different hospitals according to the stepped wedge design of NePeriQIP, of which the studies presented in this thesis form a part (103). The 12 study hospitals were grouped into four clusters (wedges) with three hospitals (one high volume, one medium volume, and one low volume) in each wedge. At the beginning of the study, there was an initial period with no cluster exposed to the intervention. After initiating the intervention in the first wedge, there was a subsequent three-month delay for the second, third and fourth wedge to receive the intervention. This stepped wedge design, allowed all clusters to be exposed to the intervention by the end of the study. This design mimics the classical randomized control trial and has many practical advantages (133). The design allowed for pragmatic implementation of the intervention that would have been resource-consuming if it had been carried out at the same time at all hospitals.

Standards used for evaluation of knowledge and skill level on neonatal resuscitation

For the evaluation of the knowledge and skills of health workers on neonatal resuscitation, the correct responses to 14 out of 17 questions (82%) was set as the standard to pass the knowledge test, and 14 out of 18 questions (78%) was set as the standard to pass the skill test (Paper II). The standards were set based on previously used cut-offs in several settings (57,59).

Generalizability of findings

This thesis presents the combined results of the first multi-center large-scale studies to assess the effectiveness of scaled-up interventions in improving newborn care practices in Nepal. For Paper II, we enrolled a relatively large number of participants compared to most of the previous studies that evaluated the effect of QI interventions on neonatal resuscitation. The training participants were selected by the hospitals themselves; the training participants represent the average level of health workers in terms of knowledge, experience

and skills in Nepal. A large number of newborns were enrolled for the assessment of the effect of the QI package during the period of one and a half years. The intervention was introduced in the existing set-up of hospitals, without any modifications in structure or management. The participating hospitals represent the existing hospital levels in Nepal, and differ in terms of geography, ethnicity, and languages of the population they serve. Therefore, the findings presented in this thesis can be fairly generalized in similar hospital settings in Nepal and other countries.

Limitations

Observation effect

Two papers (III and IV) presented in this thesis are based on the observations of the clinical actions of health workers. The observations were performed by trained nurses having knowledge of both clinical practice and data collection. Therefore, our result might have been subject to a degree of the Hawthorne effect in terms of changes in clinical behavior of health workers due to the presence of trained nurses (134). Also, the results might have been affected, to some extent, by social desirability bias; the health workers might have deliberately tended to show appropriate clinical behaviors in front of the data collectors to avoid negative evaluations (135). There is a possibility of influence of the direct observation on the behaviors of the health workers as well as the mothers, especially during the initial period of data collection. After some months, the health workers began to consider data collection team members as their colleagues and these effects were normalized.

Ethical dilemma

For data collection, we recruited nurses with experience in nursing management and research. The reason for this selection was based on the assumption that the data collection process would be effective and smooth when recruiting personnel with prior knowledge and skills in the related field. The assumption was proved to be wise, as the data collectors performed well during the training and also during the data collection process. However, this created some degree of ethical dilemma amongst the data collectors, and also amongst the study team. Having knowledge and skills on neonatal care, our data collectors were expected to support, in some instances, health workers in providing care to the newborns. This expectation was against the protocol followed by our data collectors; they were not allowed to intervene in the routine practice of the health workers in the hospital. This issue was discussed with the hospital

management during the visit of the study team and resolved to some extent, by clarifying the role of our data collectors to health workers. Our argument was that the data collectors were an added resource in hospitals, without any authority to interfere with standard care practices. However, this dilemma indicated the need of considering the selection of data collectors from other, non-health-related, fields.

Besides these, there are some other limitations of the study which are worth mentioning. For study II, the intention to perform the paired comparison of training participants led to a reduced number of participants for analysis. Out of the total 798 participants enrolled in the basic training, only 47.6% were included in the final analysis. There is a possibility of Hawthorne effect since the participants in the basic training were informed about the refresher training planned six months later (134). The duration gap between basic and refresher training was not the same for all of the hospitals. Although the refresher training was planned to be conducted exactly after six months of basic training, it could not happen in some of the hospitals. It was because the training dates were decided by the respective hospitals, and the study team had not had much control over it. The decision of hospitals depended on the organizational and contextual factors; for example, there was an unforeseen and long strike in one of the participating hospitals that delayed the date for refresher training.

