Improving the Quality of Essential Newborn Care in Solomon Islands

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Submitted in total fulfilment of the requirements

of the degree of Doctor of Philosophy

November 2019

Abstract

Gaps in the quality of hospital care in low- and middle-income countries contribute to neonatal death and morbidity. Most neonatal deaths occur in the first few days of life, many from preventable or treatable causes. Essential newborn care consists of low-cost interventions, such as basic resuscitation, early breastfeeding and skin-to-skin contact, which have been shown to improve outcomes. Successful essential newborn care implementation requires understanding of the setting in which it is being delivered and the contextual factors that enable healthcare workers to provide quality care for newborns. Solomon Islands is a low-resource country in the Western Pacific and a Small Island Developing State with high neonatal mortality rates, increasing births per capita and limited healthcare resources and personnel. The Ministry of Health and Medical Services (MHMS) and stakeholders implemented an intervention to improve newborn quality of care in Solomon Islands.

This thesis evaluates the quality of care in hospitals of Solomon Islands and describes contextual factors that enabled successful implementation of a multifaceted intervention to improve essential newborn care.

This thesis used a mixed methods design comprising the following sequential studies: (1) Quality of hospital care for newborns was described through a cross-sectional study using a structured assessment tool to identify strengths and limitations in structure and process components of existing care. (2) Three years of perinatal outcomes were audited to determine stillbirth, perinatal and neonatal mortality rates and the main causes of neonatal morbidity and mortality. (3) The impact of the World Health Organization Early Essential Newborn Care training program on knowledge and skills of healthcare workers was assessed, using a before-and-after study that identified the factors associated with improved retention of knowledge and skills. (4) The implementation process was described through interviews of healthcare workers, and interview data were triangulated with quantitative results to describe features of the intervention that supported implementation.

This thesis demonstrated gaps in structure and process elements in quality of newborn care, which limited provision of appropriate, timely clinical care in the hospitals. Very high perinatal mortality rates, mainly owing to stillbirths, were identified. The provinces had higher rates of perinatal mortality than the National Referral Hospital. The main

causes of neonatal mortality were complications of prematurity, birth asphyxia and infection. Knowledge and skills of healthcare workers significantly increased following the coaching program. At the time of evaluation, some loss of skills over time had occurred, particularly in cadres of healthcare workers that did not routinely use relevant skills. The evaluation of the implementation process reflected strengths of the intervention, specifically the training methods (content, short duration and practical approach) and the impact of a small training team of MHMS midwives and nurses who delivered the program independently. The challenges and sense of anxiety faced by healthcare workers in remote, isolated settings with infrequent exposure to resuscitation were highlighted. The barriers to establishing independent, ongoing quality improvement activities reflect the challenge of sustaining action across a large geographical area that has a dispersed health workforce when there is little capacity for regular oversight and support.

This thesis highlights the potential impact from a multifaceted intervention to improve essential newborn care. Together with efforts to address stillbirths and improve intrapartum quality of care and quality of care in the neonatal period, essential newborn care may form an important part of a strategy to improve outcomes for newborns.

Declaration

I hereby declare that:

1. This thesis comprises only my original work towards the degree of Doctor of Philosophy except where indicated in the Preface.
2. Due acknowledgement has been made in the text to all other material used.
3. This thesis is fewer than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices.

Shidan Tosif

Preface

This research was conducted in Solomon Islands along with colleagues at the MHMS and doctors, midwives and nurses at the Department of Paediatrics and the Department of Obstetrics, National Referral Hospital (NRH). I collaborated with the Solomon Islands country offices of the United Nations International Children's Emergency Fund (UNICEF), the country and regional representatives for Reproductive, Maternal, Child and Newborn Health at the World Health Organization (WHO) and doctors with the Centre for International Child Health (CICH), University of Melbourne. Individuals from these organisations contributed to the refinement of the project's implementation and evaluation and assisted with facilitation of the training and evaluation stages. Specifically, Dr Divinal Ogaoga provided critical support throughout the project through the Reproductive and Child Health Division of MHMS, particularly at the project's inception and early stages. Ms Anna Jatobatu (MHMS) and Ms Anita Maepio (Department of Obstetrics, NRH) were involved in planning and implementing training and assisted with evaluation elements. Paediatricians and paediatric registrars from NRH assisted with the provincial hospital site visits and evaluations. Paediatric registrars (CICH) assisted with training and evaluation in Early Essential Newborn Care (EENC).

Chapters 4–6 consist of my own original work, supervised by Prof Trevor Duke, and co-supervised by Dr Amy Gray and Ms. Katherine Gilbert. There are four publications arising from the research conducted for this thesis and these are presented as result chapters. The Advisory Committee has approved the inclusion of these publications in this thesis and a signed *Declaration for a Thesis with Publication Form* for each publication is provided as *Appendices A–D.* I am the first author of all the included publications and the major contributor to the manuscripts. My contributions included critically appraising the related literature, developing the study design, collecting data, analysing the data and preparing the manuscript. I was responsible for obtaining ethics approval through the University of Melbourne Human Research Ethic Committee (HREC) and the Solomon Islands Health Research and Ethics Review Board. All co-authors have authorised the inclusion of the publications within this thesis. The publications, contributors and status of publications are described in more detail in the **Publications Arising from this Thesis** table on page vi of this thesis.

No portion of the work related to this thesis has been submitted elsewhere. All of the work contained in this thesis was carried out following commencement of PhD candidature. Elite Editing assisted with formatting this thesis, and intervention was restricted to Standards D and E of the *Australian Standards for Editing Practice*.

The Centre for International Child Health, Department of Paediatrics, University of Melbourne provided funding support for this thesis.

Publications

Table 1 describes the publications included in this thesis, the contributions of the respective co-authors and current publication status.

Publications Arising from this Thesis

Publication and co-author contributions	Status
Tosif, S., Nasi, T., Gray, A., Sadr-Azodi, N., Ogaoga, D., & Duke T. (2018). Assessment of the quality of neonatal care in the Solomon Islands. *Journal of Paediatrics and Child Health, 54*(2), 165–171. *ST, TD and OD conceived and designed the study. ST and TN coordinated site visits for data collection. ST adapted data collection tools and completed the data analysis. TD and AG contributed to the interpretation of results. ST wrote the draft manuscript; all authors provided substantial input and comments. All authors read and approved the final manuscript.* *This publication is presented as result Chapter 5.*	*Published*
Tosif, S., Jatobatu, A., Maepioh, A., Subhi, R., Francis, K. L., & Duke, T. (2020). Cause-specific neonatal morbidity and mortality in the Solomon Islands: An assessment of data from four hospitals over a three-year period. *Journal of Paediatrics and Child Health*, *56*(4), 607-614. *ST and TD conceived and designed the study. ST, AJ, AM and RS collected the data. KF and ST completed the data analysis. ST drafted the manuscript. All authors provided substantial comments to the manuscript and approved the final version.* *This publication is presented as result Chapter 6.*	*Published*
Tosif, S., Jatobatu, A., Maepioh, A., Gray, A., Sobel, H., Mannava, P., & Duke, T. (2020b). Healthcare worker knowledge and skills following coaching in WHO early essential newborn care program in the Solomon Islands: a prospective multi-site cohort study. *BMC Pregnancy and Childbirth, 20*(1), 84. *ST conceived and designed the study. ST, AJ and AM collected the data. ST completed the data analysis. AG, HS and PM contributed to analysis. ST drafted the manuscript, with substantial contributions from all authors, who approved the final version.* *This publication is presented as result Chapter 7.*	*Published*

Tosif, S., Jatobatu, A., Maepioh, A., Gray, A., Gilbert, K., Hodgson, J., & Duke, T. (2020). Implementation Lessons from a Multifaceted National Newborn Program in Solomon Islands: A Mixed-Methods Study. *The American Journal of Tropical Medicine and Hygiene*, *102*(3), 667-675.	*Published*
ST, AG and TD conceived and designed the study. ST, AG and JH created interview guides. ST, AJ and AM conducted interviews. Transcripts were reviewed, coded and analysed by ST, AG, KG and JH. Structural evaluation data were collected by RS and ST and analysed by ST. ST drafted the manuscript. All authors contributed to manuscript and read and approved the final version.	
This publication is presented as results Chapter 8.	

Publications Arising During Thesis

Publications completed during the period of this PhD candidature, which were not related to this thesis, included:

- Graham, H., **Tosif, S**, Gray, A., Qazi, S., Campbell, H., Peel, D., … Duke, T. (2017). Providing oxygen to children in hospitals: A realist review *Bull World Health Organ*, *95*(4): 288–302. https://doi.org/10.2471/blt.16.186676
- Heenan, R. C., Volkman, T., Stokes, S., **Tosif, S.**, Graham, H., Smith, A., … Paxton, G. (2018). `I think we've had a health screen': New offshore screening, new refugee health guidelines, new Syrian and Iraqi cohorts: Recommendations, reality, results and review. *J Paediatr Child Healthm 55(1): 95-103*. https://doi.org/10.1111/jpc.14142
- Kaufman, J., Fitzpatrick, P., **Tosif, S.**, Hopper, S. M., Bryant, P. A., Donath, S. M., & Babl, F. E. (2016). The QuickWee trial: Protocol for a randomised controlled trial of gentle suprapubic cutaneous stimulation to hasten non-invasive urine collection from infants. *BMJ Open*, *6*(8), e011357. https://doi.org/10.1136/bmjopen-2016-011357
- Kaufman, J., Fitzpatrick, P., **Tosif, S.**, Hopper, S. M., Donath, S. M., Bryant, P. A., & Babl, F. E. (2017). Faster clean catch urine collection (Quick-Wee method) from infants: Randomised controlled trial. *BMJ*, j1341. https://doi.org/10.1136/bmj.j1341
- Kaufman, J., **Tosif, S.**, Fitzpatrick, P., Hopper, S. M., Bryant, P. A., Donath, S. M., & Babl, F. E. (2016). Quick-Wee: A novel non-invasive urine collection method. *Emerg Med J*, *34*(1), 63–64. https://doi.org/10.1136/emermed-2016-206000
- Nguyen, T., Cranswick, N., Rosenbaum, J., Gelbart, B., & **Tosif, S.** (2018). Chronic use of teething gel causing salicylate toxicity. *J Paediatr Child Health, 54(5): 576-578*. https://doi.org/10.1111/jpc.13861
- **Tosif, S.**, & Duke, T. (2017). Evidence to Support oxygen guidelines for children with emergency signs in developing countries: A systematic review and physiological and mechanistic analysis. *J Trop Pediatr, 63(5): 402-413*. https://doi.org/10.1093/tropej/fmw100

  Tosif, S., Kaufman, J., Fitzpatrick, P., Hopper, S. M., Hoq, M., Donath, S., & Babl, F. E. (2017). Clean catch urine collection: Time taken and diagnostic

implication. A prospective observational study. *J Paediatr Child Health, 53(10):970-975*. https://doi.org/10.1111/jpc.13595

Presentations

- *A multifaceted intervention to improve newborn care in Solomon Islands,* August 2019. PhD Completion Seminar, Melbourne, Australia (presentation).
- *One million annual newborn deaths: Regional challenges and opportunities in the era of SDGs*, December 2018. Melbourne Children's Global Health Seminar, Melbourne Australia (presentation).
- *Training in neonatal health,* October 2018. Campus Education Week, Royal Children's Hospital Melbourne, Australia (presentation).
- *A multifaceted intervention to improve newborn care in Solomon Islands* February 2018. 3 Minute Thesis, Melbourne, Australia (presentation).
- *Newborn quality of care in Solomon Islands*, January 2017. PhD Confirmation Seminar, Melbourne, Australia (presentation).
- *Cause-specific neonatal morbidity and mortality in Solomon Islands*, May 2018, Paediatric Academic Society, Toronto, Canada (poster presentation).
- *Neonatal quality of care in Solomon Islands*, May 2017, Paediatric Academic Society, San Francisco, USA (poster presentation).
- *Newborn care in low-middle income countries*, November 2016, Global Health Week, Murdoch Children's Research Institute, Melbourne Australia. (presentation).

Acknowledgements

This PhD would not have been possible if not for the tremendous support and encouragement from my supervisors, fellow clinicians in Solomon Islands and my wonderful family.

I would like to thank my supervisors Professor Trevor Duke, Dr Amy Gray and Ms Katherine Gilbert. To Trevor, for this unique opportunity and for providing thoughtful mentoring and support throughout. For exemplifying the true meaning of collaboration, an approach characterised by respect and humility. To Amy, for her mentoring and support in the approach of this thesis. For relating to the challenges of mixed methods research and sharing invaluable reflections and insight from the lessons learned through her own experiences. To Katherine, for her important perspectives and understanding of health in Solomon Islands, for sharing expertise in qualitative research and bringing a broad understanding to this project and its context.

This PhD was made possible through the relationships that had developed over many years with paediatric and MHMS colleagues in Solomon Islands. Through Trevor, the Centre for International Child Health has provided registrars to work alongside paediatric colleagues in Solomon Islands for over 10 years. I was fortunate to have this opportunity in 2011. Had it not been for the longstanding friendships that had been built over time, this thesis would not have been possible.

In particular, I would like to thank the paediatricians and MHMS staff for their time and support for this project. They provided assistance amidst their many competing commitments. Dr Divinal Ogaoga (MHMS), who provided support throughout the project particularly at its inception and early stages, provided avenues for collaboration and lent his support to the multifaceted intervention. Ms Anna Jatobatu (MHMS) for her continuous effort in establishing EENC, her assistance with planning training and evaluation elements of the research. Ms Anna Maepio (Department of Obstetrics, NRHl) for assistance in the EENC training and evaluation components. Dr Nasi Titus, for his support and time, and assistance with coordination of the activities in this project. Paediatrician Dr Carol Titiulu, Dr Janella Solomon, Dr Steven Lumasa and Dr Bardley Ludarwane (NRH) who supported and assisted the evaluation of facilities.

Dr Howard Sobel (WHO) has worked tirelessly to establish the WHO EENC program, and its implementation through the region. Chloe Damon and Simon Burggraaf (WHO) provided assistance in the establishment and participation of the Newborn Stakeholders Committee. I thank Nahad Sadr-Azodi and the Solomon Islands (UNICEF) team for their support for the activities of this thesis.

The CICH family, especially Dr Rami Subhi and Dr Coen Butters, who supported training and skills evaluations while they were undertaking placements in Solomon Islands, My colleagues and friends, Hamish Graham, Dan Engelman, Caitlyn Robinson, Sanjeewani Pathirage (SJ), Jane Hawtin, Melinda Morpeth, Kate Milner, Andrew Steer, Fiona Russell and Steve Graham.

Most importantly, I would like to thank my family. My wife Jarnah, who provided support and encouragement, despite the challenges of frequent travel and many evenings spent doing this work. During the period of this thesis, we have grown as a family and now have two children, Kai and Layli, whose enthusiasm, determination and creativity brings so much joy to my heart. My parents, Mehrdad and Mojgan, gave me every opportunity in my education and provided me with a framework for viewing the world based on unity and solidarity with all people. My siblings, Shervin and Parissa, and their families for their interest and enthusiasm for this work.

Prior to the commencement of this PhD, I had the opportunity to work in Solomon Islands in the Special Care Nursery at NRH. I observed many newborn deaths which were a stark contrast with my home setting in Australia, 3 hours away. The complexity of challenges despite the perseverance of healthcare workers was evident. I dedicate my thesis to the continued efforts to improve outcomes for newborns in Solomon Islands and their families

Finally, at a time when fellow Baha'is in Iran continue to be deprived of higher education, I feel privileged to have had the opportunity to undertake this thesis.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AAP	American Academy of Pediatrics
ANC	Antenatal Care
CI	Confidence Interval
EENC	Early Essential Newborn Care
ENC	Essential Newborn Care
FGD	Focus Group Discussion
HBB	Helping Babies Breathe
IQR	Interquartile Range
MDG	Millennium Development Goal
MHMS	Ministry of Health and Medical Services
NRH	National Referral Hospital
SBD	Solomon Islands Dollar
SCN	Special Care Nursery
SDG	Sustainable Developmental Goals
SIDS	Small Island Developing States
SSI	Semi-structured Interview
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
VLBW	Very Low Birth Weight
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

An estimated 4 million newborns die in the first month of life, three-quarters within the first week and nearly half during the first 24 hours [1, 2]. Estimates show that 99 % of neonatal deaths and 98 % of stillbirths occur in low- and middle-income countries [1, 3]. The Millennium Development Goals (MDGs) comprised eight core goals to improve social and health priorities worldwide for the 15 years from 2000 to 2015. The Sustainable Development Goals (SDGs) were adopted in 2015, consisting of 17 goals to improve health to 2030. SDG 3.2 targets a reduction of neonatal mortality in all countries to at least as low as 12 per 1000 live births.

The global rates of death and morbidity for newborns reduced slower in the period of the MDGs, than for older children. Neonatal deaths accounted for 46% of all under-5 deaths in 2016, compared with 41% in 2000 [4]. Deaths in the first 28 days of life constitute 44% of mortality in under-5 children, an increase from 36% in 1990 [5]. More countries are projected to be at risk of missing the neonatal SDG target than the under-5 mortality target [6].

No single intervention is available to address the problem of neonatal deaths and morbidity. The most common causes of neonatal mortality vary in aetiology, risk factors and management: birth asphyxia, infection and complications of prematurity [1]. Neonatal health is a reflection of maternal health and complications of the intrapartum period. More than 190 separate interventions are identified to improve health along the continuum of maternal, newborn and child health [7].

It is estimated that out of all births, 3–6% of babies require basic resuscitation with a bag and mask device to prevent death [8]. These statistics led to a focus on neonatal resuscitation in facility and community-based settings, which could reduce intrapartum-related deaths by up to 30% [9]. Essential newborn care (ENC) consists of important steps for the mother and baby in the first few moments of life to prevent complications [10]. ENC steps include breastfeeding, skin-to-skin contact, thermal considerations and reduction of harmful interventions that may cause sepsis and hypothermia.

As efforts shift from achieving the MDGs to achieving the SDGs, there is increased recognition of the need to ensure quality of care to improve gaps in outcomes for newborns in low- and middle-income countries. Although the proportions of facility-based births and births overseen by healthcare workers have increased, disparities in providing effective interventions have limited potential gains [11]. Hence the role of quality improvement has become paramount in efforts to improve newborn outcomes.

Newborn health is a priority area for the Western Pacific. The Action Plan for Healthy Newborn Infants in The Western Pacific Region highlights healthcare steps that can be provided for newborns in the first days of life [12]. Studies assessing the quality of newborn care in Solomon Islands and other countries illustrate the link between assessments, implementation of guidelines, improved health policy and quality improvement activities [13-15].

1.2 Aims

This thesis aimed to describe the quality of newborn care in Solomon Islands, to understand the impact from a multifaceted intervention for ENC and to examine the implementation factors that are barriers or enablers of the intervention in that setting. Table 1.1 outlines the individual research questions and the related studies that comprise this thesis.

Table 1.1: Research Questions and Associated Study

No.	Question	Study
1	What is the state of hospital quality of care for newborns in Solomon Islands?	Chapter 5: **Assessment of the Quality of Neonatal Care in the Solomon Islands: A Cross-Sectional Study**
2	What are the causes of neonatal morbidity and mortality in Solomon Islands?	Chapter 6: **Cause-specific Neonatal Morbidity and Mortality in the Solomon Islands: An Assessment of Data from Five Hospitals over a Three-year Period**
3	What is the impact of the Early Essential Newborn Care coaching program, on healthcare worker knowledge and skills in Solomon Islands?	Chapter 7: **Healthcare Worker Knowledge and Skills Following Coaching in WHO Early Essential Newborn Care program in the Solomon Islands: A Prospective Multi-site Cohort Study**
4	What is the implementation experience from a multifaceted	Chapter 8: **Implementation Lessons from a Multifaceted National Newborn Program in Solomon Islands**

intervention to improve newborn care in Solomon Islands?

1.3 Chapter Overview

Chapters 2 and Chapter 3: provide the background literature that underpins the approach taken for this thesis. Chapter 2 summarises relevant frameworks and definitions for neonatal quality of care, providing a rationale for the guiding frameworks used in the studies that comprise this thesis. The literature identified through a review of studies examining the role of quality improvement in improving newborn quality of care is described, and the main themes of relevance to implementation of multifaceted interventions are synthesised. Chapter 3 describes the health demographics of Solomon Islands, the facilities available for childbirth and the recent social and environmental challenges that the country faced. The description provides the contextual circumstances relevant for newborn care implementation.

Chapter 4 describes in detail the methods used in the thesis. The pragmatic research approach used is described, as well as the strengths and limitations of the mixed methods approach. For each individual study, the background, objectives, procedures and rationale are described.

Chapters 5–8 are the results chapters. The results are presented as publications in the form in which these were submitted. Chapter 5 addresses the question of the quality of newborn care in Solomon Islands provincial hospitals and National Referral Hospital (NRH). Chapter 6 addresses the question of the main causes of perinatal morbidity and mortality. Chapter 7 describes the impact from the ENC training program on healthcare worker knowledge and skills. Chapter 8 describes the implementation experience of the multifaceted intervention and strengths and barriers to successful implementation.