We did not study the association of the specific QI tools in the package with uptake and retention of knowledge and skills, which could have generated a deeper understanding of ways to improve QI interventions themselves.
For Paper III and IV, it was difficult for data collectors to observe and fill the form on clinical activities of health workers especially when there were multiple deliveries. Therefore, data collectors might have failed to observe and record some of the action steps on EENC and neonatal resuscitation. We did not analyze existing contextual factors of hospitals against the performance of health workers on EENC practices and neonatal resuscitation. We could observe only 62% of the total deliveries during the study period that might have some effect of selection bias in our results. We could not observe the remaining deliveries mainly due to the lack of mothers' consent and due to referral for cesarean delivery. Also, the data collectors failed to observe some of the deliveries because of time constraints. We did not analyze the association of specific quality improvement interventions with outcome variables, which could have produced a better understanding of the effect of specific interventions on EENC including neonatal resuscitation.

Conclusions

Quality improvement interventions improve the uptake and retention of neonatal resuscitation knowledge and skills among health workers. It also improves the transfer of knowledge and skills into clinical practice on neonatal resuscitation.

By addressing the gaps in health care system, quality improvement interventions improve early essential newborn care practices including neonatal resuscitation in hospitals.

Quality improvement interventions improve behavior of health workers in terms of better newborn care practices.

Quality improvement interventions can be considered effective when scaled up in other public hospitals of Nepal and other similar settings to improve neonatal care practices.

Further researches are required to sustain the gains of the quality improvement interventions on newborn care. Researches are also required to search for ways to improve the timing of bag and mask ventilation and skin-to-skin contact.

Summary

To date, newborn deaths are unacceptably high in resource-poor countries including Nepal. In 2019, almost 2.4 million newborns died worldwide, mostly in low-and middle-income countries. Poor quality of care around the time of birth is associated with one-third of these deaths. Poor quality of care is often linked with human resources, equipment and infrastructure. To further reduce newborn mortality, World Health Organization calls for wider coverage and a massive improvement in the quality of evidence-based care around birth. Nepal is committed to reduce the current neonatal mortality rate from 21 per 1000 live births to 12 per 1000 live births by 2030, which cannot be achieved without improving the quality of newborn care services. To address the gaps in quality of newborn care, a quality improvement (QI) package was developed by the Ministry of Health and Population, Nepal, and was scaled up in 12 secondary level public hospitals. The QI package incorporated the multifaceted QI interventions to improve neonatal care practices in the hospitals. This thesis aimed to evaluate the effect of this QI package on early essential newborn care including neonatal resuscitation.

After introducing the QI package, the knowledge and skills of health workers on neonatal resuscitation improved significantly. The multifaceted interventions bundled in the QI package helped health workers maintain the acquired knowledge and skills on neonatal resuscitation over time. This improved and retained knowledge and skills transferred into the clinical practice resulting in an improved performance on neonatal resuscitation; especially the initiation of bag and mask ventilation (BMV) and clearing the airway among non-crying newborns. The time taken to initiate ventilation to non-crying newborns was 39.5 seconds less during the intervention period compared to baseline. We also observed improved early essential newborn care practices (EENC), especially early initiation of breastfeeding (EIBF) and delayed cord clamping (DCC). The overall EIBF increased from 5% during control to 13% during the intervention period, and DCC increased from 25% to 31% during the same period. The composite score (three out of the four observed EENC) increased in all study hospitals after the introduction of the QI package.

Overall, we found that the QI package had a positive impact on improving the performance of health workers on EENC practices including neonatal resuscitation that would contribute to reducing neonatal deaths. QI interventions can be scaled up in other health facilities in Nepal and similar settings.