The final chapter synthesises the results, discusses the novel findings of the research in relation to existing studies and provides considerations for future research in relevant settings.

Chapter 2: Literature Review

2.1 Introduction

Improving newborn quality of care is a critical requirement for advancing outcomes in low- and middle-income countries, which have the greatest gaps in coverage, equity and quality [16-19]. Attempts to improve newborn care may be regarded as a 'complex' intervention owing to the many interacting components along the continuum of care for maternal and newborn health that play a role [20]: For instance, women may need services for pre-conception planning, counselling and treatment of infections. Pregnant women need comprehensive antenatal care that includes support, monitoring and treatment throughout the peripartum period by skilled birth attendants. Newborns require Essential Newborn Care at the time of birth and tailored care in the first months of life depending on health needs. Mothers require postpartum care and support for monitoring of newborn health into infancy and childhood. All of these steps are interrelated, occurring within unique contexts in which healthcare service delivery occurs, and all may be affected by quality of care, which has ramifications that extend well beyond the perinatal period.

Effective, inexpensive evidence-based interventions already exist to improve perinatal outcomes [7, 21]. These interventions for the most part do not require sophisticated equipment, but primarily focus on healthcare worker behaviour [22]. The application of these interventions is most critical around the time of birth when risk of morbidity and mortality is highest than at any other time in the life of the mother or newborn [23]. Better newborn outcomes lead to improved survival through avoidance of complications and the longer-term impact from poor neurodevelopmental outcomes. Estimates suggest that closing the 'quality gap' in maternal and newborn care could lead to averting up to 113,000 maternal deaths and between 531,000 and 1,325,000 neonatal deaths annually [24].

Despite increasing access to, and use of, healthcare services for maternal and newborn health, effective interventions may not be provided at these facilities by healthcare workers, which adversely affects outcomes. In the period of the MDGs, important gains were achieved in health-centre-focused intrapartum care [25-28]. These gains were associated with a focus on strategies to ensure a skilled birth attendant was present during childbirth. As a result, there was an increase in use of facilities for births, and rates of skilled birth attendants at birth were estimated to reach 80% in 2017 [29]. Skilled birth

attendants have a vital role in preventing maternal and perinatal mortality [30]. However, the availability of skilled birth attendants, facility-based births and resources have not translated into the degree of desired outcomes [23, 31, 32]. Access to facilities, skilled birth attendants and resources are crucial, but their presence alone is insufficient to improve quality of care [33-35].

The following sections summarise provide a literature review of ENC and related frameworks. Themes arising in studies improving quality of ENC where a quality improvement program was implemented are presented (see Appendix E for search criteria and methods).

2.2 Newborn Quality of Care

Defining quality of care is important as a means with which to assess, and compare, the impact of initiatives [31]. However, defining newborn quality of care is a challenge. Numerous definitions of quality have been proposed, which reflect the diverse contexts and viewpoints of the segments of the healthcare system from which quality of care may be considered [36]. The World Health Organization (WHO) provides a broad definition, outlining expectations from health services in providing quality care [32]:

> the degree to which maternal and newborn health services (for individuals and populations) increase the likelihood of timely, appropriate care for the purpose of achieving desired outcomes that are both consistent with current professional knowledge and take into account the preferences and aspirations of individual women and their families.

Frameworks for quality of care help healthcare providers and policymakers prepare for the multiple aspects of newborn quality of care interventions. The widely referenced Donabedian model [37] describes three components: The first, ‘Structure’, refers to the context in which care takes place, such as the adequacy of facilities and equipment, as well as political, legal, professional and organisational components. The second, ‘Process’, refers to whether medical care that is considered ‘good’ has been provided, such as performance of therapeutic procedures and provision of continuity of care. The third, ‘Outcomes’, is the impact of care on health, specifically, ‘recovery of function and survival’ [37]. Further, Donabedian asserts that the three components are interdependent, however ‘outcomes’, are commonly used for assessing quality of care because these are often specific and tangible [37].

More recent frameworks, of specific relevance to newborn quality of care, have further evolved the Donabedian model. The concept of 'outcomes' has been extended by adding themes of positive user experience, increased demand and timely utilisation of health services [31]. Building on the Donabedian framework, the WHO quality of care framework [23] integrates both the 'provision' and 'experience' into the 'process' of care. This framework consists of eight domains for quality of care and incorporates the various dimensions of care from the perspectives of users, service providers and managers (see Figure 2.1: WHO Quality of Care Framework).

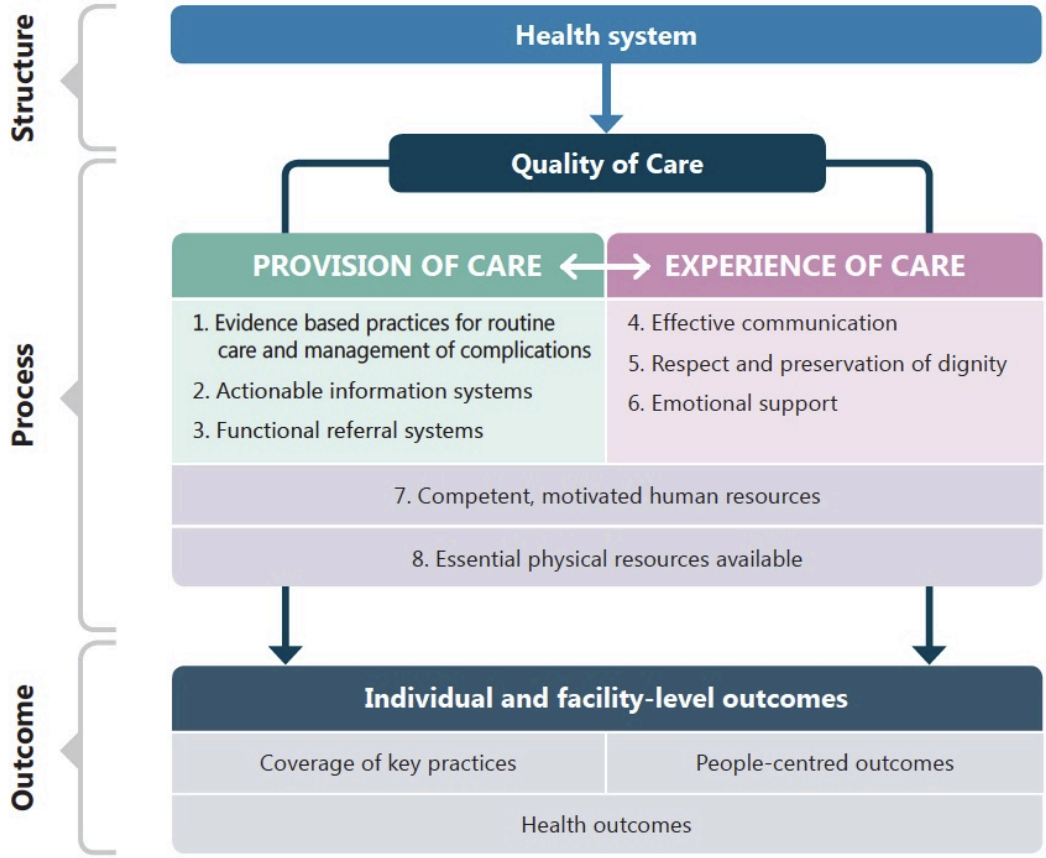


Figure 2.1: WHO Quality of Care Framework

Austin et al. [31] adapt the Donabedian model for maternal and newborn health by providing a conceptual framework accounting for various levels of facilities (community, district and facility levels). This framework is particularly helpful in understanding the drivers of quality in facility-based care [31]. The framework highlights the relationship between levels of healthcare facility and disaggregates the structure, process and outcome elements of the Donabedian framework according to the type of health facility. This framework is particularly relevant for countries that have isolated or disparate health

facilities. Figure 2.2 shows the adapted version of the quality of care framework for newborn care (see Figure 2.2: Adapted Quality of Care Framework by Austin et al.).

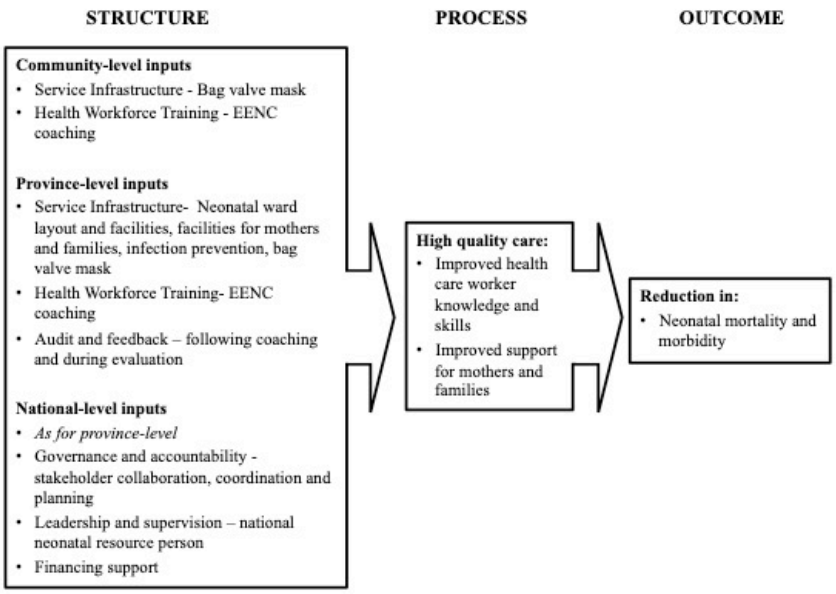


Figure 2.2: Adapted Quality of Care Framework by Austin et al. [31]

A range of assessment tools and methods for quality improvement endeavours may be used. Among these diverse approaches, standardised measurement of impact on quality is a core aspect of improvement efforts [38]. Quality standards provide an expectation of what components should be provided to achieve high-quality care around the time of childbirth [39]. Quality measures provide a benchmark of comparison, which would be helpful within facilities as a specific objective as well as for comparison between health facilities. Global plans, such as the Every Newborn Action Plan [40], and other programs describe desired measures [38]. However, monitoring outcomes outside research or programmatic activities can be challenging when routine data collection and health information systems are unavailable or inadequate.

In a comprehensive guide of maternal and newborn quality standards, the WHO proposes detailed standards of care [39]. These standards are mapped to structure, process and outcome measures for adaptation to interventions. Although the standards align closely with the WHO quality of care framework, some factors mapped to structure in the quality standards are designated as process indicators in the WHO framework. Examples of those

standards specifically relevant for ENC are shown in Figure 2.3: Adapted Quality Standards from WHO Framework for Quality of Maternal and Newborn Health Care [39].

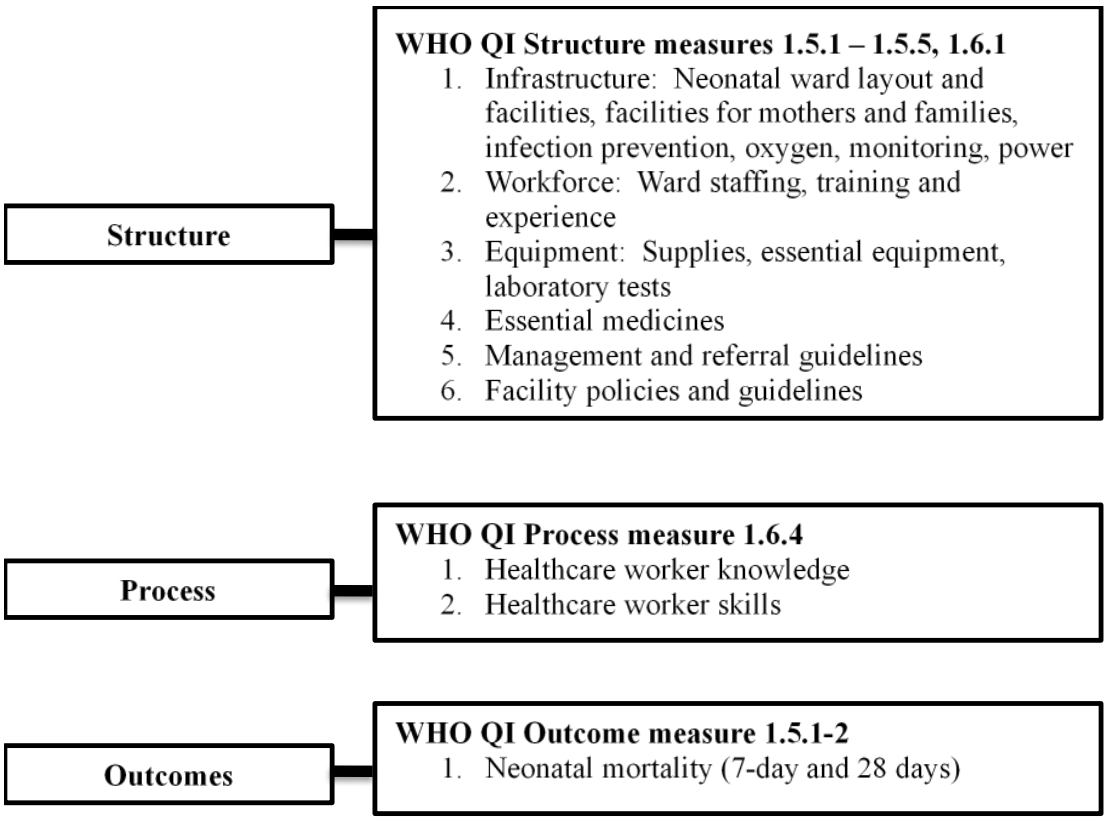


Figure 2.3: Adapted Quality Standards from WHO Framework for Quality of Maternal and Newborn Health Care [39]

2.3 Essential Newborn Care

ENC addresses the potentially reversible factors that cause morbidity and mortality in the newborn period. Care in the first minutes and hours of life are critical. In these first moments, potentially lifesaving interventions for the newborn can be applied, measures can be taken to prevent complications, such as infection, and potentially harmful practices can be avoided [41, 42]. In this period, most newborn deaths occur owing to complications of prematurity and low birthweight, birth asphyxia and infection [43]. In addition to ENC, training programs focused on this period are often referred to as Early Essential Newborn Care (EENC), Basic Newborn Care or Essential Childbirth Care, depending on the program.

ENC typically comprises the following key elements [44-47]:

1. Basic preventative care

- clean birth process
- provision of warmth: adequate ambient temperature, immediate drying, immediate and prolonged skin-to-skin contact, warming, wrapping and delayed bathing
- support for early initiation and exclusive breastfeeding
- delayed cord clamping (for at least 1 minute).

2. Early detection of problems/danger signs

    - immediate assessment of breathing while drying.

3. Treatment of problems/basic newborn resuscitation

    - stimulation by drying or rubbing back
    - ensuring clear patent airway
    - providing positive-pressure ventilation with bag-and-mask equipment of appropriate size.

These measures are simple and non-invasive, but are often not provided to mothers and newborns in the perinatal period despite evidence of benefit [42]. A hygienic birth process can be achieved through handwashing, sterile equipment use and clean delivery process, which is linked with prevention of intrapartum acquired infection [48, 49]. Skin-to-skin contact immediately after birth, such as through Kangaroo Mother Care, improves breastfeeding rates and bonding between mother and infant and reduces chance of hypothermia [50, 51]. Among its many benefits, early breastfeeding is associated with lower neonatal mortality and morbidity in low- and middle-income countries [52]. Delaying cord clamping is beneficial for preventing anaemia and low iron levels in infancy [53].

ENC interventions impact the quality of care and neonatal outcomes [54-56]. More commonly, ENC is bundled with other interventions as part of packaged interventions. Examples include a study in Philippines, which described the positive impact from initiatives to improve quality of ENC, including practice-based training, formation of working groups, regular assessments and hospital meetings [54]. ENC implementation, with staff coaching, quality improvement assessments and changes to hospital environments, were associated with fewer NICU admissions and increased breastfeeding rates in Vietnam [56]. In Sri Lanka, an ENC training program found improvement in key

practices, such as umbilical cord care, breastfeeding rates and clinical outcomes [55]. Together, these examples show the impact from focussing on key practices around the time of birth.

2.4 Implementation Approaches to Improving Quality of ENC

Although ENC provision relies on some basic equipment, the greatest gains from interventions lie with changing healthcare worker behaviour. However, enabling and sustaining behaviour change in newborn care is a challenge. Systematic reviews [10, 57-59] of newborn care training programs describe knowledge and skills fall-off of health workers over time [9, 60]. Therefore, implementation of a program to improve ENC needs to consider a broad range of training methods, quality improvement approaches and contextual factors to be effective.

2.4.1 Training methods to improve ENC

Helping Babies Breathe (HBB), a course developed by the Global Implementation Task Force of the American Academy of Pediatrics [61], is widely used in low and middle-income countries [62, 63]. The training is conducted over two days and focuses on the 'Golden Minute', the first minutes of a neonate's life. It involves use of simulation scenarios related to 'routine care' and 'neonatal resuscitation'; the course structure is designed to reflect contemporary educational theory, with active learning, skill practice, case scenarios and structure assessment of knowledge, skills and performance [62]. It is adaptable to cultural and linguistic differences [63]. Trained providers are expected to subsequently train others in 'on-the-job' and in refresher trainings, with other healthcare workers in the same facility in a cascade approach [64].

The program has had increased attention towards quality improvement, mentoring, supportive supervision and data-based monitoring in recent years [65]. An example of this is the Uganda HBB 'plus' program, which saw the Ministry of Health place extra emphasis on quality improvement through mentorship and a focus on high-quality newborn services at all levels. Without quality improvement components, follow-up assessments demonstrate improved simulated performance that does not translate into clinical management, and significant skills fall-off with time [66]. A report of the rollout of HBB in Bangladesh and Malawi found that external support was required to establish regular skills practice in the workplace [67]. The program evolved to introduce 3-monthly HBB refresher trainings, which were designed to review and practice the HBB curriculum

[64]. Supervision was recognised to have an important role in strengthening the program; yet, relying on government public health supervision alone has been insufficient, as shown in other studies [67]. Some programs have shifted focus towards strengthening systems and integrating quality improvement processes, such as mentoring, improved data analysis and utilising a 'low-dose, high-frequency' approach to refresher training by which a few minutes are spent at regular weekly or monthly intervals to practice skills [68].

HBB and its implementation have been widely studied [65]. In Tanzania, Msemo et al. [64] conducted a before-and-after study to assess the reduction of early neonatal deaths and rates of fresh stillbirths following implementation of HBB at eight hospitals. The program was implemented in association with 'on-the-job' training and regular refreshers in the form of a simulator placed where the desired skills were expected to be used. Each provider was required to document the application of basic skills using the simulator at the beginning of every shift. The implementation was associated with improved stimulation of the newborn (relative risk [RR] with training 1.87; 95% confidence interval [CI] 1.82–1.90; P </= .0001), a significant reduction in neonatal deaths (RR 0.53; 95% CI 0.43–0.65; P </= .0001) and lower rates of neonates needing ventilation (RR with training 0.76; 95% CI 0.64–0.90; P = .001) [64]. However, a subsequent study in Tanzania that evaluated the longer-term impact on quality of care found that although ENC improvements (e.g. breastfeeding rates) were maintained from the original intervention, provider skills, assessed by using structured clinical scenarios, declined between baseline and endline assessments [69].

The WHO EENC program was developed by the Western Pacific Region Office of WHO in 2014 in response to regional efforts to improve newborn outcomes and followed a previous training program for perinatal care by WHO [12, 70]. The program focuses on the 'First Embrace', a sequence of steps for ENC [71]. The training is delivered over two days, with an onsite 'coaching' methodology [46]. This approach aims to establish health-worker practice through role-play, re-enactment and open questioning to appreciate reasons behind each step of the desired practice. Coaching is intentionally free flowing, interactive and participatory without didactic methods. WHO EENC facilitators complete the two-day course and receive an additional half-day orientation. The implementation follows a 'train the trainer' approach, whereby participants continue training others in their respective province after attending centralised trainings. The program supports the autonomy of local health workers in delivering the training without external support.

Many other programs have utilise nationally developed training materials or adaptations of HBB and the WHO Essential Newborn Care course [72-77]. Yet, few studies compare impact from different newborn curriculums. A study in the Democratic Republic of Congo on the effect of training using the WHO Essential Newborn Care Program and HBB found no immediate impact on perinatal mortality. It was only after a period of utilisation and re-enforcement of training in the year following ENC training that a decline in neonatal mortality occurred (RR 0.73; 95% CI: 0.56–0.96) [78]. A study comparing a self-directed learning approach with a conventional 5-day training course for improving EENC in Brazil found no significant difference between the two strategies, although the self-directed approach was cheaper. Neither approach caused the desired impact on quality of care, and the study highlighted the need for complementary approaches to training [79].

2.4.1.1 Training refreshers

A recurrent theme in sustaining change in quality care is the need for active monitoring and support for establishing competency, and ongoing training or refreshers through low-dose, high-frequency practice [10, 59, 80]. A study in Ghana demonstrated significant improvement in knowledge assessment results before and after three sequential neonatal quality improvement sessions over a 12-month period; higher pre- and post-training test scores were achieved on the second and third quality improvement sessions. Repeat participants scored consistently higher than first-time participants on pre- and post-tests (85.8% vs. 73.4%, $P < 0.001$) and on post-training tests (93.9% vs. 88.9%, $P < 0.001$) [76]. Mduma et al. performed an intervention following standard HBB training that had not improved clinical management of neonates [81]. They used frequent, brief onsite training over a 12-month period and found a significant reduction in neonatal mortality following this form of ongoing training—mortality on the first day of life reduced from 11.1/1,000 to 7.2/1,000 ($p = 0.040$). They suggested this method had impact through improved competency as well as improved healthcare worker confidence. These approaches are supported by the educational theory behind 'spaced learning', by which learning outcomes improve when teaching is spaced apart in time rather than on the same day [82].

Training without a form of ongoing support and practice of skills should not be promoted [10]. A review of high-income countries found that skills generally decrease from three months after resuscitation training, which may be prevented by skills and refresher

trainings conducted at least every six months [83]. International resuscitation guidelines recommend neonatal resuscitation training should be held at least once every year [2]. In a related review, Gülmezoglu and Lawrie [84] reviewed progress on MDGs 4 and 5; they identified that regular refresher sessions are required to ensure skill retention of healthcare practitioners and proposed that healthcare workers should be assessed regularly for competency and within 3–6 months of training. However, there may be recognition of the need for maintaining skills through these avenues, but the driving force to ensure this regular action is carried out is often a barrier. Establishment of training coordinators, who plan and lead refresher sessions, is one strategy to overcome inaction at the facility level [85].

2.4.1.2 Training pedagogy and approach

Despite increased recognition of adult learning methods and the challenge of changing healthcare provider behaviour, few studies have described the impact from training methodology and the theory of educational approaches employed (e.g. pedagogical theory, practical versus written aspects, use of simulation, settings) on participant reaction and satisfaction. Table 2.1 presents studies that described outcomes of healthcare workers in low- and middle-income countries, who received a training program, addressing an aspect of newborn care in the first 24 hours of life, in facilities where a quality improvement program was implemented. Teaching methods and evaluation process are summarised to provide a background to the breadth of approaches.

The employment of a variety of educational approaches that pay greater attention towards the method of training delivery, in addition to content, has been highlighted [80]. Giving participants an opportunity to practice resuscitation as individuals, pairs or in small groups rather than didactic methods allows *application* of knowledge [86 -89]. Practical training delivery methods also provide opportunities for peer-to-peer learning and reinforcement. Feedback on demonstrated skills in a training environment can be an important component of a learning experience; however, studies cite the need for feedback comments to be balanced and not excessively critical [90]. Direct clinical supervision received mixed responses in a qualitative summary of experiences from one training intervention, with some health workers feeling that the team would come to scrutinise mistakes, and engagement was dependent on the health worker's general interest in change [90]. Building an environment of trust and collaboration, which has participant ownership in the learning process, is associated with improved quality of

learning interactions [75]. Training is also dependent on adequate ratios to ensure sufficient mentoring [86], and smaller group sizes are a positive feature [88, 89].

2.4.2 Complementary quality improvement approaches

While training forms the core component in improving quality of ENC, associated activities that form the quality improvement approach that focus on healthcare workers and health systems have an important role. Raven et al. [91] summarises approaches and methodology for quality improvement of maternal and newborn health in developing countries, in a descriptive review of 34 papers and reports. Approaches for quality improvement include the need to establish a 'culture of quality' for greater awareness of, and commitment to improving, quality and to promote a respectful attitude towards staff and patients. Cited examples from Honduras [92] and Morocco [93] demonstrate greater ownership following involvement of all cadres of health staff, including management, to engage those involved at the systems and operational process level [31]. Engaging in high-level activity in building a quality improvement culture, in addition to the health worker, is highlighted in another review [94]. Other approaches include the use of quality improvement champions or leaders, and the need for establishing quality improvement teams [31]. In addition, audits are beneficial and change practice when combined with feedback mechanisms [95].

Ongoing learning can be supported through mentorships visits, consisting of direct observation of patient care, coaching and feedback sessions [76, 77, 88]. Frequent support from trained staff in quality improvement methods and regular visits from external coaches were described as an essential factor for reduction in neonatal case-fatality rates in a trial in Malawi [96]. In other studies, complementary activities include daily practice, equipment checks and audits [86].

Table 2.1: Essential Newborn Care Training Program and Evaluation Characteristics

Author, Year	Training Period	Intervention: Training Program	Description of Learning Methods	Evaluation Method	Evaluation Timing
Matendo, 2011 [78]	3 days	WHO ENC in active baseline study, followed by HBB in cluster randomised trial	Clinical practice sessions, demonstrations	Perinatal mortality data	3-monthly time periods up to a year post training
Colbourn, 2013 [96]	Not specified	Resuscitation drills for asphyxia	Practical neonatal resuscitation drills	Monthly community surveillance of all pregnant women and their infants until 2 months after delivery, verbal autopsy, facility-based case-fatality rates	15-month baseline vs. 15-month intervention period
Ashish, 2016 [97]	2 days	HBB	Practical simulation, written flipchart	Assessment of video recordings of deliveries	Ongoing until 2 months post-refresher training
Pasha, 2013 [98]	3–5 days	Emergency Obstetric and Newborn Care (EmONC) and Johns Hopkins Program for International Education in Gynecology and	Not specified	Perinatal mortality	12 months post intervention

		Obstetrics (JHPEIGO) emergency obstetric and newborn care curriculum			
Jayanna, 2016 [77],	5 days	Customised: bedside coaching, case demonstrations, use of case vignettes and job aids	Not specified	Case-sheet audits, provider knowledge through standardised interviews, provider practice through audit of patient case sheets	End of intervention period
Spector, 2012 [74]	1 day	WHO Safe Childbirth Checklist program	Written materials, lectures, instructional video, hands-on simulation	Direct observation of births scored with checklist	Pre vs. post-intervention period
Bang, 2016 [86]	3 days	HBB	Practical: small group demonstration and simulation (6 participants: 1 trainer) Other: Flipchart, written workbook	Testing before and after training, and before refresher, with standard HBB tools to test resuscitation knowledge and skills	Mean of 6.7 (SD 2.49) months after the initial training
Bellad, 2016 [89]	Not specified	HBB	HBB training materials and equipment: learner workbook, facilitator flip chart, a neonatal simulator, written action plan	Registry of birth outcomes >/= 1500 g pre-post HBB training	Perinatal mortality rates 12 months pre- and post-intervention period

Brantuo, 2014 [76]	2 days	Modified AAP, WHO Kangaroo Mother Care Program, customised guidelines	Didactic teaching combined with interactive sessions: hands-on skills practice	Written assessments	Immediately before and following refresher, during 12-month period
Hirschhorn, 2015 [72]	3 days	WHO Safe Childbirth Checklist training, BetterBirth package	Coaching in World Health Organization Safe Childbirth Checklist	Observed birth practice	Pre-intervention prior to coaching intervention, Post-intervention 4 to 12 weeks after
Iyengar, 2014 [88]	Senior doctors, district managers: 1-day Senior nurse-midwives: 21 days Nurse-midwives: 5 days	Customised training	Training with guidebook as reference	Checklist of delivery observations and facility-based assessments	2–3 months for an average of 15 months (range: 6–20 months)
Sibley, 2014 [75]	7 days	Adapted American College of Nurse-Midwives' Home Based Life Saving Skills Program	Not available	Written and clinical skills assessment	24-months post-baseline assessments
Werdenberg, 2018 [99]	2 days every 3 to 5 months	HBB, advanced neonatal care	Not available	Healthcare worker attitudes, QI practices	3 months prior to QI start, monthly during 18-month implementation
Woods, 2015 [73]	1 day	Customised: Clinical skills practice model	Practical (case scenarios, simulation)	Scenario-based assessment	7–11 months post training

Some programs adapted their approach during their implementation of educational programs after recognising shortfalls in training methods. The utilisation of a WHO Safe Childbirth Checklist in addition to training played a major role in changing a range of practices associated with childbirth in a study undertaken in Karnataka, India, [74]. Poor improvement in essential birth practices occurred following coaching in use of a checklist in Uttar Pradesh, India. [72]. An adaptive study design led to increased duration and frequency of coaching education for staff in successive phases of the study, which had greater impact.

2.4.3 Multifaceted interventions

Implementation of newborn training programs often occurs as part of a packaged program. In one example of this approach in Malawi, Colbourn et al. performed a cluster randomised controlled effectiveness trial with a combined facility improvement and women's group community intervention [96]. The intervention facets were based on the three delays model [100]. This model was used as a framework to address barriers on the 'supply side' (health system) and 'demand side' (community and individual) in a 'change package' [96]. The quality improvement component involved coaching of facility staff in quality improvement methodologies, and the use of 'Plan–Do–Study–Act' cycles at health centres and hospitals. A quality improvement team was assembled within each facility and consisted of various provider roles, including clerical, medical and nursing staff. The main causes of morbidity in that setting were prematurity, asphyxia and sepsis, which were targeted by a neonatal package involving Kangaroo Mother Care, a resuscitation drill and sepsis prevention and treatment protocols. The neonatal mortality rate was 22% lower (OR = 0.78, 95% CI: 0.60–1.01) in the quality improvement and community intervention clusters, and perinatal mortality was 16% lower (OR = 0.84, 95% CI 0.72–0.97) in the community intervention clusters. No significant impact on maternal mortality was identified. The authors suggest that the women's groups had a greater impact on perinatal and early neonatal mortality than facility improvement, through impact on community mobilisation.

Sousa and Mielke [80] performed a qualitative systematic review, addressing themes important for the setting in which training of birth attendants take place, specifically community, institutional and combined community and institutional. They identified basic neonatal resuscitation to be more effective when offered as one part of a larger ENC program and that the majority of successful interventions focused on births outside of the

institutional setting. They also highlighted the importance of using a variety of educational approaches concurrently to enable learning and the need to promote regular and continued training.

Although a multifaceted intervention approach attempts to take into account diverse avenues to provide quality care, justification from rigorous research is limited. Haws et al. [101] reviewed 41 studies reporting neonatal health outcomes (including 19 RCTs) that implemented packages of interventions. Packages of interventions were defined as having more than one component of an intervention, across the antenatal, perinatal and/or postnatal periods. However, the analysis of the evidence base was weak and most interventions were bundled out of convenience or funding requirements. Studies addressing care across the continuum were absent, and very few RCTs examined the impact of intervention on neonatal health outcomes.

Multifaceted strategies face risk if not all components are adequately supported. Pasha et al. [98] conducted a large cluster randomised study with intervention across both community- and facility-based activities that had a quality improvement focus. The study did not result in detectable impact on perinatal mortality [98]. The authors proposed that the intervention focused too heavily on its community-based components, and the lack of a well-functioning hospital system with trained and motivated staff affected the results. They identified that deficiencies in structural aspects of the health systems (supplies and infrastructure) were too great for the interventions planned, and efforts by ministries and other health agencies in this regard were insufficient [98].

2.4.4 Implementation approaches

In planning and delivering an intervention to improve ENC, implementation strategies are needed that address the specific determinants of clinical practice and contextual barriers. A summary of the quality improvement interventions identified to improve ENC is presented in Table 2.2. Contextualisation of the intervention is recognised as a defining feature of implementation research in global health [9, 91, 102]. Too often, interventions are delivered without being tailored to the context in which they are targeted. In addition to recognising the health system context, recognition of cultural, language and historical factors is needed. Developing contextualised strategies for scaling up interventions, rather than uniform strategies are needed [103]. ENC implementation may need to be tailored to meet the specific needs of parents in health-seeking behaviour, hospital-based care for critical newborn care and obstetric care for maternal complications.

Descriptions of implementation approaches in ENC include a range of individuals and organisations, at various time points throughout the intervention period. Pre intervention, the involvement of non-clinical staff in a ENC quality improvement intervention in India had a positive impact, through the endorsement by persons of authority, such as hospital leadership staff [39]. Broad engagement of multidisciplinary participants in the quality improvement team [74, 97, 98], such as council members, agricultural leaders and clergy [75, 98], were described as positive features. Sites where hospital management took an active role and where there was strong local leadership resulted in much greater success in an intervention to improve paediatric and newborn care [90].

Entities beyond the immediate implementation team are also important. Engagement by higher levels in the health system, such as of Ministries of Health and regional health institutions, can provide political leadership and support [75]. Sites where hospital management took an active role and where there was local facility leadership and support of the implementing team resulted in much greater success in an intervention to improve paediatric and newborn care Kenya[90].

2.4.5 Healthcare worker attitudes

Among the contextual aspects to be considered in an intervention are the attitudes of the healthcare workers themselves. As the main target of quality improvement activities, interventions to influence behaviour change must address the needs and attitudes of those directly involved in ENC for the implementation to be effective in each unique context. A qualitative study of the implementation of nurse mentors and the barriers and facilitators to obstetric and emergency neonatal care highlighted interdependent contextual factors impacting clinical care [104]. These included problems with human resources, nurse–nurse hierarchy, physical resource shortages and corruption. Enabling factors of the intervention included improved skills and confidence, the inclusion of doctors in training and strong mentor–mentee relationships.

A qualitative study of the factors affecting effective ventilation during resuscitation among midwives in rural Tanzania found intrapartum monitoring, preparation of equipment, teamwork and frequent practice as having a positive impact, and stress of ventilating a non-breathing baby as leading to poor performance as well as difficulties in the assessment of the babies condition [105]. Lack of knowledge and skills, organisational constraints, such as lack of equipment, and poor-communication among team members were identified in a qualitative assessment of experiences of midwives from Jordan [106].

A recurring theme in qualitative explorations of healthcare worker attitudes to ENC is limitations of equipment and resources and impact on quality care. Organisational aspects, such as ward layout and access to resuscitation equipment, have flow-on effects, including delays in reaching positive-pressure devices [106, 107]. ENC requires minimal equipment and resources, but these structural factors affect the process of delivering care.

2.5 Conclusion

The perinatal period is a critical time for the survival of the newborn, and ENC practices can have a significant impact on reducing neonatal morbidity and mortality. Successful ENC implementation relies most on a sustained change in healthcare worker practice, in addition to structural factors. Previous studies highlight the importance of practical training methods and a specific need for regular refreshers. ENC implementation benefits from complementary quality improvement activities delivered through well-supported multifaceted interventions. Engaging broad stakeholder groups as well as the targeted healthcare workers plays an important role in sustaining momentum in implementing and achieving broader health system changes. The literature describing ENC is diverse, reflective of the various contexts in which it is applied.

However, the published literature describing ENC and its implementation has some gaps. Contextualisation of ENC implementation for Small Island Developing States (SIDS), such as Solomon Islands is needed. Comparison of training methods and resources to demonstrate impact on health care behaviour change are necessary to inform programs in ENC. The themes identified in this chapter provide lessons for the approach for this thesis and highlight areas requiring future research. The following chapter describes the Solomon Islands experience related to newborn care and the contextual factors relevant to this implementation.

Table 2.2: Interventions to Improve Essential Newborn Care Through Quality Improvement Strategies

Author, Year	Title	Location	Study Design	Intervention: Training Program	Intervention: Quality Improvement, Specific Details	Primary Outcomes	Training Participant	Number of Participants	Results
Matendo et al., 2011 [78]	Reduced perinatal mortality following enhanced training of birth attendants in the Democratic Republic of Congo: a time-dependent effect	Congo	Active baseline before/after, then cluster randomised trial	WHO ENC in active baseline study, followed by cluster randomised trial of the Neonatal Resuscitation Program (NRP)	• Intervention (NRP) arm: repeated observations with standardised responses • Refresher course at six months • Reinforcement of training, review and gaps discussed at monthly meetings	Perinatal mortality	Birth attendants	Pre-ENC period = 1,867 births, following ENC training but before NRP training, a period of about 13 months, there were 5,528 births	Perinatal mortality decreased (RR 0.73; 95% CI: 0.56–0.96)
Colbourn et al., 2013 [109]	Effects of quality improvement in health facilities and community mobilisation through women's groups on	Malawi	Cluster randomised controlled effectiveness trial	Resuscitation drills for asphyxia (customised for intervention)	• Plan–Do–Study–Act cycles • 'Implementing change' packages • Conducting death reviews	Maternal, perinatal and neonatal mortality	All health workers	14,576 and 20,576 newborns were recruited during the baseline and intervention	Neonatal mortality rate decreased (OR 0.78, 95% CI 0.60–1.01), perinatal mortality rate decreased

	maternal, neonatal and perinatal mortality in three districts of Malawi: MaiKhanda, a cluster randomized controlled effectiveness trial				• Additional training for local improvement leaders • Neonatal resuscitation drills • Use of protocols				(OR 0.84, 95% CI 0.72–0.97); no intervention effects on maternal mortality
Ashish et al., 2016 [97]	Reducing perinatal mortality in Nepal using Helping Babies Breathe	Nepal	Cohort design, including a nested case-control study, before and after implementation of QIC	HBB	• Weekly review • Reflection meetings • Daily bag-and-mask skill checks • Self-evaluations • Peer review of the HBB protocol adherence • Daily debrief • Refresher training	Stillbirth rate, first-day mortality	Staff at delivery units	9,588 and 15,520 deliveries took place at the hospital in the baseline and intervention periods	Intrapartum stillbirth rate decreased (9.0/1000 to 3.2/1000), first-day mortality (5.2/1000 to 1.9/1000), inappropriate use of suction and stimulation decreased 87% (OR 0.13, 95% CI 0.09–0.17) and 62% (OR 0.38, 95% CI 0.29–0.49). Infants receiving

									bag-and-mask ventilation within 1 minute of birth: 0% increased to 83.9%
Pasha et al., 2013 [98]	A combined community- and facility-based approach to improve pregnancy outcomes in low-resource settings: a Global Network cluster randomized trial	India, Pakistan, Kenya, Zambia, Guatemala and Argentina	Community-based, two-arm cluster randomised trial	EmONC, JHPEIGO emergency obstetric and newborn care curriculum	• Maternal and perinatal mortality audits • Regular provider training and facility reviews • Community level, village-level core groups were formed (facilitated community meetings of mothers, family and community birth attendants over the course of the trial)	Perinatal mortality	Physician, nurses, midwives	1,459 healthcare workers	No significant difference in perinatal mortality
Jayanna K et al., 2016 [174]	Effectiveness of onsite nurse mentoring in improving quality of institutional births in the	India	Parallel, cluster randomised trial design	Customised: bedside coaching, case demonstrations, use of case	• Supportive onsite visits Specific training in quality improvement • Clinical	Improved facility readiness, provider preparedness (knowledge)	Staff nurses	54 clusters in randomised, 54 in control	Improved knowledge of neonatal resuscitation (48.5% vs.11.7%, AOR 10.7,

	Primary Health Centres of high priority districts of Karnataka, South India: A cluster randomized trial			vignettes and job aids	refresher every six months • Visits to sites every two months (3 days) • Self-assessment checklists • Develop action plans • Clinical mentorship: bedside coaching, case demonstrations, case vignettes, job aids • Case-sheet audits and observations of staff practices • Planning meeting and ended with a debrief				95% C.I 4.6–25.0) and low birth weight newborn care (58.1% vs. 40.9%, AOR 2.4, 95% C.I 1.2–4.7). Case sheet audits showed improved compliance with the protocols for newborns (73.9% vs. 32.8%, AOR 24.1, 95% C.I 8.1–72.0).
Spector et al., 2012 [113]	Improving quality of care for maternal and newborn health: Prospective pilot study of the WHO Safe Childbirth	India	Pilot, pre-post-intervention	WHO Safe Childbirth Checklist Program	• Engagement of local administrative or clinical leaders • Facility-based implementation lead used checklist and	Rate of successful delivery of essential practices	Healthcare workers	499 birth events during the baseline period and 795 birth events after introduction of the checklist program	Essential practice at each birth increased from an average of 10 of 29 practices at baseline (95%

	Checklist Program				strategies to improve strategies • Evaluation and ongoing monitoring • Outside physician 'coach' visited the facility fortnightly				CI 9.4, 10.1) to an average of 25 of 29 practices (95%CI 24.6, 25.3; *p*-value < 0.001)
Bang et al., 2016 [86]	Helping Babies Breathe (HBB) training: What happens to knowledge and skills over time?	India and Kenya	Pre-post	HBB	• Refresher training (0.5 days) • Daily ventilation practice • Equipment checks • Death audits • Resuscitation debriefings • Site visit • Biweekly site conference calls	Knowledge and skills of the birth attendants	Birth attendants: physicians and nurses	835 birth attendants	Improved knowledge 74 to 99%. Improved ventilation of mannequin 5% to 97% (*p* < 0.0001), 99% passed the resuscitation evaluation. Pre-refresher training evaluation, 99% passed knowledge test, resuscitation skills tests successful completion

									rate fell to 81%
Bellad et al., 2016 [124]	A pre-post study of a multi-country scale-up of resuscitation training of facility birth attendants: Does Helping Babies Breathe training save lives?	Kenya	Pre-post	HBB	• Direct supervision • Team building • Daily equipment availability and cleanliness checks • Low-dose/high-frequency bag-and-mask ventilation practice • Resuscitation debriefings and death audits • Observation of deliveries or HBB skills • Regular and unannounced site visits • Data review calls	Perinatal mortality rate	Birth attendants: physicians and nurses	35,328 pre births, 34,830 post	No significant difference in the PMR among all registry births ≥1500 g pre-post training or in the 7-day NMR