Sammanfattning

Antalet barn som dör i samband med förlossning och under den första levnadsmånaden är fortfarande oacceptabelt högt i resursfattiga länder, inklusive Nepal. År 2019 dog nästan 2,4 miljoner nyfödda i världen, mestadels i låg och medelinkomstländer. Bristande kvalitet i förlossningsvården är en bidragande orsak till en tredjedel av dessa dödsfall. Bristande vårdkvalitet är ofta kopplat till resurstillgång i form av personal, utrustning och infrastruktur. För att minska dödligheten hos nyfödda efterlyser Världshälsoorganisationen WHO ett ökat fokus på åtgärder som kraftigt kan förbättra kvaliteten på evidensbaserad vård i samband med förlossning och säkerställa tillgång till denna vård för alla. Nepal har åtagit sig att minska den nuvarande neonatala dödligheten från 21 per 1 000 levande födda till 12 per 1 000 levande födda fram till 2030, vilket inte kan uppnås utan att förbättra kvaliteten på vården för nyfödda. För att komma till rätta med bristerna i vårdkvaliteten för nyfödda utvecklades en interventionsstrategi med ett flertal komponenter av Hälsoministeriet i Nepal, vilken sedan skalades upp till 12 offentliga sjukhus på distriktsnivå. Interventionsstrategin inkluderade ett flertal åtgärder som syftade till att förbättra omhändertagandet av nyfödda i samband med förlossning vid dessa sjukhus. Denna avhandling syftar till att utvärdera effekten av detta interventionspaket i relation till vård av nyfödda, inklusive neonatal hjärt-lungräddning (HLR).

Efter att interventionspaketet hade införts förbättrades sjukvårdspersonalens kunskaper om och färdigheter för neonatal HLR avsevärt. De mångfacetterade interventionerna hjälpte sjukvårdspersonalen att bibehålla de förvärvade kunskaperna och färdigheterna om neonatal HLR över tid. Dessa förbättrade och bibehållna kunskaper och färdigheter resulterade även i en förbättrad handläggning av neonatal HLR i den kliniska vardagen, särskilt med avseende på initiering av ventilation och rensning av luftvägarna. Tiden det tog att påbörja ventilering var 39,5 sekunder kortare efter interventionen jämfört med innan. Vi observerade också förbättrad handläggning av viktiga förlossningsrutiner, särskilt tidig initiering av amning och fördröjd navelsträngsklämning. Tidig initiering av amning (inom en timme efter förlossningen) ökade från 5 % innan till 13 % efter interventionen, och andelen barn där navelsträngen klämdes av efter mer än en minut ökade från 25 % till 31 % under samma period.

Totalt sett fann vi att interventionspaketet hade en positiv inverkan på att förbättra vårdkvaliteten i samband med förlossning, inklusive förbättrad handläggning av neonatal HLR. Interventionspaketet kan skalas upp i andra hälsoinrättningar i Nepal och liknande miljöer.

Summary in Nepali (सारांश)

हालसम्म्म पनि विकाशोन्मुख तथा विकाशसिल राष्ट्रहरुमा नवजात शिशुको मृत्यु धेरै हुने गरेको पाईन्छ । सन् २०१९ मा विश्वमा लगभग २४ लाख नवजात शिशुहरुको मृत्यु भएको थियो जसमध्ये धेरैजसो मृत्यु अविकसित राष्ट्रहरुमा भएको थियो । यसमध्ये झन्डै एक तीहाई मृत्यु शिशु जन्मनु अगाडी वा जन्मनासाथ गर्नुपर्ने स्याहार/सेवाको कम गुणस्तर संग जोडिएको पाईएको छ । कम गुणस्तरको सेवा विशेष गरेर मानव संशाधन, औजार/उपकरणको उपलब्धता, तथा भौतिक संरचनासंग जोडिएको पाईन्छ । आगामी दिनमा नवजात शिशुको मृत्युलाई थप घटाउनका लागि विश्व स्वास्थ्य संगठनले गरिव तथा विकाशसिल राष्ट्रहरुमा नवजात शिशु केन्द्रित प्रमाणित सेवाहरुलाई लाई व्यापक विस्तार गर्नुपर्ने तथा उक्त सेवाहरुको गुणस्तरमा व्यापक सुधार गर्नुपर्ने कुरालाई जोड दिएको छ । नेपालले हालको नवजात शिशु मृत्युदर (२१ प्रति हजार जीवित जन्म) लाई घटाएर सन् २०३० सम्ममा १२ प्रति हजार जीवित जन्ममा झार्ने प्रतिबद्धता जाहेर गरेको छ। यसै सन्दर्भमा नवजात शिशु सेवाको गुणस्तर संग सम्बन्धित समस्याहरुलाई सम्बोधन गर्नका लागि स्वास्थ्य तथा जनसंख्या मन्त्रालयले नवजात शिशु सेवा केन्द्रित गुणस्तर सुधारको प्याकेज तयार गरी देशका विभिन्न १२ वटा अस्पतालहरुमा लागू गरेको थियो । यस नवजात शिशु सेवा गुणस्तर सुधार प्याकेजमा गुणस्तर सुधार सम्बन्धि विभिन्न गतिविधिहरु समावेश गरिएको थियो । प्रस्तुत सोधपत्रले उक्त अस्पतालहरुमा लागू गरिएको गुणस्तर सुधार प्याकेजले नवजात शिशु जन्मनासाथ गरिनुपर्ने स्याहार तथा जन्मदा श्वास नफेरेका नवजात शिशुहरुलाई दिनुपर्ने कृत्रिम श्वासप्रश्वास सेवामा ल्याएको परिवर्तनको सम्बन्धमा अध्ययन गर्ने उद्देश्य लिएको थियो ।