Brantuo et al., 2014 [76]	Evidence-based training and mentorship combined with enhanced outcomes surveillance to address the leading causes of neonatal mortality at the district hospital level in Ghana	Ghana	Pre-post	Modified AAP, WHO Kangaroo Mother Care, customised guidelines	• Onsite clinical mentorship • Monthly full-day visit • Mentorship visits • Ad hoc sessions for teaching, equipment and logistical challenges • Direct mentorship and monitoring	Training test scores	All healthcare workers at facility	278 participants	Significant improvement in provider knowledge (73% vs. 89% correct, P < 0.001), improvement greater among trainees receiving recurrent refresher training (86% vs. 94% correct, P < 0.001)
Hirschhorn et al., 2015 [72]	Learning before leaping: Integration of an adaptive study design process prior to initiation of BetterBirth, a large-scale randomized controlled trial in Uttar Pradesh, India	India	Pre-post	WHO Safe Childbirth Checklist training, BetterBirth package	• Leadership engagement • Education of facility staff • Coaching • Data feedback loop • Safe birth supplies	Percentage use WHO Safe Childbirth Checklist	Birth attendants	N/A	Improvement in early breastfeeding initiation (3 to 64%), checklist use (range 32 to 88 %), all $p <$ 0.01

Iyengar et al., 2014 [88]	Adherence to evidence based care practices for childbirth before and after a quality improvement intervention in health facilities of Rajasthan, India	India	Pre-post	Customised training of evidence-based delivery-newborn care and skilled birth attendance	• Cycles of regular facility assessment, feedback, training and action	Change of practice through checklist assessments	District managers, doctors, nurse-midwives	44 public health facilities in 10 districts of Rajasthan, India. District hospitals (9), community health centres (32) and primary health centres (3)	10 of 17 care practices improved significantly; e. g. reduced routine suction of newborns (0 = 0.0005), listening to foetal heart sounds during labour (p = 0.0001)
Mdumaa et al., 2014 [158]	Frequent brief onsite simulation training and reduction in 24-h neonatal mortality—An educational intervention study	Tanzania	Pre-post	HBB, customised with frequent and brief onsite simulation training	• Simulator placed in labour ward for frequent practices • HBB action posters mounted • Repeated monthly training sessions	Clinical practice and 24-h neonatal mortality	Midwives, nurse students, operating nurses and doctors	4,894 deliveries pre and 4,814 post-implementation	Mortality at 24-h decreased from 11.1/1000 to 7.2/1000 (p = 0.040)
Sibley et al., 2014 [74]	Improving maternal and newborn healthcare delivery in rural Amhara and Oromiya	Ethiopia	Pre-Post	Adapted American College of Nurse-Midwives' Home Based	• Quality improvement teams • Participatory problem solving • Antenatal care registration	Performance of health workers, trainings scores	Health extension workers, community health development agents and	808 participants	Mean pretraining scores ranged from 16% to 27%, immediate post-training

	regions of Ethiopia through the Maternal and Newborn Health in Ethiopia Partnership			Life Saving Skills Program	• Family meeting attendance • Iterative cycles of idea generation and testing		TBAs trained by MaNHEP		scores increased 78% to 82% and post-intervention were 72% to 80% (all P < .001)
Werdenberg et al., 2018 [99]	Successful implementation of a combined learning collaborative and mentoring intervention to improve neonatal quality of care in rural Rwanda	Rwanda	Pre-post	Medical equipment supply, HBB, advanced neonatal care	• 'Learning Collaborative' with monthly mentorship visits • QI team formation	Implementation process measures, healthcare reported impact on attitudes and practice of QI	Healthcare workers	71 pre and 67 post intervention	Reduction in barriers to quality care delivery related to training ($p = 0.018$); increased QI capacity (knowledge 37 to 89%, $p < 0.001$); confidence (47 to 89%, $p < 0.001$), QI leadership (59 to 91%, $p < 0.001$); and peer-to-peer learning (37 to 66%, $p = 0.024$)

Woods et al., 2015 [73]	An innovative approach to in-service training of maternal health staff in Cambodian hospitals	Cambodia	Quasi-experimental comparison of intervention participants and control	Customised: Clinical skills practice model	• Practice sessions and follow-up visits	Rates of neonatal resuscitation, magnesium sulphate dilution and aortic compression clinical assessment	Healthcare workers	559 healthcare workers attended at least one CSP practice session. The skills assessment included 47 doctors and 210 midwives	Neonatal resuscitation improved (mean score 31.22 vs 17.00; $P < 0.001$), intervention participants had higher pass rate after adjustment for hospital level and profession ($P \leq 0.05$)

Chapter 3: Newborn Care in Solomon Islands

3.1 Introduction

Solomon Islands is a lower-middle-income country in the Oceania region, 2,000 kilometres north east of Brisbane and south of Papua New Guinea. An estimated population of 600,000 is spread across 10 provinces [108]. The country is an archipelago characterised by mountainous, heavily forested islands. Solomon Islands has a land area of 28,400 square kilometres divided among six major islands and more than 900 smaller islands, dispersed over 1,300 square kilometres of ocean (see Figure 3.1).

Figure 3.1: Map of Solomon Islands

The population of Solomon Islands is young and growing rapidly (see Figure 3.2). The population growth rate was 3% for the period of 1999–2009, and although an estimated 80% of the population live in rural areas, there was a trend towards urbanisation [110]. In 2009, the median age was 19.8 years and 41% of the population was less than 15 years of age.

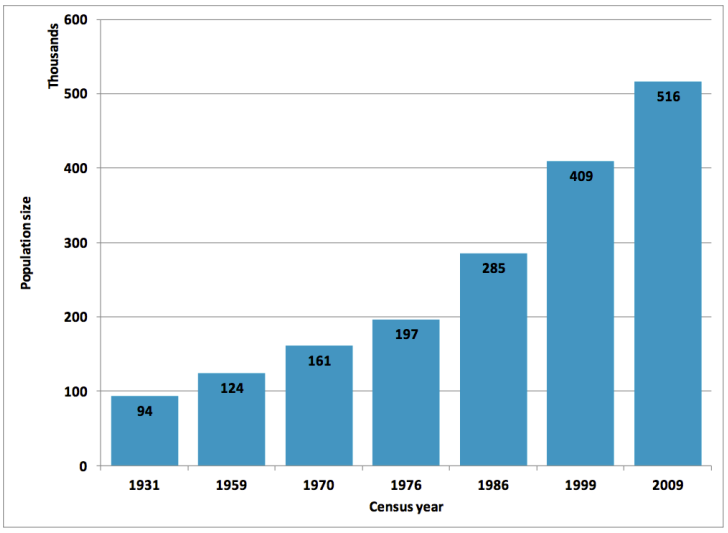


Figure 3.2 Solomon Islands Intercensal Population Growth [110]

3.1.1 Economic, social and political challenges

A volatile economy, social unrest and environmental challenges have impacted efforts to improve health care over the past 15 years. Economically, Solomon Islands remains on the UN list of Least Developed Countries, due to low gross national income, weak human assets and high degree of economic vulnerability [111]. The World Bank lists Solomon Islands as a lower middle-income country, and it had a global gross domestic product ranking of 172 and USD 2,162.70 per capita in 2018. Economic growth in Solomon Islands has been slow, and its gross domestic product has historically contracted in periods owing to environmental disasters, such as by 0.2% in the wake of flooding in 2014.

The country is emerging from a period marked by social unrest and frequent natural disasters. From 1999 to 2003, a civil conflict caused a breakdown of social order and democratic law followed by further unrest during riots following elections in 2006. Natural disasters, such as the 2007 earthquake and tsunami, 2013 earthquake and cyclone-related flooding in 2014, caused fatalities, displaced thousands and caused extensive damage to infrastructure. These events have had a direct impact on primary and secondary child health services [15].

Deliveries and newborn care account for a significant proportion of health resources and expenditure in Solomon Islands. A Health Facility Costing Study [112] identified deliveries as the most common reason for admission at hospitals, area health clinics, rural health clinics and nurse aide posts, ranging from 14-42% of admissions. The cost of deliveries was high and varied from SBD2,250 (USD275) at NRH and SBD2,949

(USD365) at provincial hospitals to SBD1,277 (USD160) at nurse aide posts. Newborn care required a significant proportion of the overall labour, facility work and costs at hospitals. At NRH, 6% of all admissions were to the Special Care Nursery (SCN) in 2012, the average length of stay was 9 days and the SCN had the second highest ratio of staff to beds among all wards.

3.2 Neonatal Morbidity and Mortality Indicators

Reliable data for indicators pertaining to neonatal and child health in Solomon Islands are limited, and published data are often based on projected calculations. Solomon Islands has a high mortality rate for children below the age of five and did not meet its MDG 4 target [178]. In 2014, there were approximately 235 neonatal deaths and 500 child deaths [114]. Solomon Islands was ranked 76 for the under-5 mortality rate globally based on the rate of 26 per 1,000 live births in 2016, a reduction from 39 in 1990. Infant mortality was 22 in 2016, a reduction from 32 in 1990[115].

Neonatal morbidity and mortality data are not routinely reported by the MHMS; however, estimates reflect neonatal mortality at 8.33 and 9 per 1,000 live births [116, 117] and a trend that suggests steady improvement (see Figure 3.3). These rates place Solomon Islands as having achieved SDG targets [118]. However, these estimates differ from higher reported perinatal mortality rates [6, 119-122] and the higher rates of mortality observed in neighbouring countries in the Western Pacific that have similar health and demographic profiles [123, 232]. Neonatal deaths are estimated to account for up to 44% of under-5 mortality [12].

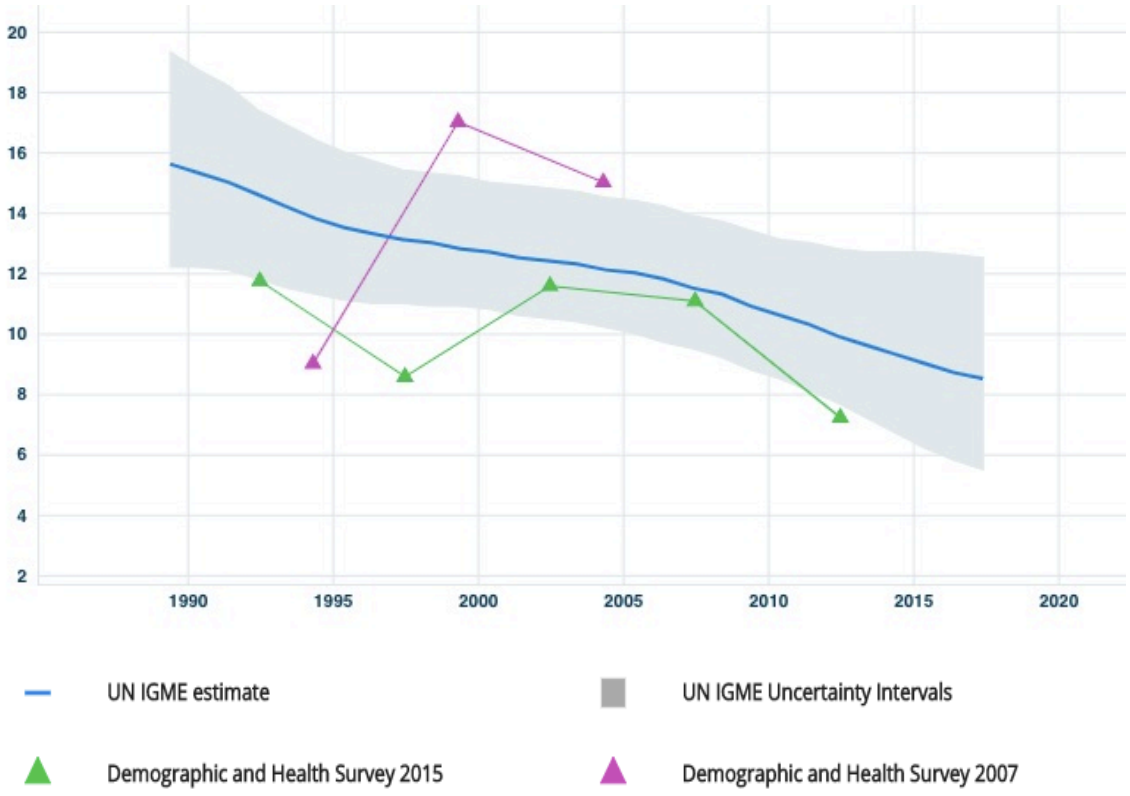


Figure 3.3: Reported Neonatal Mortality Rates for Solomon Islands [125]

3.3 Facilities Where Newborns are Born

The country has a wide range of facilities where babies are born, and healthcare workers of varying cadres and skills provide care for mothers and newborns among other clinical needs of the local community. In 2014, there were approximately 17,000 births in Solomon Islands, delivered across 244 facilities and a high facility birth rate of approximately 85–89% [126, 127]. The health facilities and typical staffing arrangements are highlighted in Table 3.2.

Table 3.2: Health Facilities and Typical Staffing [126]

Facility (number)	Essential Services	
	Public Health, Prevention and Outreach	**Clinical (Primary and Secondary)**
Nurse aid post (177)	• Counselling • Family planning and nutrition • Sanitation and hygiene • Community development • Environmental health • Health promotion and education • Immunisation	• Basic medical services • First-aid treatment for emergencies • Treatment of mild ailments or injuries • Patient stabilisation for referral

	• Infection control • School health • Vector-borne disease control	• Management of antenatal care, low-risk birthing and postnatal care not requiring hospitalisation
Rural health clinic (109)	• As for nurse aid posts • Disaster preparedness • Health surveillance • HIV/AIDS and STI prevention, including screening, surveillance and education • Programs to reduce tobacco, alcohol consumption and substance abuse • Reproductive health	• Child health including Integrated Management of Childhood Illness • Community-based rehabilitation • Dental care (extraction) • Family planning services • Management of antenatal care, low-risk birthing and postnatal care • Management, treatment and care of STIs, including HIV/AIDS • Medical and minor surgical emergencies • Mental health, including counselling • Outpatient consultations with full clinical assessment • Primary eye care • Treatment for chronic diseases, including follow-up care
Area health centre (33)	• As for rural health clinics ○ Inspection of food facilities ○ Programs to reduce tobacco, alcohol consumption, substance abuse and obesity	• As for rural health clinics ○ Basic X-ray ○ Dental care (extraction, fillings, dentures) ○ Management of antenatal care, birthing and postnatal care ○ Basic pathology
Provincial hospitals (10)	• As for area health centres	• As for area health centres ○ Between 25–150 beds each ○ Mental health ▪ National Psychiatric Unit at Kilu'ufi Provincial Hospital ▪ Outpatient services
National Referral Hospital (1)	• As for provincial hospitals	• As for provincial hospitals ○ 300–400 beds ○ Full range of secondary clinical care ○ Operating theatre ○ Emergency department ○ Outreach to provinces (twice a year) ○ Mental health ▪ Acute Care Unit ▪ Inpatient and outpatient care

Notably, 33% of all births in the country in 2014 took place in Honiara [126]. Four provinces, Guadalcanal, Honiara, Malaita and Western, accounted for 69% of all births.

The increasing number of births in Honiara (33% increase) and Malaita (35% increase) over the past four years reflects a trend towards urbanisation and more women travelling to major centres to give birth. When viewed by health facility, only four facilities have more than 500 births per year. Two-thirds of health facilities have 10 or fewer deliveries per year.

3.4 Interventions to Improve Newborn Care

The Regional Action Plan for Healthy Newborn Infants in the Western Pacific Region [12] was launched in 2014, with a view to address preventable causes of newborn mortality through implementation of core interventions for the prevention and care of preterm and low birth weight newborns and reduction of harmful care practices, and for a focus on intrapartum and newborn care during the first 24 hours after birth (see Table 3.3). The cornerstone of the plan is the EENC program, which was rolled out from February 2015 in Solomon Islands, as part of a Newborn Health Program established under the Reproductive Child Health Division at the MHMS.

Table 3.3: Core EENC Interventions

		Intrapartum care	Newborn care
All mothers and newborn infants	The First Embrace	• Labour monitoring (partograph)	• immediate drying • immediate skin-to-skin contact • appropriately timed clamping and cutting of the cord • exclusive breastfeeding • routine care – eye care, vitamin K, immunizations, weighing and examinations
At-risk mothers and newborn infants	Preterm and LBW infants	Preterm labour • elimination of unnecessary inductions and caesarean sections • antenatal steroids • antibiotics for preterm PROM	• Kangaroo Mother Care (KMC) • breastfeeding support • immediate treatment of suspected infection
	Sick newborn infants	Obstructed/prolonged labour Fetal distress • assisted delivery • caesarean section	Not breathing at birth • resuscitation Suspected sepsis • antibiotic treatment

Historically, newborn care has been a component of several training programs in the country. These have been delivered through the MHMS and development partners and include specific modules or content related to immediate newborn care. Targets of these programs have been predominantly nurses and midwives, and these have been delivered in specific sites as opposed to a national program (Table 3.4).

Table 3.4: Training Programs in Solomon Islands Encompassing Newborn Care

Name	Content	Duration	Past Trainings
WHO Pocketbook training	A pocket-sized manual for use by doctors, nurses and other health workers for care of young children. Includes up-to-date guidelines for management of childhood illnesses in low-resource countries. Neonatal component includes neonatal resuscitation and management of neonatal sepsis, low and very low birth weight infants.	4–5 days total (Neonatal module 1 day)	Multiple centres
Mother Baby Friendly Hospital Initiative (MBFHI)	Implement practices that protect, promote and support breastfeeding.	3 days	Multiple centres
Focused Antenatal Care (FANC)	Basic antenatal care: safe, simple, cost-effective to maintain normal pregnancies, prevent complications and facilitate early detection and treatment of complications.	N/A	
Integrated Management of Childhood Illness (IMCI)	A strategy for delivering key interventions that prevent and treat common causes of mortality in children under five years old, including neonatal infections, pneumonia, diarrhoea, measles, malaria and under-nutrition.	11 days; short course possible	Multiple centres
Emergency Obstetric and Newborn Care (EmONC)	To provide high-quality emergency obstetric care services in underserved areas to prevent maternal and neonatal mortality and morbidity.	NA	NRH 2012, Kirakira 2013
Community-Based Maternal and Newborn Care (CBMNC)	A program aimed at improving community awareness of maternal and newborn issues, such as basic health and hygiene, antenatal care and danger signs in newborns through a program of home visitation.	5 days	Tulagi, Sept 2014 Kirakira, July 2014
Integrated courses	Combined course by United Nations International Children's Emergency Fund (UNICEF), including MBFHI, EENC, FANC and WHO Pocketbook (see UNICEF reports).	5 days	Tulagi, Aug 2014 Kirakira, June 2014

3.5 Small Island Developing States

Solomon Islands faces challenges regarding the provision of quality universal healthcare because of a combination of geographic and economic factors. Economic challenges occur from limited resources and a small economy. Geographic distance and complexity of travel across water and terrain lead to higher associated costs in a dispersed health services system. These issues are common among SIDS, a recognised group of 58 low-lying nations with comparable economic, social and health challenges [128, 129]. These nations have been highlighted by the UN for specific considerations of the impact arising from the combination of climate change and economic vulnerability [130, 131]. Specific health risks in SIDS are those related to environmental conditions, such as poor water quality and limited quantity, as well as high costs of healthcare delivery that limit coverage [128, 132]. However, data describing outcomes or approaches relating to perinatal and newborn objectives of quality care in the unique context of SIDS in the Western Pacific are scarce.

3.6 Conclusion

The true neonatal mortality and morbidity in Solomon Islands is not known, and estimates of neonatal mortality rates are inconsistent with audits and reports. In addition, perinatal care outcomes have had low visibility in national policy, data reporting and programs. Historically, a national program to improve neonatal quality of care has not been launched, but rather an ad hoc approach has been adopted to training according to availability of financing and smaller-scale programmatic endeavours.

Solomon Islands faces specific challenges to the provision of quality care arising from the unique context of its geography, economy, small health workforce and health facility distribution. The impact of these factors needs to be considered in implementation of newborn care programs. Providing training or ongoing refreshers to improve and maintain quality of newborn care in this context requires an approach that adapts interventions to these contextual limitations.

Chapter 4: Methods and Research Design

4.1 Introduction

This chapter outlines the background, approach and rationale for each of the methods used to address the research questions of this thesis. To address these questions, four studies were designed in line with the methodology derived from the findings of the literature review and quality of care framework presented in Chapters 2 and 3. While the research methods are outlined in each respective results chapter as part of the published and submitted manuscripts (see

Table 1.1: Research Questions and Associated Study), they are described in this chapter in greater depth.

4.2 Mixed Methods Research in Implementation Science

Mixed methods research sits between quantitative and qualitative research methods and attempts through a pragmatic design to consider viewpoints and perspectives from both methods [133]. It has been described as the third major research paradigm along with quantitative and qualitative methods [133]. Historically, mixed methods originated in sociology; it is increasingly applied in behavioural and human sciences and has now become an established research design in implementation research [134]. The mixed methods study design suited the approach of this thesis to the research questions of merging qualitative and quantitative data sources to provide contextualised results and incorporate multiple standpoints. This approach allowed data and analysis to go beyond 'what' impact was observed to 'how' and 'why' changes occurred.

The use of mixed methods allows better contextualisation of information through triangulation of results and thereby provides more useful insights on the impact of the multifaceted intervention. 'Methodological triangulation' refers to the use of different methods to answer a research problem by overcoming the limitations arising from employing a single-method approach and provides a deeper understanding [135, 136]. Using mixed methods allows integration of qualitative and quantitative sources, thereby maximising the strengths and minimising the weakness of study data [137]. Specifically, it is anticipated that the quantitative data used in this thesis may be of limited statistical power due to small sample size, a common problem faced in implementation research

[138]. Triangulation with qualitative data compensated for this inherent weakness, an approach used in other mixed methods studies [139].

A further reason for adopting quantitative and quantitative methods was to examine both the intervention *and* context. The mixed methods allows describing the intervention in the context in which it was introduced: a 'real-world' setting, with inherent variability and complexity, as opposed to a controlled environment, such as in an efficacy study [139]. When clinical care is provided in a complex setting, such as Solomon Islands, qualitative methods are able to describe contextual factors to enable success in addition to describing quantitative outcomes. This 'complementarity' of data analysis allows enhancement and clarification beyond the scope of each method alone.

Often absent from research regarding newborn care quality in low- and middle-income countries is the voice of stakeholders, such as healthcare workers who received the intervention or parents of neonates who may have been affected by its change in practice. Qualitative methods enable attitudes and perspectives of stakeholders to be heard. Documenting barriers and stakeholder attitudes may be critical for implementation [138]. Apart from identifying themes from stakeholders, which may shape future implementation, stakeholders may equally gain from the process, empowered through the opportunity of participating in reflection and evaluation. This research model helps to move beyond unidirectional research to a more reciprocal exchange as 'an inherently collaborative form of inquiry in which researchers, practitioners, and consumers must leverage their different perspectives and competencies to produce new knowledge about a complex process' [138].

These factors shaped the thesis research model, and similar to previous studies and commentary on research in this field [140, 141], this approach met the pragmatic needs of the study, in that a small research team could conduct the required elements with limited resources across the large geography of the country. A further reason for adopting these methods was to be able to adequately describe and compare process measures among the study sites. Although reduction in neonatal morbidity and mortality was the ultimate aim of the project, the research team was faced with the challenge that '"statistically significant" reductions in mortality would be undermined by worries over bias, residual or unrecognized confounding' [102, 140]. By focusing on process measures, the team aimed to avoid overinterpretation about the underlying reasons for the quality of care observed [142].

4.2.1 Overall study design

This thesis used a mixed methods explanatory design [137]. The two-phase approach allowed the separate collection of, first, quantitative data and, then, qualitative data (see Figure 4.1). Quantitative data consisted of the data generated from the structured assessments of the quality of care (Chapter Chapter 5:), perinatal morbidity and mortality outcomes (Chapter 6) and impact on healthcare worker knowledge and skills from WHO EENC training (Chapter 7). The data collected through the focus group discussions (FGDs) and semi-structured interviews (SSIs) provided the qualitative data (Chapter 8).

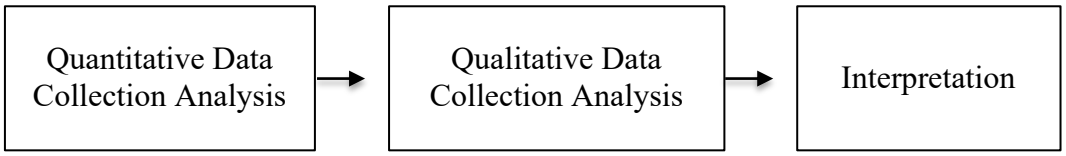


Figure 4.1 Mixed Methods Design, Adapted from Creswell et al. [143]

4.3 Study Setting

4.3.1 Hospital selection

Four provincial hospitals (Gizo, Western Province; Kilu'ufi, Malaita Province; Kirakira, Makira-Ulawa Province; and Good Samaritan Hospital, Guadalcanal Province) and the NRH (Honiara Town Council) were selected for this study (see Figure 4.2: Solomon Islands Map with Study Hospitals Highlighted). In discussion with MHMS, the hospitals were chosen purposefully owing to their location in the provinces with the highest births for the country, and where 80% of the population of the entire country reside. The hospitals were also selected on the basis of accessibility, namely, reasonably regular access by plane or boat within feasible time frames for the project.

The hospitals were known to have sufficient staff and supports for receiving the intervention (e.g. training coordinators). The initial plan was to include area health clinics and nurse aid posts in the study, but geographic and financial obstacles impeded their inclusion. Instead, at every provincial centre, the training coordinators would invite participants from surrounding areas to participate in the training and evaluation activities.

Hospital characteristics and demographics of their associated province reflect the varying state of each study site and are described in detail in Table 5.1.

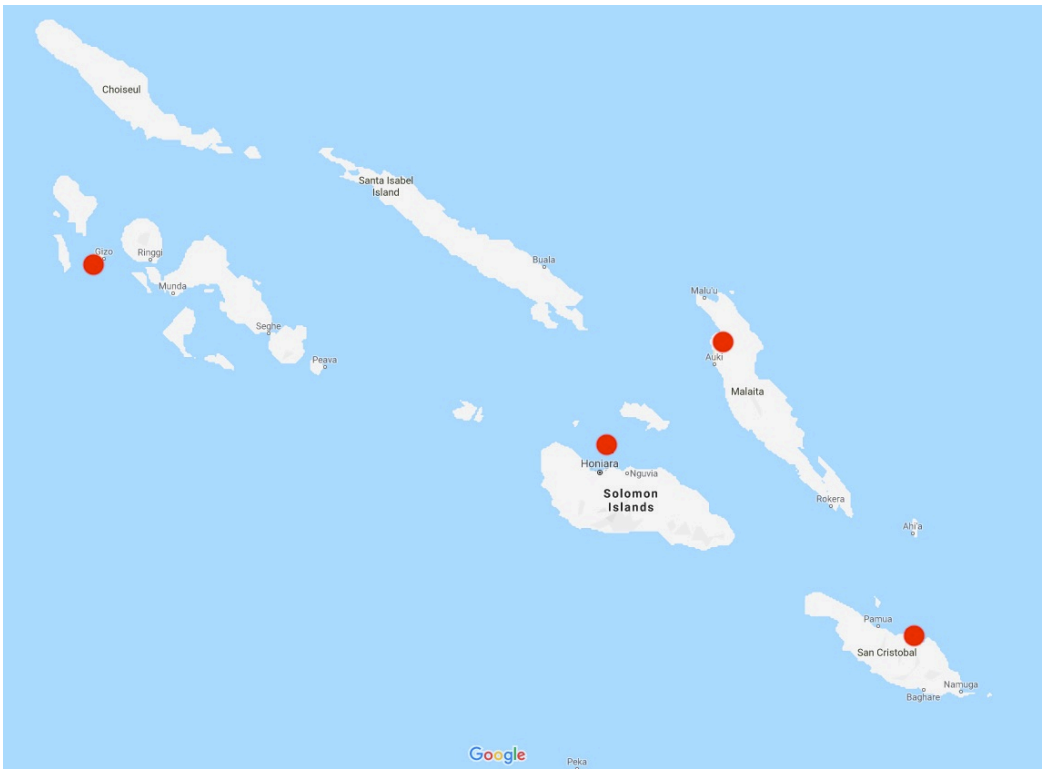


Figure 4.2: Solomon Islands Map with Study Hospitals Highlighted

The hospitals varied in their past experience of training and support in newborn care. NRH has historically received the most direct specialist support through strong links to the Departments of Paediatrics based at NRH, and all three paediatricians and paediatric registrars worked at this site during most of the study period. In 2015, one paediatrician was based at Kilu'ufi Hospital for the duration of the year only. Specialist obstetric care was also heavily focused towards NRH which employed most of the country's obstetricians and registrars, and Gizo was the only other hospital where an obstetrician was present for the duration of the study period. Except for the Good Samaritan Hospital, a missionary Hospital, all were publicly funded facilities. All hospitals receive visiting medical staff and volunteers on an ad hoc basis.

NRH is located across the Kukum highway from MHMS and WHO establishments and close to the United Nations International Children's Emergency Fund country headquarters. This fact has historically resulted in greater visibility of programmatic, technical and healthcare workforce needs at this hospital, which has hence received a more significant proportion of training and interventions owing to its accessibility and size.

4.3.2 Study team

The study team was led by the principal investigator (ST), and it included two co-researchers. Ms Anna Jatobatu was the newly appointed neonatal resource person at the commencement of the study in 2014, with responsibility for coordinating the training and implementation of the EENC program nationally. Ms Anita Maepio was a midwife and educator for the Department of Obstetrics at NRH and was a master trainer for the EENC program. The three researchers conducted the data collection for the EENC evaluation components, supported by paediatric registrars from NRH who were involved in some of the site visits initially. The research was conducted with oversight and support from international supervisors (University of Melbourne) and regular local input from MHMS. The principal investigator, in liaison with Ms Jatobatu and Ms Maepio, managed planning and timing of all activities.

4.4 Assessment of the Quality of Newborn Care in Solomon Islands

4.4.1 Background

Data to describe quality measures according to the quality of care framework relating to input, process and outcome measures were sought to explain the quality of care in Solomon Islands.

Little was known regarding the current quality of newborn care in Solomon Islands, and there were no *input* or *process* measures routinely recorded at the study facilities available for analysis. Data on the *outcomes* for newborns, such as causes of morbidity and mortality data, were also limited. There were no vital registration systems or routine morbidity and mortality reporting outside NRH. The MHMS has a system in place for data collection of numbers of births at each facility; however, no other data on neonates, such as diagnosis to SCN or deaths, are collected. The process of data collection and transfer from the health facility to MHMS was weak and vulnerable to inconsistencies, and gaps in data arose from the data collection process. Typically, data were first compiled from ward logbooks, and monthly summary forms were generated from the logbook entries and faxed to the Honiara-based statistics unit for collation. This approach relied on sequential steps of adequate documentation, storage and access to logbooks and healthcare workers' abilities to summarise and send forms—all of which were subject to potential failures. These issues relating to data integrity have been acknowledged in previous reports and affect the validity and interpretation of results [122].

Alternate avenues of data collection, such as national surveys, have not routinely captured perinatal data in detail. The Solomon Islands Census, the most recent one that was completed in 2009, provides demographic details for each province and estimates of child mortality, but lacks questions relating to newborns and stillbirths [110]. Although a health survey in 2015 estimated neonatal mortality rates between 5 and 15 depending on province, very few neonatal deaths and stillbirths were captured in the survey sample, which affects the validity of the results [122]. Most international reports for neonatal mortality in Solomon Islands rely on calculated or modelled data, which may not be accurate or up to date. They have shown a steadily improving neonatal mortality rate over recent years [127].

In an attempt to define more explicitly the components of high-quality care, standards for quality of care are proposed [39, 144]. However, a commonly expressed concern is the lack of routine availability of process-based indicators, a challenge experienced in this study. A range of approaches for assessment are used to assess quality of newborn care in hospitals throughout low- and middle-income countries, which identify the strengths and weaknesses in facilities, their resources and context. Most commonly, external evaluations or analysis of self-reported data are utilised [145-149]. Assessments typically cover domains of infrastructure, healthcare workforce characteristics, medication, equipment, medical records and observed practice and are adapted to suit the local context.

Therefore, to answer the research question to determine the *input* and *process* outcomes for quality of care in Solomon Islands, the research team undertook a comprehensive, structured assessment of the study hospitals. It adapted the *Making Pregnancy Safer: Assessment tool for the quality of hospital care for mothers and newborn babies,* WHO Regional Office for Europe (2009 and updated in 2014) [150] for use in the local Solomon Island context. This tool was designed for assessments of perinatal health at facility level and is used widely. It was developed as a generic framework that can be adapted to epidemiology and structure in individual countries. Data sources include hospital statistics, medical records, direct observation of cases and interviews with staff and with patients. This tool was previously adapted for assessment in Papua New Guinea [151], a country that shares many health, geographic and demographic qualities related to newborn care with Solomon Islands. A participatory approach is used, which offers scope for end-of-assessment feedback at each site and a written report. See Appendix F for the complete survey.

The research team modified the structured assessment tool to include details that better reflected the quality of care themes of the research question. For example, the presence of a bag and mask on inspection did not account for its appropriate assembly and location within reach from a resuscitation area, and hence, this indicator was added. Similarly, alcohol hand rub would be checked to ensure it was filled and in an appropriately accessible location (e.g. close to doors, or on entry of high-acuity areas) rather than being present (yes/no) only.

4.4.2 Study objectives

Using the framework for quality improvement described in Chapter 2, this study aimed to evaluate the input, process and outcome measures affecting newborn quality of care. The approach had two components, designed to answer the first two research questions. *Input* and *process* data were described to answer the first question: **What is the current state of hospital quality of care for newborns in Solomon Islands?** *Outcome* data were collected to address the second question: **What are the main causes of neonatal morbidity and mortality in Solomon Islands?**

4.4.3 Study design

This study was a cross-sectional assessment using a structured neonatal assessment tool at the four study hospitals.

4.4.4 Study procedures

Data were collected using the structured assessment tool, modified for the local context. The information collected covers the domains of equipment, healthcare provider training and availability of clinical guidelines. In addition, opportunity was given to staff to provide open feedback and suggestions about issues they felt were of importance to neonatal care in their setting but were not specifically covered by the assessment. Healthcare workers of all cadres were invited to share their priorities for improving newborn care in an informal discussion at the end of the evaluation.

Table 4.1: Allocation of Assessments of the Facilities

Hospital	Kilu'ufi		Kirakira		Gizo		NRH	
Date	May 2014	Aug 2017	June 2014	Nov 2017	June 2014	Nov 2017	June 2014	Nov 2017
Assessor(s)	ST	ST	ST + SL	ST	ST + JS	ST	ST	ST

4.4.5 Timing of facility assessments

The facility assessments were performed prior to the implementation of the newborn care program (Table 4.1: Allocation of Assessments of the Facilities). The timing of this analysis was important both for descriptive purposes and to inform the implementation design, specific equipment requirements and training needs.

4.4.6 Data collection procedures and data management

The steps of the facility assessment were as follows:

1. Prior to the audit, available data from MHMS were requested from the Chief Medical Statistician at the Ministry of Health. Data on the population of each province, number of births and facilities where births took place were requested.
2. The facility audit forms were printed prior to arrival at the study site. For the assessment, 1–3 days would be allocated per facility. The local training coordinator (if available), as well as head nurse or head doctor, would be contacted to arrange the assessment at an acceptable time in light of staff availability and allocation.
3. Inspection of the hospitals, face-to-face discussions with staff members and impromptu meetings with nurses, midwives, doctors and administrators were used to gather required information.
4. Upon arrival at the health facility, the assessors together with the local head nurse or training coordinator would commence at the beginning of the assessment form after a discussion regarding the aims and purpose of the audit. The assessment was explained as a tool to identify strengths and areas for improvement in newborn care at the facility. It was emphasised that the assessment was to be done as a participatory process, rather than an external 'score card', and that the local participants' views were particularly valued.

5. The group would then visit each area relevant to the assessment together (e.g. labour ward, postnatal ward and SCN) and other sites (e.g. emergency department and antenatal clinic) as required. Typically, all areas where newborns could be cared for at the facility were inspected.
6. Using the assessment tool, the group would visually inspect for required items. If an item was not readily visible (e.g. bag/mask), the local member of the assessment group would be invited to provide rationale or identify the availability of the item for context. For example, if a bag/mask was not visible, the nurse may clarify whether it was in use elsewhere in the facility and give a general sense of frequency of the occurrence. Similarly, regarding equipment stockouts and structural problems (e.g. lack of electricity), a general idea of frequency of occurrence was documented. At one assessment, 24G cannulas were not available owing to use for treatment in a recent outbreak of diarrhoea among young children, although the local nurse was able to clarify that this item was usually available and that this was not a common occurrence. This item would then be given a qualifying statement in the assessment, even though it was absent.
7. Photographs and scans were taken of special care and nursery logbooks and monthly summaries, which were uploaded for later analysis in a password-protected folder (see Figure 4.3: Examples of Logbook Entries). The following data were sought for each patient admitted to the hospital SCN or labour ward:

    a. neonatal characteristics (date of birth, age at birth, weight and sex)
    b. diagnoses (provisional and final)
    c. treatment (antibiotics)
    d. outcome (alive, deceased and discharged against medical advice)
    e. missing fields.

8. Case management sections of the assessment were completed with consent from parents whose neonates were in the SCN. Available medical records and observation charts were used to identify relevant data.
9. Upon completion of the assessment, participants were invited to share experiences and additional issues in relation to the assessment. This sharing was a valuable component of the process as it allowed open dialogue from healthcare workers to freely express their thoughts.
10. The visiting team consisted of paediatricians and paediatric registrars. Although outside the scope of the assessment, an important component of the process was

a case discussion or request for clinical advice following the assessment. If there was an unwell newborn or child, medical input would be provided by the assessment team at preference to completion of the assessment.

11. Upon completion of the assessment, the written assessment forms were manually entered into an excel spreadsheet before further analysis.

4.4.7 Data analysis

The data from the facility audit were analysed in the following steps:

1. To describe the structural and organisational elements of the quality of care from the assessment, data from each facility were entered into an excel spreadsheet and cleaned. This allowed a comparison between facilities to be visualised.

Figure 4.3: Examples of Logbook Entries

2. To describe the characteristics of neonates, descriptive statistics (means, medians and interquartile ranges) were calculated as appropriate using Excel (Microsoft Corporation, Redmond, WA, USA).
3. To describe the causes of mortality by diagnosis, case-fatality rates were calculated by dividing the number of deaths from each diagnosis over the period of the study by the number of neonates with the diagnosis and then multiplied by 100.
4. Proportion and range of deceased newborns, according to diagnosis, was calculated using STATA (Version 15.1).

4.4.7.1 Definitions

Definitions for birth weight categories were assigned according to WHO standard definitions [152]:

Table 4.2: WHO Birth Weight Category Definitions [152]

Category	Measured Birth Weight
Extremely low birth weight	< 1000 g
Very low birth weight	1000–1499 g
Low birth weight	1500–2499 g
Normal birth weight	2500–3999 g
Large for gestational age	> 4000 g

4.4.8 Limitations of the facility assessments

The facility assessments could only provide a snapshot of the newborn care facilities, supplies and equipment, workforce attributes and data on numbers of births. The assessments relied on the presence of key healthcare workers on the day(s) of the assessment to provide an informed perspective beyond the visual inspection of the facility and were subject to the interpretation of the assessors. The assessment occurred in the context of ongoing deliveries. Healthcare workers providing care were not interrupted to join the assessment, and others were absent between shifts; therefore, not all perspectives of the healthcare workers at the hospital on the day of the assessment were obtained.

4.5 Assessment of the Impact on Healthcare Worker Knowledge and Skills from WHO Early Essential Newborn Care Coaching

4.5.1 Background of WHO EENC Coaching Program

Training programs targeting healthcare workers are a common avenue to improve knowledge and skills [153, 154]. Educational outreach programs and in-service training have had positive effects [155, 156]. To determine the impact of the EENC coaching on healthcare worker knowledge and skills, a range of methods for measurement of the *process* indicators were considered for this study. These included direct observation, video recordings, maternal exit interviews, simulated assessments and review of hospital records. Evidence validating these indicators and their accuracy is limited, and previous studies used a range of methods. In a description of methods for assessing knowledge and skills following training, a systematic review found that 26 studies used written examinations, 38 assessed birth attendant skills (of these 24 were for specific skills at the request of the examiner) and 13 studies used simulated scenario from direct observation and seven from chart review or maternal/healthcare worker recall [58].

4.5.2 Evaluation methods

Several methods for evaluation of impact from the WHO EENC program were considered. Direct observation of real-life practice in a clinical setting by an observer is often regarded as the 'reference standard' for assessing process in quality of care. Compared with direct observation, other methods, such as use of checklists by experienced observers and interviews, have shown good sensitivity and are better than review of medical records [157]. Other forms of direct observation utilise simulated patients or video/audio recordings. Practical, scenario-based assessments or standardised patient interactions are favourable in allowing the assessment to occur in controlled conditions. For events that occur at low frequency, such as responding to a non-breathing baby, as of interest in this study, a large number of deliveries would need to be observed to capture one event. Direct observation in the delivery room by an observer may not be culturally appropriate (especially if a male observer is present) and can unintentionally promote the display of desired behaviours (i.e. the Hawthorne effect). In this regard, Donabedian asserts that subjects become accustomed to the presence of the observer and revert eventually to their routine practice [37].