अस्पतालहरुमा उक्त गुणस्तर सुधार प्याकेज लागू भएपश्चात जन्मदा श्वास नफेरेका नवजात शिशुहरुलाई कृत्रिम श्वासप्रश्वास दिने स्वास्थ्यकर्मीरुहको ज्ञान र सीपमा उल्लेख्य सुधार भएको पाईएको छ । साथै उक्त प्याकेजमा समावेश गरिएका विभिन्न गुणस्तर सुधारका गतिविधिहरुको अभ्यासले स्वास्थ्यकर्मीहरुलाई तालिमबाट आर्जित ज्ञान र सीपलाई लामो समयसम्म दीगो राख्न सहयोग पुऱ्याएको पाईएको छ । यसरी सुधारीएको ज्ञान र सीपको प्रत्यक्ष असर स्वास्थ्यकर्मीहरुको क्लिनिकल अभ्यासमा समेत देखा परेको छ । विशेष गरेर जन्मदा श्वास नफेरेका नवजात शिशुहरुलाई कृत्रिम

श्वासप्रश्वासका माध्यमबाट सामान्य रुपमा श्वास फेर्नका लागि सहयोग गर्न प्रयोग गरिने ब्याग एन्ड मास्क भेन्टिलेसन तथा श्वासमार्ग सफा गर्ने जस्ता महत्वपूर्ण अभ्यासहरुमा उल्लेख्य सुधार भएको पाईएको छ। यसैगरी उक्त प्याकेज लागू हुनुपूर्वको तुलनामा लागू भएपश्चात जन्मदा श्वास नफेरेका शिशुलाई दिईने पहिलो कृत्रिम श्वाप्रश्वास शुरु गर्ने अवधि ३९.५ सेकेन्डले कम भएको पाईएको छ जुन उक्त प्याकेजको एउटा महत्वपूर्ण उपलब्धी मानिएको छ। यसैगरी अस्पतालहरुमा जन्मनासाथ तुरुन्तै नवजात शिशुलाई आमाको दूध चुसाउने आमाहरुको दर तथा विश्व स्वास्थ्य संगठनको सुझाव अनुसार जन्मेपश्चात १ देखि ३ मिनेट पछिमात्र नाभी काट्ने दरमा पनि सुधार आएको पाईएको छ। उक्त प्याकेज लागू भएपश्चात अध्ययन गरिएका सम्पूर्ण अस्पतालहरुको समग्र तथ्यांक हेर्दा जन्मनासाथ तुरुन्तै स्तनपान गराउनेको दर ५ प्रतिशतबाट बढेर १३ प्रतिशतमा तथा जन्मेपश्चात १ देखि ३ मिनेट पछिमात्र नाभी काट्ने दर २५ प्रतिशतबाट बढेर ३१ प्रतिशतमा पुगेको पाईएको छ।

यस सोधपत्रको समग्र नतिजाले गुणस्तर सुधारका गतिविधिले शिशु जन्मनासाथ गर्नुपर्ने अत्यावश्यक स्याहार तथा जन्मदा श्वास नफेरेका शिशुहरुलाई प्रदान गरिने कृत्रिम श्वासप्रश्वास स्याहारमा सुधार ल्याएको दर्शाएको छ। तर्सथ नवजात शिशु सेवा सुधार गरी नवजात शिशुहरुको मृत्युदरलाई घटाउन गुणस्तर सुधारका क्रियाकलापहरु नेपाल तथा नेपालजस्तै अन्य राष्ट्रका स्वास्थ्य संस्थाहरुमा लागू गर्न उपयुक्त हुने देखिन्छ।

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