Patient interviews in the form of structured questionnaires or interviews following a clinical encounter are feasible for assessments of some variables. However, a comparison of maternal exit interviews and direct observation of newborn care indicators in Kenya found low validity for variables related to timing or sequence of clinical events [159]. Studies testing the validity of maternal reporting for perinatal indicators have found that few indicators meet validation criteria, citing limitations in maternal recall and difficulties with terminology or question wording and recall of indications for interventions [159-162]. A systematic review found that patient report had greater accuracy regarding attributes of clinician performance compared with medical record review and clinician self-report, but is affected by decrease in recall over time [163]. Exit interviews, in some cultures, may also be affected by a 'courtesy bias', a tendency for patients to respond in a way that does not undermine their treating clinician.

Medical records are usually readily available and present the documented version of patient care. The use of audits of medical records in facilities is affected by availability and adequacy of medical details. Clinical record completeness is an independent measure of the quality of care provided [37], and the records in themselves may not be a true reflection of quality of care relying on judgement, observation and clinical synthesis—skills that depend on the expertise of the clinician to identify and document. Medical records are useful for specific clinical actions, such as medication administration or laboratory orders, but lack validity in areas such as patient counselling compared with clinician self-report and direct observation [163].

In considering the approach for assessing impact of EENC training in Solomon Islands, we weighed the feasibility, access and time required in determining the most suitable method. The low numbers of patients in smaller facilities would have significantly limited frequency of observing births, resuscitations and parent interviews. The EENC coaching materials included a standardised written test and observational checklists for the two scenarios around which the program was focused. Similar to previous studies on impact from training, the assessments in our study were derived from the content of the training materials themselves [86, 164, 165]. However, the use of training-derived assessment carries some risk since the course may help simulated performance, but not clinical management of neonates [66].

4.5.3 Objectives

This study addressed the third research question of the thesis: **What is the impact of the WHO Early Essential Newborn Care coaching program on healthcare worker knowledge and skills in Solomon Islands?** The assessments of healthcare worker skills and knowledge aimed to evaluate the impact from the EENC training program and to determine the factors that supported or detracted from skills and knowledge retention. Further, the assessment aimed to determine whether the EENC was well received by participants.

4.5.4 Study design

A prospective multi-site cohort study of healthcare workers at the four hospital study sites in Solomon Islands was conducted.

4.5.5 Study population and timing

Participants who attended EENC refresher training at the study sites between August and November 2018 were invited to participate after obtaining their informed consent. Eligible participants were healthcare workers who had attended prior EENC training since March 2015. Written consent was obtained prior to participation in the knowledge and skills assessment. Healthcare workers who had not attended a previous EENC training were excluded. See Figure 4.4 for the timeline of research activities.

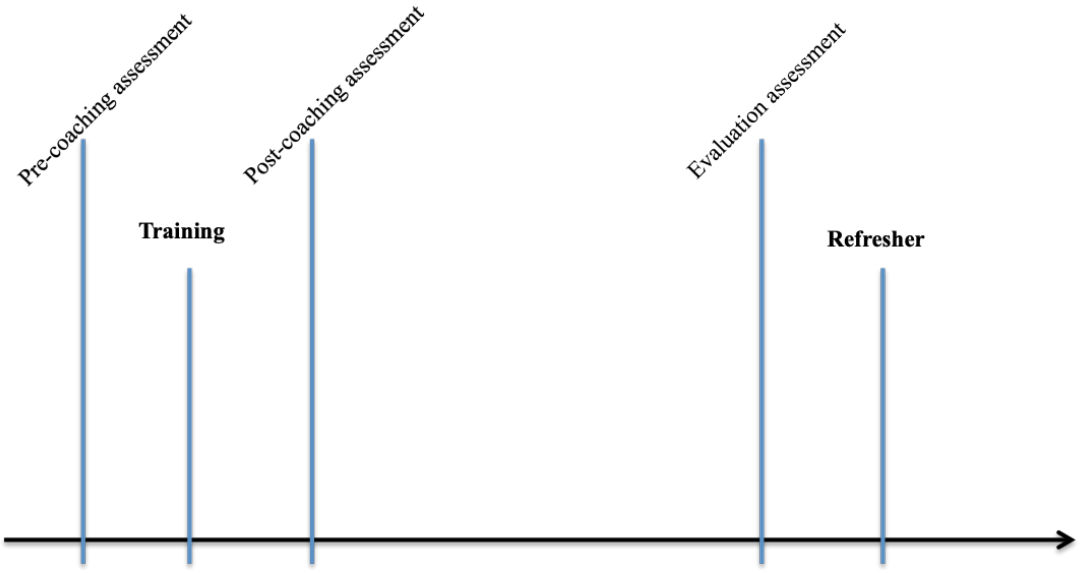


Figure 4.4: Timeline of Skills and Knowledge Assessments

4.5.6 Study procedures, data types and data collection

All healthcare workers, both from the provincial hospital where the training was held, as well as those from surrounding area health clinics and nurse aid posts who attended the EENC refresher training, were invited to participate in the evaluation assessment. Prior to the start of the evaluation, the purpose of the study was explained and the plain language statement was supplied (see Appendix G: Plain Language Summary and Appendix H: Participant Consent Form). At NRH, where several days of recruitment were required to capture the targeted staff, signs were posted in the labour ward and postnatal areas. Members of the research team would invite participants by visiting the hospital wards during each shift and recruiting participants. Staff who were on active clinical duties would usually attend during their allotted lunch or break period.

4.5.6.1 Written test and questionnaire

The written test and questionnaire were carried out concurrently. The written test was conducted in a standardised manner across all settings. A separate quiet room was nominated adjacent to the skills assessment area for this purpose. Participants would write their name on the written test and complete the form before or after the skills evaluation (see Appendix I: Written Survey and Test). The written test was accompanied by a questionnaire addressing specific details of clinical experience and demographic details of importance to describe the characteristics and experience of the participants. A member of the research team was on hand to answer questions related to the survey or test, as well as to translate any words or queries into Solomon Islands Pigin English language as required. No time limit was set for completion of the written test.

The written test consisted of 12 questions from the original EENC training on the themes of routine care, breastfeeding and resuscitation and was unchanged from the original assessment. Answers were either in multiple choice or short answer format.

The questionnaire was targeted at the secondary outcomes of interest and their impact on knowledge and skills retention and asked for the following information:

- healthcare workers:
    - role and qualifications
    - years of experience
    - place of work and duration at current work

- neonatal experience
    - births attended over preceding four weeks
    - resuscitation (bag and mask/stimulation only)
    - prior EENC refresher
    - prior EENC Health Facility Strengthening activities
    - prior neonatal training.

4.5.6.2 EENC skills assessment

The aim of the skills assessment was to assess the skills of the participant in managing a newborn in two scenarios, the 'breathing' and 'non-breathing' baby. The scenarios were carried out in a room prepared for the purpose under examination conditions. The skills checklist was the assessor's reference throughout the assessment (see Appendix J: Skills Checklist). Standardised steps were followed for the assessment based on the content of EENC training modules with minor modifications:

1. The training room was prepared: Either the facility's labour room or a room similarly arranged was used. The room had to have a delivery bed, sink, soap, paper towels, room thermometers and wall-clock.
2. A standard set of supplies was sourced from the facility or supplied by the research team as required:
    a. manikins (NeonataliesTM and MamaNataliesTM) with 2 L bottle for water to fill manikins with spraying bottles
    b. suction device
    c. newborn bag and mask (0 and 1 sizes)
    d. delivery kits included forceps, ties, clamps, sterile scissors, clean gloves (and a box of extra gloves), syringe and oxytocin
    e. four large cloths: one each for drying and for covering the baby and two for the newborn resuscitation area.
3. When two assessors were present, one would provide instructions and the second assessor would perform the actions required while wearing the birth simulator (MamaNatalie^{TM}) for the scenario.
4. The assessment began with a description of the scenario as per the EENC scenario:

Scenario 1: Breathing baby

'The woman is fully dilated. Participants have already weighed her, taken her blood pressure, listened for fetal heart tones and recorded information on a partograph. There is no more time; she will deliver in about one minute. Please demonstrate perfect immediate routine care of the newborn, including setting up of equipment.'

Assessor monitors progress of participant with checklist, offering prompts as required.

Scenario 2: Non-breathing baby

'The baby is born and needs drying. On assessment, the baby is not breathing.'

Assessor keeps time, participants have the first minute to ventilate the baby. Upon getting good chest rise, they have to demonstrate 30–50 breaths per minute.
If achieved after 30 seconds of ventilation, the facilitator should simulate umbilical pulsations of > 100 per minute and chest rises of 40 per minute.

Figure 4.5: MamaNatalie Birthing Stimulator (source: https://www.laerdal.com/)

1. The participant was assessed according to the skills checklist. Each activity on the checklist was scored out of 2: 0 = not demonstrated, 1 = partial demonstration or prompting required and 2 = demonstrated. Prompting by the assessor was offered as required. However, if prompted the maximum score for the task was 1. Following the assessment, if two assessors were running the scenario, the scoring marks were discussed to ensure agreement.

2. A total score was calculated for each participant, for each scenario, and entered into a password-protected Excel database.
3. Following the assessment, participants were invited to review the steps of the scenarios on which they did not score 0 or 1. Specific attention was given to ensuring participants were proficient with the bag-and-mask technique.

4.5.6.3 Practical elements and post-training review

The assessors endeavoured to make the assessment environment stress-free and supportive. Following the formal component of the training sessions, the assessors would facilitate a discussion and demonstration on the common areas of strengths or challenges identified in the scenarios and assessment.

4.5.7 Data analysis

Assessment scores were entered into an excel database, and prior assessment scores were retrieved from the EENC training database. The data were analysed in STATA for descriptive and statistical results.

4.5.7.1 Paired T-test

A distinguishing feature of this evaluation compared with previous research was the ability to compare assessment data for the same participant at different times through their pre- and post-test assessment scores, and pre-refresher scores. Doing so enabled the research team to describe the retention of knowledge and skills over time for the same individual, rather than relying on group averages to describe impact.

A paired *t*-test helps to describe the difference between two variables for the same subject. It compares the null hypothesis (i.e. true mean difference between paired sample is 0) with the alternate hypothesis (i.e. true mean difference between paired samples is not equal to 0). We used a cut-off value for statistical significance (*p*-value) of less than 0.05.

4.6 Implementation Evaluation of a Multifaceted Intervention

4.6.1 Background

This study is set within the evolving paradigm of implementation research, a field that aims to describe the reasons and the way in which implementation of evidence-based interventions may succeed or fail. As described in Chapter 3, a broad range of theories

and methods fit within the definition of implementation research [102]. In the field of global health, there is increasing momentum towards conducting implementation research owing to its applicability in addressing challenges in implementation and scale-up of interventions [166]. The targets of implementation research can be broad and extend beyond those of traditional clinical research to cover operational research, policy implementation, program evaluation, implementation of evidence medicine and participatory action research [102].

Implementation research has specific benefits as a research approach through the contextual nature of its application. Implementation studies have tested protocols in the context of programs in the 'real world', as compared with controlled experimental methods. In low- and middle-income country settings, where resources and personnel are constrained, previous implementation research findings have led to significant changes to national and WHO Guidelines [167] and improved patient care in underserved settings by highlighting contextual themes for policymakers [168].

A definition of implementation science specifically relevant to the scope of this study is as follows:

> Implementation science is a multidisciplinary specialty that seeks generalisable knowledge about the behaviour of stakeholders, organisations, communities, and individuals in order to understand the scale of, reasons for, and strategies to close the gap between evidence and routine practice for health in real-world contexts. [169]

The methodological approach of implementation science distinguishes it from basic science and randomised control trials. One such defining feature is its specific relation to assessing effectiveness within *routine* settings, mostly through the descriptive, case-control and retrospective or prospective cohort analysis methods [170]. Hence implementation research seeks balance between the desire for rigorous scientific approaches and feasible, timely research [102]. When implementing programs to improve quality of care, implementation research can be used to describe outcomes, assess the feasibility of the new interventions and advocate policy change [170]. This approach can facilitate the generation of research questions from programs by using simple designs focused to answer the implementer's questions and supports close collaboration between the research partner and program staff [170].

Nevertheless, implementation research methods have some limitations. The highly contextual nature of the research question and its exploration in a specific setting may limit broader application of findings.

4.6.2 Study objectives

The objective of this study was to describe the experience of the implementation, and to identify strengths and weaknesses of the approach of the intervention, to address the fourth research question: **What is the implementation experience from a multifaceted intervention to improve newborn care in Solomon Islands?** The study aimed to describe the lessons learned from the implementation process that were specific to the context of Solomon Islands and to describe factors that could shape future implementation.

4.6.3 Data collection

Qualitative data were obtained through SSIs and FGDs with healthcare workers who had received the intervention at the time of the EENC refresher. Quantitative data were obtained from structured assessments at the conclusion of the intervention using the structured assessment tool described in Section 4.4.4. For the interviews at NRH, selection of interviewees was purposive to reflect the diversity of cadres and the breadth of roles/responsibilities of healthcare workers in program implementation. At provincial hospitals, all participants who attended the refresher training participated in the FGDs.

Owing to the challenges with access, the quantitative assessments were timed as close to the end of the implementation as possible. The evaluation was performed in a practical manner, within the constraints of staff availability, transport options, cost and availability of the local team to be present for researchers' visits. Evaluations were timed to occur with other components of the intervention (e.g. refresher training) to maximise the utility of visits to the provincial hospitals because of limited research resources.

It was key to the approach of this thesis for participants to genuinely reflect on their experiences, their challenges and positive experiences. Therefore, the discussion environment needed to be comfortable and free of criticism, perceived implication or identification of comments. Therefore, some time was spent at the outset of the interview to highlight the interviewers' roles and to explain the need for recording, the individuals who would view transcriptions, the ways in which the interview information would be used and the process of de-identification.

At the provincial hospitals, focused group discussions were the main form of qualitative data collection. At the NRH, more SSIs with key stakeholders were conducted. This approach was adopted because of the smaller numbers of participants at the provincial hospital sites, where a natural flow for participants to progress together through the assessments and research components was established through the timing of the training days. The FGD, as compared with an individual SSI, reduced the formality that could have been associated with interviewing each participant separately.

During the FGDs, participants often needed time to become comfortable in answering more sensitive questions, such as critiquing the implementation experience and highlighting the challenges of their workplace and workplace culture. Often, a more outspoken member of the group would broach the more sensitive issue and others would follow with thoughts of their own. If the FGD did not flow, the facilitators would prompt or suggest experiences from other settings with which participants were likely to relate.

For the FGDs and SSIs, questions were based on the domains of the theoretical domains framework, a validated framework for describing behaviour change in implementation research [171]. Experienced qualitative researchers reviewed the guide (AG and JH), and it was trialled by the research team (AJ, AM and ST) prior to use. The language and terminology were modified to be appropriate to the local context. Probe questions were included in the protocol to allow interviewers to follow threads of inquiry as required. Two female Solomon Island midwife investigators (AJ and AM) and one male paediatrician from Australia, the primary researcher (ST), conducted the interviews and FGDs.

Of the 12 themes available from the theoretical domains framework [171], seven themes specifically related to the multifaceted intervention were selected and these formed the basis of the interview guide (see Appendix K: Interview Guide):

- professional role and identity
- social norms
- beliefs about capabilities
- skills, knowledge, emotion
- beliefs about consequences
- environmental context and resources
- goals.

4.6.4 Data recording and transcription

All interviews and FGDs were recorded using AudioNote (v 7.0.2 for iOS 11). The app ran from a portable electronic device and allowed simultaneous note taking, time stamping and highlighting within the recording. Interviews were conducted in English and Solomon Islands Pidgin English by one or two interviewers. Recordings were transcribed into English and entered into NVivo (v 12, QSR International Pty Ltd, Victoria, Australia).

4.6.5 Study population

Eligible participants were healthcare workers (doctors, nurses, midwives and nurse aides), who had previously attended EENC training and who gave consent to be interviewed. Recruitment continued until data saturation was observed, which occurred after five interviews and eight FGDs.

4.6.6 Data analysis

The analysis continued throughout the interview process. An inductive approach was utilised, in which iterative analysis was conducted simultaneously with data collection, which enabled the main themes to be refined with subsequent data collection [119, 172]. This method involved brief, discussion-based analysis following each round of interviews by the investigators. The investigators would reflect on themes arising from the interviews and use these to enable questions to evolve in an iterative process.

Using the first four transcripts, three experienced researchers (JH, AG and ST) independently developed the coding scheme for application to all of the transcribed interviews [173]. Using the coding scheme, categories were developed to summarise responses to the research questions. These were coded as ‘nodes’ in NVivo to allow visualisation of the interview excerpts relevant to each category. Then, themes were derived from the categories and illustrative quotes were chosen as being representative of each theme.

4.6.7 Ethical and institutional clearance

This study was approved by the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16; see Appendix L) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1; see Appendix M).

Approval for the intervention and its evaluation was given by the head of Reproductive and Child Health Division, MHMS, Honiara, Solomon Islands. Prior to commencing the research activities at each facility, the research team met the head of medical and nursing and discussed the planned activities.

4.7 Conclusion

The methods chosen to investigate the questions in this thesis were designed to be feasible, in step with the evolving neonatal care services, and driven to provide useful and pragmatic answers to the research questions in the Solomon Islands context. The use of qualitative and quantitative methods, which involved use of multiple data sources and time points, reflects an attempt to reconcile scientific rigor with the practical reality of delivery and assessment of a newborn care program with a complex causal chain.

The following four chapters present the results of the thesis utilising the methods described, in response to the research questions (see Table 1.1: Research Questions and Associated Study).

Chapter 5: Assessment of the Quality of Neonatal Care in the Solomon Islands

This chapter is presented as published, however, the numbering of the sections, figures and tables has been changed for continuity and ease of cross-reference.:

Tosif, S., Nasi, T., Gray, A., Sadr-Azodi, N., Ogaoga, D., & Duke, T. (2018) Assessment of the quality of neonatal care in the Solomon Islands. *Journal of Paediatrics and Child Health, 54*(2), 165–171.

5.1 Overview

This study presents the results of an assessment of the quality of care in five hospitals in Solomon Islands. It used the framework described in Chapter 2 and describes the *input* and *process* aspects of newborn quality of care using a standardised, structured assessment tool. The strengths and weaknesses of the state of newborn quality of care were presented, which shaped the intervention (Chapter 7) and form a baseline of comparison for later evaluation (Chapter 8).

5.2 Abstract

Aim: This study aims to identify strengths and obstacles for improving the quality of newborn care in Solomon Islands. Improving the quality of newborn care is a priority in the Sustainable Development Goals and the Action Plan for Healthy Newborns in the Western Pacific. The neonatal mortality rate in Solomon Islands, a lower-middle-income country, has decreased more slowly than the overall child mortality rate. In 2013, neonatal mortality (13.2/1,000) constituted 44% of under-5 deaths (30.1/1,000).

Methods: A cross-sectional study of newborn care in five provincial hospitals was conducted using a World Health Organization assessment tool for hospital quality of care. Twelve months of neonatal records of the National Referral Hospital (NRH) labour ward and nursery were audited.

Results: Essential medications and basic equipment were generally available. Challenges included workforce shortages and lack of expertise, high costs, organisation and maintenance of equipment, infection control and high rates of stillbirth. In the NRH labour ward, there were 5,412 live births, 65 (1.2%) 'fresh' stillbirths and 96 (1.8%) 'macerated' stillbirths in 12 months. Over the same period, there were an associated 779 nursery admissions, and the main causes of mortality were complications of prematurity, birth asphyxia, congenital abnormalities and sepsis. Total neonatal mortality at NRH was 16 per 1,000 live births, and 77% of deaths occurred in the first 3 days of life.

Conclusions: Infrastructure limitations, technical maintenance and equipment organisation were obstacles to newborn care. Greater healthcare worker knowledge and skills for Early Essential Newborn Care, infection control and management of newborn complications are needed.

Keywords: Developing countries, neonatal assessment, neonatal mortality, quality of care, small island nation, Western Pacific

5.3 Introduction

Ending preventable newborn deaths in Oceania is a global and regional priority. Mortality in this age group was estimated to account for 44% of under-5 deaths in Solomon Islands in 2013 [12]. Regardless of the significant improvements in mortality for children under the age of 5 years, newborn mortality has decreased at a much slower rate, and improving outcomes for newborns is a priority under the Sustainable Development Goal agenda. Poor progress reflects challenges in access to facilities providing quality care for newborns, an objective inseparable from improving maternal health [31, 175]. The majority of newborn deaths occur in the first three days of life despite the availability of simple, cost-effective interventions to prevent these [12].

Solomon Islands, a lower-middle-income country and small island nation, faces unique challenges in the provision of health care across a large geographical area serviced by a small workforce. It is recognised as a fragile state [176], and over the past 15 years, efforts to improve health care have been challenged by economic vulnerability, social unrest and a series of complex emergencies. Solomon Islands remains at high risk of susceptibility to extreme natural events [177].

Unlike in many countries facing such challenges, Solomon Islands has a high rate of institutional delivery of newborns (95% urban, 84% rural) [115]. The rates of routine immunisation and proportion of exclusively breastfed infants under 6 months of age are improving [178]. The Solomon Islands Ministry of Health and Medical Services (MHMS) is in the process of establishing universal health coverage and, together with development partners (World Health Organization [WHO] and United Nations International Children's Fund), aims to identify and improve the types of health facilities available and improve core services, infrastructure and equipment for newborns.

As Solomon Islands embarks on efforts to improve and scale up newborn care, an understanding of the baseline quality of care is required. Previous studies assessing the quality of care for children in Solomon Islands [15] and neonates in other countries [179] have illustrated the links between assessments, health policy and quality improvement activities. Information regarding gaps in standards of care, referral guidelines, infrastructure (basic equipment and medications for neonatal care) and health systems for neonatal services are essential to understand, shape and prioritise interventions. The purpose of this study was to assess newborn services and describe the obstacles to improving newborn quality of care.

5.4 Methods

5.4.1 Study sites

A purposeful sample of health facilities was chosen following consultation with the Solomon Islands MHMS and paediatricians from the National Referral Hospital (NRH). The provinces in which hospitals were selected account for 80% of the population of the country. They were chosen as being representative owing to size and location, and as the sites with the highest number of births (see Table 5.1). Four provincial hospitals (Gizo, Western Province; Kilu'ufi, Malaita Province; Kirakira, Makira-Ulawa Province; and Good Samaritan Hospital, Guadalcanal Province) and the NRH (Honiara, Capital Territory) were systematically assessed over 1–2 days per site.

Table 5.1: Data on Study Sites

Hospital	NRH	Kilu'ufi	Gizo	Kirakira	Good Samaritan
Province	Honiara town council	Malaita	Western	Makira-Ulawa	Guadalcanal
Province population	64,609	137,596	76,649	40,419	93,613
Provincial births (2013)	5,561	3,123	2,283	1,234	1,443
Provincial hospital births (2013)	5,554	953	587	405	626
Travel time to NRH	-	8 h (boat)	48 h (boat)	24 h (boat)	1 h (drive)
Mean births per month (range)	451 (388–514)	88 (71–102)	53 (35–77)	34 (23–44)	56 (43–67)
Special care nursery	Yes	Yes	Yes	Yes	No
Capacity (neonatal beds)	22	6	10	2	N/A

Mean nursery admissions per month (range)	65 (44–84)	11 (6–16)	6 (2–9)	3 (2–3)	N/A

5.4.2 Data collection

An audit of 12 months of birth and neonatal admissions for 2014 at NRH was conducted by extraction of data from ward logbooks. Data collected from the labour ward included number of births, stillbirths and neonatal deaths. Birth weight, duration of admission, diagnosis, treatment, survival and length of stay were retrieved from the NRH newborn nursery logbooks. The outcomes of interest were diagnoses, causes of mortality, rates of stillbirth, low birth weight and age at death. Data were entered into Excel (Microsoft 2011) for analysis. Descriptive statistics were calculated for clinical characteristics and neonatal outcomes. A facility-based neonatal mortality rate was calculated by combining data from neonatal and labour ward logbooks, removing duplicates and data on outborn neonates.

Site inspections were conducted together with the provincial hospital administrator and senior nursing staff in May 2015 and June 2016. The assessment team comprised a paediatrician from NRH (TN) and two NRH paediatric registrars (JS and SL) accompanied by a visiting paediatrician (ST). An assessment tool adapted for the local context from the WHO assessment tool for hospital quality of care was used [180]. The assessment covered all facility areas where newborn care was delivered (labour ward, postnatal ward, neonatal, children's wards and emergency and outpatients departments). Data were collected through observation of facilities and equipment and review of ward admission records for the preceding 12 months. Interviews with available healthcare workers were used to fill gaps in data and to provide them an opportunity to raise issues not covered elsewhere in the assessment. At the end of the assessment, healthcare workers were asked to discuss their priorities to improve newborn care. Data were entered into a standardised form and compared between sites to identify common themes, specifically regarding indicators important for newborn care.

This study was approved by the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1).

5.5 Results

The main findings of the hospital assessments are summarised in Tables 5.2 and 5.3. Basic equipment and supplies for the resuscitation and care of sick newborns, including bag and mask, oxygen source and pulse oximeters, were generally available. However, no site had these items ready and organised for routine and emergency newborn care in a resuscitation area. Facilities to support expressing and storing breastmilk, and items required for neonates with feeding difficulties (e.g. refrigerator for storage of expressed breastmilk and cup/spoon) were limited. Apart from NRH, which was regularly overcrowded, physical space in the nurseries was adequate and supported direct access for mothers. Most hospitals had access to running water. Electricity supply was by mains power, which was erratic, with surges and blackouts occurring commonly. Backup generators were present at all sites but frequently failed at the two largest hospitals. With regard to infection control, hand sanitiser dispensers were present in each ward but were invariably empty.

Table 5.2: Hospital Assessment for Newborn Indicators

Facility	NRH	Kilu'ufi	Gizo	Kirakira	Good Samaritan
Equipment/Supplies					
Oxygen source	Cylinder + concentrator	Cylinder	Concentrator	Cylinder + concentrator (not in use)	Cylinder + concentrator
Oximeter with neonatal probes	1	1	1	1	1
Overhead warmers	3	1	2	0	2
Phototherapy system	3	1	2	1	0
Self-inflating resuscitation bags	4	3	2	2	2
Thermometers	Yes	Yes	Yes	Yes	Yes
Stethoscopes	Yes	Yes	No	Yes	Yes
Glucometers + strips	Yes	Yes	Yes	Yes	Yes
Nasogastric tubes sizes 6, 8, 10, 12F	Yes	Yes	Yes	Yes	Yes
Facilities for Mothers					
24-h access to newborn	Yes	Yes	Yes	Yes	Yes
Cups/spoons for feeding babies	No	Yes	No	No	No

Dedicated EBM milk fridge	No	No	No	No	No
Ward Organisation					
Bag and mask assembled and within reach of resuscitation area	No	No	No	No	No
Overcrowding	Yes	No	No	Yes	N/A
Direct access (labour ward, operating theatre, postnatal)	Yes	Yes	Yes	Yes	N/A
Direct line of sight to high-dependency neonates	Yes	Yes	Yes (if nurse allocated)	No	No
Designated resuscitation area	Yes	Yes	Yes	No	Yes
State of building repair and maintenance	Satisfactory	Satisfactory	Excellent	Poor	Satisfactory
Continuous electricity supply	No	No	Yes	Yes	No
Continuous running water	Yes	Yes	Yes	Yes	Yes
Infection Control					
Wash basin, soap, water	No	No	No	No	Yes
Alcohol hand gel dispenser and supply	No	Yes	Yes	No	No
Staffing					

Paediatricians	3	1	0	0	0
Paediatric Nurse	> 10	0	1 (not on clinical duties)	0	0
Staff availability after hours	Paediatricians available on call, 3 nurses available at night	1 on-call doctor, 1-2 nurses per night	1 on-call doctor during night, 2 midwives per overnight shift	1 midwife per shift, 1 paediatric nurse, on-call doctor overnight	1 midwife, 1 nurse
First responder to resuscitation after hours	Nurse	Midwife	Midwife	Midwife	Nurse/Midwife
How is senior staff called for in emergency?	Mobile phone	Mobile phone	Mobile phone	Mobile phone	N/A
Time for senior doctor to arrive after hours	60–90 minutes, depending on availability of hospital transport	5–15 minutes	< 30 minutes	5–10 minutes	No doctor available

Table 5.3: Availability of Essential Medications for Newborn Care

	NRH	Kilu'ufi	Gizo	Kirakira	Good Samaritan
Adrenaline	Yes	Yes	Yes	Yes	Yes
Aminophylline	Yes	Yes	Yes	Yes	Yes
Ampicillin	Yes	Yes	Yes	Yes	Yes
Benzylpenicillin	Yes	Yes	Yes	Yes	Yes
Cefotaxime or Ceftriaxone	Yes	Yes	No	No	No
Chloramphenicol	Yes	Yes	Yes	Yes	Yes
Gentamicin	Yes	Yes	Yes	Yes	Yes
Phenobarbitone	No	Yes	No	No	No
Tetracycline eye drops or ointment	Yes	Yes	Yes	Yes	Yes

Almost all paediatricians, and nurses with training in paediatrics, were based at NRH, and only one other provincial hospital employed a paediatrician. Access to an on-call doctor after hours was affected predominantly by transport availability, and NRH had significant delay for paediatrician attendance. Almost all medications relevant for neonates were available at each nursery.

Data for 12 months from the NRH labour ward and nursery were analysed. At the labour ward, there were 5,412 live births, 65 (1.2%) fresh stillbirths, 96 (1.8%) macerated stillbirths and 38 neonatal deaths. In addition, 688 (12.7%) of newborns had low birth weight (< 2500 g).

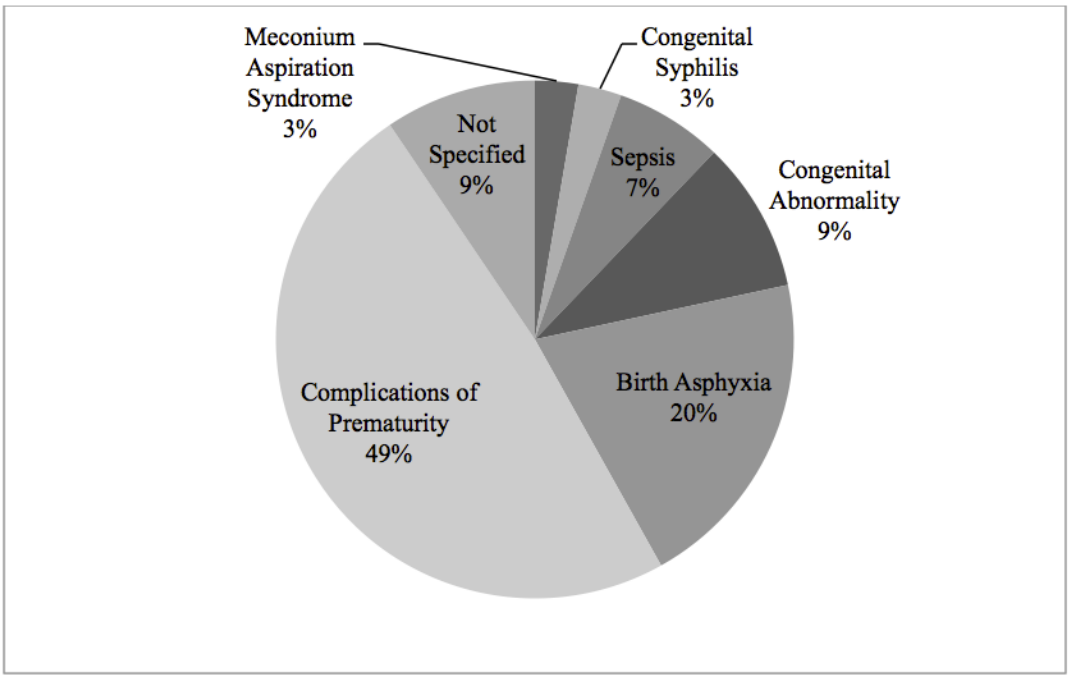


Figure 5.1: Final Diagnosis in Neonatal Deaths, NRH Nursery (n = 61) 2014

Over the same 12 months, there were 779 nursery admissions with 68 (8.7%) deaths. The final diagnosis for neonatal deaths was available for 61 neonates and is shown in Figure 5.1. Further, Figure 5.2 shows that 77% of deaths occurred in the first three days of life. Neonatal mortality increased with decreasing birth weight, with 6% mortality rate in neonates weighing more than 2,500 g, 13% mortality in neonates weighing 1,500–2,499 g, 35% mortality in neonates weighing 1,000–1,499 g and 80% mortality rate in neonates weighing less than 1,000 g. The most common reasons for admission were infection/suspected sepsis (46.5%), prematurity/low birth weight (22.2%), infection (10.0%), birth asphyxia (7.7%), hypoglycaemia (5.3%) and meconium aspiration (3.8%). Total neonatal mortality at NRH was 16 per 1,000 live births (89/5412).

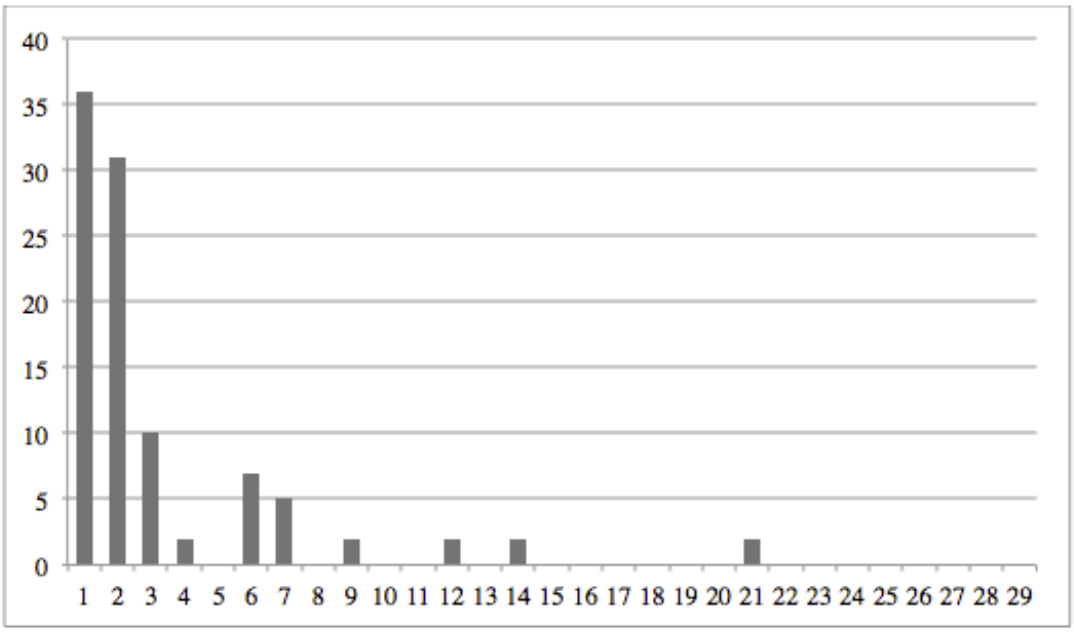


Figure 5.2: Age at Death for Newborns, by Percentage, NRH Nursery (n = 61) in 2014]

Staff interviews and group discussions raised several concerns regarding structure and process aspects of delivering neonatal care. The priority themes and challenges are described in textbox 1.

Structural: poor condition of buildings, equipment shortages (e.g. insufficient oximeters, interrupted oxygen supply and few thermometers), lack of technical support and prolonged time for repairs and spare parts (e.g. for replacement of phototherapy light bulbs)

Organisational: high workloads and insufficient numbers of nurses for care of neonates; more specially trained paediatric nurses needed

Training needs: more practical training modes preferred, staff most in need of a specific skillset were often not invited to appropriate training sessions and more opportunities for clinical attachments required

Resuscitation: concerns raised that a sense of urgency was not present in practice of immediate newborn care

Resources: more copies of references needed and guidelines most frequently cited need updating (e.g. Solomon Islands Standard Treatment Manual)

Textbox 1: Healthcare worker challenges and priorities in improving newborn care

5.6 Discussion

This study describes an assessment of four provincial hospitals and the NRH of Solomon Islands, a small but widely dispersed island nation in the Western Pacific, based on standards of newborn care established in WHO Guidelines. In these facilities, barriers to newborn care were equipment organisation, poor technical maintenance and lack of infection control measures. Health workforce limitations were marked by the scarcity of paediatric-trained nurses and lack of paediatricians outside the capital. An assessment of NRH birth and nursery admissions showed high rates of stillbirth and early neonatal deaths. The neonatal mortality rate at NRH of 16 per 1,000 live births is within reach of the SDG target of 12 per 1,000 live births [118]. However, at least as many stillbirths occur as neonatal deaths, which need to be accounted for in reaching targets to improve perinatal care.

The general availability of essential medications, oxygen and electricity was positive and constitutes an improvement based on an assessment in 2003 following 5 years of civil unrest [15]. However, maintenance and organisation of equipment was a problem. Empty hand sanitiser dispensers or hand hygiene facilities not within working reach of patient care areas point to the lack of a system for replenishment, procurement and distribution and lack of practical awareness of the importance of the basics of infection control. Although a bag and mask were present in each health facility, no hospital had an assembled, accessible bag and mask ready to use where neonates were born. This lack would lead to delays in initiation of resuscitation or recognition of resuscitation opportunities, which may contribute to the high rates of stillbirth and early neonatal death found in the audit conducted in this study, as described in other settings [181]. Routine newborn care is reliant on the availability of a few, but important, pieces of equipment in a timely manner. Resuscitation devices for newborns are listed as one of 13 lifesaving commodities in the improvement of maternal, child and newborn health outcomes [182].

Solomon Islands is emerging from a period of social unrest and environmental and economic challenges, which have adversely affected health service delivery. As a small island nation, it encounters challenges specific to this setting, such as high commodity and transport costs. Low staffing numbers, and the flow-on effects of strikes and low pay of nurses in particular, present challenges to workforce culture and quality and consistency of services. Training and maintenance of skills for such a dispersed population of healthcare workers, and births across a large number of facilities, is

logistically difficult and expensive. Sick neonates, whose conditions are fragile and require time-sensitive management, can face days of travel by road or sea, depending on prevailing weather conditions and availability of transport such as hospital ambulances or boats.

Similar to our findings, missing or underutilised essential equipment, logistical difficulties and poor supply have been described in low-and-middle income countries as barriers to delivering newborn care [183-185]. Inadequate hygiene measures, documentation, staff knowledge and skills, and insufficient essential equipment, are common themes [185-188]. In other assessments that found that essential equipment was available, other systemic factors, such as hand hygiene, inadequately trained staff, poor routine care and documentation and prescribing practices, affect quality of newborn care [153, 189], highlighting the need to focus beyond structural improvements.

The findings of the audit of admissions and neonatal mortality at NRH are consistent with those observed in low- and middle-income countries, where neonatal infections, birth asphyxia, complications of preterm death and congenital abnormalities account for the greatest disease burden among neonates [190], and highlight that more specialised training is needed in this area. This specialised training needs to take into account the health workforce in the country. In countries such as Solomon Islands, such training needs to include training of paediatric nurses with neonatal skills as well as more training for non-specialist medical officers who will practice in remote areas. A high rate of stillbirths could represent missed opportunities for resuscitation of a newborn [181] or the need for greater intrapartum monitoring [191, 192].

We identified health workforce problems, such as shortages of skilled staff and high turnover in this assessment, an issue identified in other countries [41, 193]. Our observations showed that knowledge and skills in recognition and management of the sick newborn were limited. Equipping healthcare workers with skills for resuscitation and capacity to care for sick newborns in the first week and beyond are essential [8, 181, 192]. These training issues need to be considered when equipment is made available. Resuscitation training is proposed to reduce term intrapartum related deaths by up to 30% [22]. Education programs focusing on this content were not consistently delivered in ways that will be effective and instead relied on one-off trainings provided by external agencies. Past assessments of healthcare worker knowledge and skills in newborn care in low-middle income countries have also identified that many staff perform below competency

levels [148, 194]. Barriers in establishing supportive practices following birth, such as with Kangaroo Mother Care, require significant training time and resources [179, 195], and resuscitation skills can be affected by decrement in knowledge and skills over time, requiring a long-term approach to quality improvement[58, 81].

To accelerate improvement in neonatal care, it is necessary to focus on interventions around the time of birth and identification and treatment of infections and intrapartum and birth complications [196]. Greater emphasis should be placed on evidence-based practices, which are known to improve outcomes in care of sick newborns and premature and low birth weight babies. These include nursing even very sick babies with their mothers for skin-to-skin contact to reduce hypothermia and to facilitate feeding, breastfeeding or the use of expressed breastmilk; preventing hospital-acquired infections; providing basic respiratory support, such as safe use of oxygen and CPAP; improving infection control; and limiting invasive procedures that carry risks [197, 198]. In addition to high-quality routine birth care, specific attention is required towards sick and small newborns and increased community-based postnatal care [196]. Simple interventions, such as implementing protocol-based management, enforcing hand hygiene and aseptic procedures, establishing Early Essential Newborn Care and abandoning unnecessary interventions, can lead to a significant decline in mortality in hospitals with limited resources [199].

However, this study has several limitations. The selection of sites was not random, and although the largest provinces with highest birth rates were chosen, smaller provinces may face different challenges. However, in Solomon Islands, which is a small country, five health facilities form a significant proportion of its health service. Interviews with staff relied on the individuals present on the days of assessment and may be affected by bias or recollection in reporting. Further, ward admission logbooks were the most reliable source of information, but some fields were unfilled and neonatal admissions or deaths may be underestimated as a result. This study focused on newborn quality of care; however, more information regarding intrapartum monitoring and obstetric care is needed to describe factors during labour associated with stillbirth or poor neonatal outcomes.

5.7 Conclusion

This assessment highlights some of the challenges to newborn quality of care in Solomon Islands. Neonatal outcomes are characterised by high rates of stillbirth and immediate and early neonatal death, marked by a high proportion of premature and birth-asphyxiated

infants. Following substantial improvements in child survival, specific attention is now required to improve newborn outcomes through improvement in routine newborn care practices, resuscitation and specialised newborn skills, technical maintenance and a focus on infection control in Solomon Islands.

Acknowledgments

We would like to thank MHMS and the Department of Paediatrics, NRH, for their contribution and support and UNICEF Fiji for funding this assessment.

Chapter 6: Cause-specific Neonatal Morbidity and Mortality in the Solomon Islands: An Assessment of Data from Four Hospitals over a Three-year Period

This chapter is presented as published:

Tosif, S., Jatobatu, A., Maepioh, A., Subhi, R., Francis, K. L., & Duke, T. (2020). Cause-specific neonatal morbidity and mortality in the Solomon Islands: An assessment of data from four hospitals over a three-year period. *Journal of Paediatrics and Child Health*, *56*(4), 607-614.

6.1 Overview

In this study, perinatal outcomes from three years of data from NRH and three provincial hospitals are presented. Case definitions are analysed according to the revised Wigglesworth classification. SCN admission characteristics are described and contrasted between the hospitals. Case-fatality rates for neonatal conditions are calculated as well as frequency of the diagnoses in admitted neonates. The risk of death from the most common neonatal comorbidities is investigated.

6.2 Abstract

Aim: Data on stillbirths and neonatal morbidity and mortality in low-middle income Pacific Island Nations, such as Solomon Islands, is limited, partly because of weak health information systems. We describe the perinatal mortality and clinical factors associated with poor newborn outcomes at four hospitals in Solomon Islands.

Methods: We conducted a registry-based retrospective cohort study at three provincial hospitals and the National Referral Hospital (NRH) in 2014–2016.

Results: We reviewed 23,966 labour ward births and 3,148 Special Care Nursery (SCN) admissions. Overall, still birth rate was 29.2/1,000 births and the perinatal mortality rate was 35.9/1,000 births. The latter rate was higher in provincial hospitals (46.2, 44.0 and 34.3/1,000) than at NRH (33.3/1,000). The most common reasons for admission to SCN across the hospitals were sepsis, complications of prematurity and birth asphyxia. SCN mortality rates were higher at the three provincial hospitals than at NRH (18.9% (95/598) vs. 8.6% (202/2,550), P-value < 0.01). At NRH, the conditions with the highest case-fatality rates were birth asphyxia (21.3%), congenital abnormalities (17.7%) and prematurity (15.1%). Up to 11% of neonates did not have a diagnosis recorded.

Conclusions: Perinatal mortality rates are high, and intrapartum complications, prematurity and sepsis are the main causes of morbidity and mortality for neonates at hospitals in Solomon Islands. Stillbirths account for 81% of perinatal deaths. These results are useful for planning for quality improvement at provincial level. Improved vital registration systems are required to better capture stillbirths and neonatal outcomes.

What is already known on this topic?

1. Neonatal mortality in low- and middle-income countries has improved at a slower rate than in older children over the past 20 years.
2. Perinatal mortality rates are unknown in Solomon Islands, and there is no system to routinely capture neonatal outcomes

What this paper adds?

1. Perinatal mortality is high in Solomon Island health facilities. A rate of 35.9 per 1000 births in the four hospitals is four times reported country estimates.
2. Perinatal mortality was 30% higher at provincial hospitals than the NRH

At the NRH, birth asphyxia, congenital abnormalities and prematurity had the highest case fatality rates

Keywords: Child health, child survival, maternal and child health, neonatal quality of care

6.3 Introduction

Solomon Islands, a lower middle-income country in the Western Pacific, is experiencing increasing demand for newborn, child and maternal health services. Births per capita are increasing since it has a young population that is entering reproductive age [110]. The country is considered a Small Island Developing State (SIDS), a recognised group of 58 low-lying nations with comparable economic, social and health challenges [128, 129].

Data on perinatal and neonatal outcomes in Solomon Islands and other SIDS in the Pacific are scarce. The most recent national census in Solomon Islands in 2009 did not report an estimate of neonatal deaths or stillbirths, although it reported that the estimated infant mortality rate was 22 per 1,000 live births. Solomon Islands did not meet most of its health-related Millennium Development Goal targets [200]. Neonatal data mortality is not routinely reported by the Solomon Islands Ministry of Health and Medical Services (MHMS); however, estimates by the Global Burden of Disease study and United Nations International Children's Emergency Fund place neonatal mortality at 8.33 and 9 per 1,000 live births and stillbirth rate at 9.37 per thousand births [116, 117].

Births and causes of deaths are often not registered in low- and low-middle-income countries. Under-reporting of neonatal deaths is of specific concern, given that neonatal mortality rates are the highest in countries and communities with the least information on deaths [201]. Deaths on day of birth account for a third of all global neonatal deaths, and two-thirds occur in the first week of life [202]. Some early neonatal deaths may be reported as stillbirths, thus further underestimating neonatal death rates [203]. Data on cause and timing of neonatal deaths is important to effectively design perinatal and neonatal interventions in national policy and programs [204].

There are complex challenges to improving healthcare services for mothers and newborns in Solomon Islands. These include challenges in maintenance of healthcare facilities, distance and transport, environmental conditions (including the effects of climate change, floods and earthquakes) and healthcare workforce issues, including limited numbers; inadequate workforce planning, training, distribution; and few opportunities for skills enhancement [205]. Owing to geographical and economic isolation from the only tertiary referral hospital, National Referral Hospital (NRH) in Honiara, provincial hospitals play a pivotal role in neonatal care.

We performed a registry-based retrospective cohort study to describe perinatal mortality and the factors associated with neonatal morbidity and mortality at the NRH and three provincial hospitals over a three-year period, to inform planning for quality improvement in neonatal care.

6.4 Materials and Methods

6.4.1 Study design

We conducted a retrospective review of ward registers at three provincial hospitals and NRH.

6.4.2 Setting and context

Solomon Islands has a population of around 680,000 [108], and it is the fifth largest country by population in Oceania. The most recent census data identified a fertility rate of 4.2 per woman; half of the population were less than 20 years of age [110]. Total expenditure on health per capita was approximately 107 USD in 2015 (Australia $4,035 USD) [206]. In 2013, the country had 302 health facilities, mostly primary health clinics and area health centres within the catchment areas of 10 provincial hospitals.

A purposive sample of four hospitals were selected for this study (see Figure 6.1): NRH (Capital City Province), Gizo (Western Province), Kirakira (Makira-Ulawa Province) and Kilu'ufi, (Malaita Province). The four hospitals serve account for 80% of the national population. They are the four busiest delivery facilities in the country and received approximately one-third of all births from each respective province.

The NRH provides the highest level of care available for mothers and newborns. The country has four obstetricians and four paediatricians, and all are based at the NRH. The NRH Special Care Nursery (SCN) provides a level of care most similar to a Level II nursery [207] and has trained paediatric nurses, capacity for non-invasive ventilation with continuous positive airway pressure and access to surgical and subspecialty teams. Resident doctors staff provincial hospitals, and most can only deliver vaginal births. Provincial hospital SCNs can provide oxygen, antibiotics and intravenous fluids, depending on facility setup and staffing expertise [205]. The Solomon Island Standard Treatment Manual provides basic guidelines on criteria for referral of newborns from smaller facilities to provincial hospitals. Transfer to NRH for mothers and neonates from provincial hospitals is determined on a case-by-case basis, and commercial flights are

used for transferring them. Transfer decisions within provinces are influenced by distance, challenges of terrain, availability of boats and vehicles, fuel availability, as well as prevailing weather conditions.

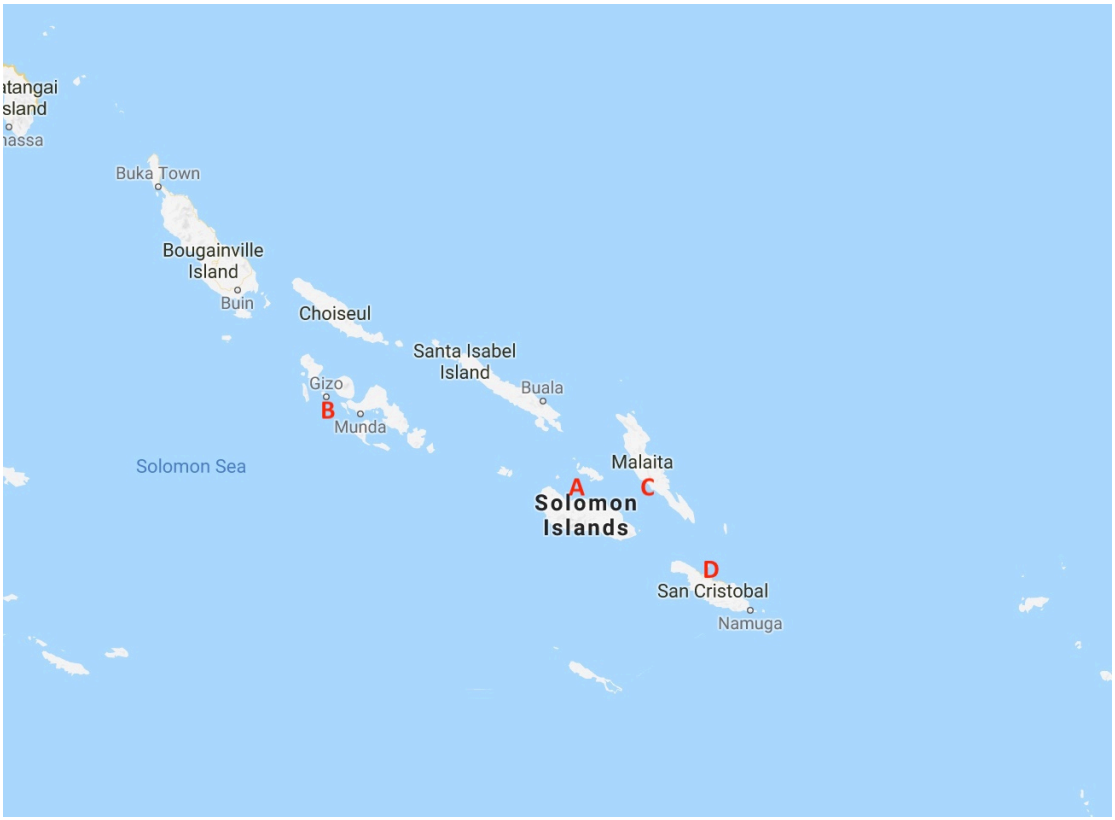


Figure 6.1: Map of Solomon Islands with Study Sites Highlighted

6.4.3 Data collection and analyses

We examined SCN and labour ward registries at the study sites, reviewing data from the 1 January 2014 to 31 December 2016 (inclusive). We documented information on the following variables if available in the SCN: date of birth, admission and discharge date, age at admission, sex, weight, referral source, diagnosis(es) and outcome (discharged, deceased). From the labour ward, we documented total births, fresh and macerated stillbirths and neonatal deaths. The data were manually entered into Excel and EpiData, before cleaning and analysis in STATA (Version 15.1). All available clinical diagnoses were coded separately for each neonate according to the registry entries. Case definitions from a revised Wigglesworth classification [208-210] were then applied, and a single cause of death was assigned using a hierarchical order (see Table 6.1 for case definitions).

Table 6.1: Case Definition and Clinical Diagnosis Criteria for Cause of Death Classification from a Revised Wigglesworth Classification [208-210]

Cause of Death	Case Definition	Clinical Diagnosis in Registry
Congenital abnormality	Lethal congenital abnormality: congenital heart, spina bifida, gastrointestinal malformation, other congenital syndromes	Multiple congenital malformation, congenital heart disease, spina bifida/hydrocephalus/anencephaly, 'syndromic baby' and death due to systemic conditions, such as gastrointestinal or renal failure
Prematurity	Prematurity, respiratory distress syndrome in preterm, necrotising enterocolitis in preterm	'Prematurity'
		'Very low birth weight' or 'Extremely low birth weight'
		Neonatal death with the following diagnosis if gestational age < 33 weeks or birth weight < 2500 g if gestational age is not known:
		Respiratory distress
		Birth asphyxia
		Necrotizing enterocolitis
		Infection
Birth asphyxia	Neonatal encephalopathy, birth asphyxia, hypoxic ischaemic encephalopathy	'Birth asphyxia' but excluding preterm infants
		Seizures and/or coma in the first two days of life in a term baby
		Early neonatal death in a term baby with no congenital malformations and a specific history of acute intrapartum insult or obstructed labour
Sepsis	Neonatal infection, sepsis/septicaemia, meningitis, pneumonia, presumed sepsis	'Neonatal infection'

		Sepsis/septicaemia Meningitis Pneumonia/acute respiratory tract infection Neonatal infection
		Pyrexia of unknown origin
		Omphalitis
		Cellulitis
Diarrhoea	Neonatal death due to diarrhoea	
Other	Specific cause of neonatal death not included in above:	− neonatal jaundice − meconium aspiration syndrome − respiratory distress syndrome in term babies

6.4.4 Study population and Definitions

The study population included all stillbirths and all neonates born at the hospital or admitted to the SCN before 28 days of life.

The following standardised definitions were used:

- neonatal period = from birth to 28 completed days
- stillbirth = foetus with 500 g birth weight and/or 20 weeks gestation without signs of life at birth [211]
- early neonatal death = death from day 0–6 of life
- perinatal mortality rate = number of stillbirths and early neonatal deaths per 1,000 births.

This study was approved by the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1).

6.5 Results

6.5.1 Perinatal mortality

Between 1 January 2014 and 31 December 2016, there were a total of 23,966 births at the labour wards of the four hospitals studied. The facility with the highest number of births was NRH (see Table 6.2). Fresh stillbirths accounted for most stillbirths in all hospitals except Kirakira, where macerated stillbirths were slightly higher. The combined still birth rate across the hospitals was 29.2/1,000 births and the perinatal mortality rate was 35.9/1,000 births. Perinatal mortality was higher in provincial hospitals than at the NRH (283/6,574 vs. 579/17,392, P-value < 0.01). Rates of low birth weight were similar at NRH (10.9%) and the provincial hospitals (11.8%). Data from Kirakira did not include referral source for neonates in the SCN; therefore, inborn/outborn status could not be determined.

6.5.2 SCN admission characteristics

The four hospitals had a total of 3,148 SCN admissions (see Table 6.2). Although smaller numbers of deaths occurred in provincial centres, the fatality rate of neonates admitted to the SCN was significantly higher as compared with NRH: 18.9% (95/598) vs. 8.6%

(202/2,550), P-value < 0.01. The most common diagnosis for a neonate admitted to a SCN across all settings was sepsis, followed by prematurity, birth asphyxia and congenital abnormalities (see Figure 6.2). Between 4–11% of admitted neonates had no admission diagnoses recorded; other data fields were incomplete at all hospitals except Gizo.

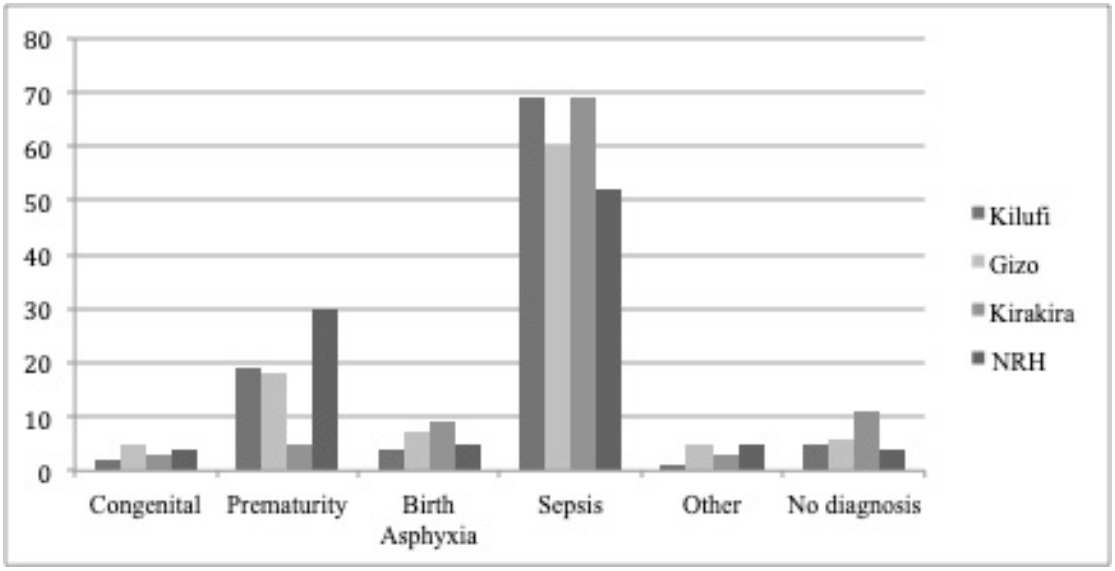


Figure 6.2: SCN Diagnosis by Hospital

NRH SCN characteristics

Further analysis was possible at NRH because of availability of detailed data. Almost half (49.3%) of neonates admitted were male, and 41.2% were female (9.5% missing sex; see Table 6.2). Deaths in the first three days of life accounted for 69.7% of all deaths. Mean birth weight was 2,801 g (SD 830 g); 1,801 (82.6%) of neonates admitted to the SCN were inborn. Median age at admission was day 0 (interquartile range [IQR] 0–1) for inborn and day 4 of life (IQR 2–10 days) for outborn, and median duration of admission was five days for all admissions (IQR 4–7).

Table 6.2: Hospital Labour Ward and SCN Demographics and Statistics, 2014–2016

Labour Ward	Hospital	NRH	Kilu'ufi	Gizo	Kirakira	Total
	Percentage of annual province births at hospital[1]	100%	29.6%	25.3%	32.4%	

	Median births per month (range)	483 (385–605)	83 (55–111)	63 (40–97)	36 (22–59)	-
	Total births (number)	17392	2988	2275	1311	23966
	Total stillbirths (macerated, fresh)	473 (203, 270)	108 (45, 63)	90 (3, 87)	30 (16,14)	701 (267, 434)
	Early neonatal deaths	106	30	10	15	161
	Still birth rate	27.2	36.1	39.6	22.9	29.2
	Perinatal mortality rate	33.3	46.2	44.0	34.3	35.9
SCN	**Hospital**	**NRH**	**Kilu'ufi**	**Gizo**	**Kirakira**	**Total**
	Admissions	2550	300	200	98	3148
	Total deaths (inborn, outborn)	202 (138, 30[†])	56 ([†])	24 (10, 14)	15 ([†])	297
	SCN fatality rate[§]	7.9%	18.7%	12.0%	15.3%	9.4%

[1]Source = MHMS Health Information 2013

[†]Incomplete data

[§]SCN Fatality Rate = percentage of deaths from all admissions to the SCN

6.5.3 NRH SCN mortality characteristics

During the study period, there were 202 deaths (7.9% of total 2,550 admissions) in the SCN, and these varied based on diagnosis (see Table 6.3). Figure 6.3 illustrates the relationship between diagnosis and death by presenting the proportion of babies that died and each diagnosis. Sepsis constituted the majority of admissions (51.6%) but accounted for only 11.4% of neonatal deaths and had the lowest case-fatality rate. The highest proportion of deaths was from prematurity (57.4% of neonatal deaths), which accounted for 30.1% of all admissions. Extremely low birth weight and very low birth weight (VLBW) newborns constituted 7.0% (n = 178) of all admissions, but 33.2% (n = 67) of deaths and the proportion of deaths increased with decreasing birth weight. Median length of stay was 22 days for VLBW neonates, five days for normal weight neonates and one day for extremely low birth weight neonates because of the high case-fatality rate in this group.

Table 6.3: NRH SCN Demographics and Outcomes, 2014–2016 (202 deaths, 2,550 Admissions)

Demographic		Admissions		Case-fatality Rate (%)	Deaths	
		n	Admissions (%)		n	Deaths (%)
Cause of death	Congenital abnormality	96	3.8	17.7	17	8.4
	Prematurity	767	30.1	15.1	116	57.4
	Birth asphyxia	127	5.0	21.3	27	13.4
	Sepsis	1315	51.6	1.8	23	11.4
	Other	135	5.3	7.4	10	5.0
	Not recorded	110	4.3	8.2	9	4.5
	Total	2550			202	
Admission weight (g)	< 1000	45	1.8	77.8	35	17.3
	1000–1499	133	5.2	24.1	32	15.8
	1500–2499	594	23.3	8.6	51	25.2
	2500–3999	1,542	60.5	4.5	69	34.1
	> 4000	144	5.6	4.9	7	3.5
	Not recorded	92	3.6	8.7	8	4.0
	Total	2550			202	

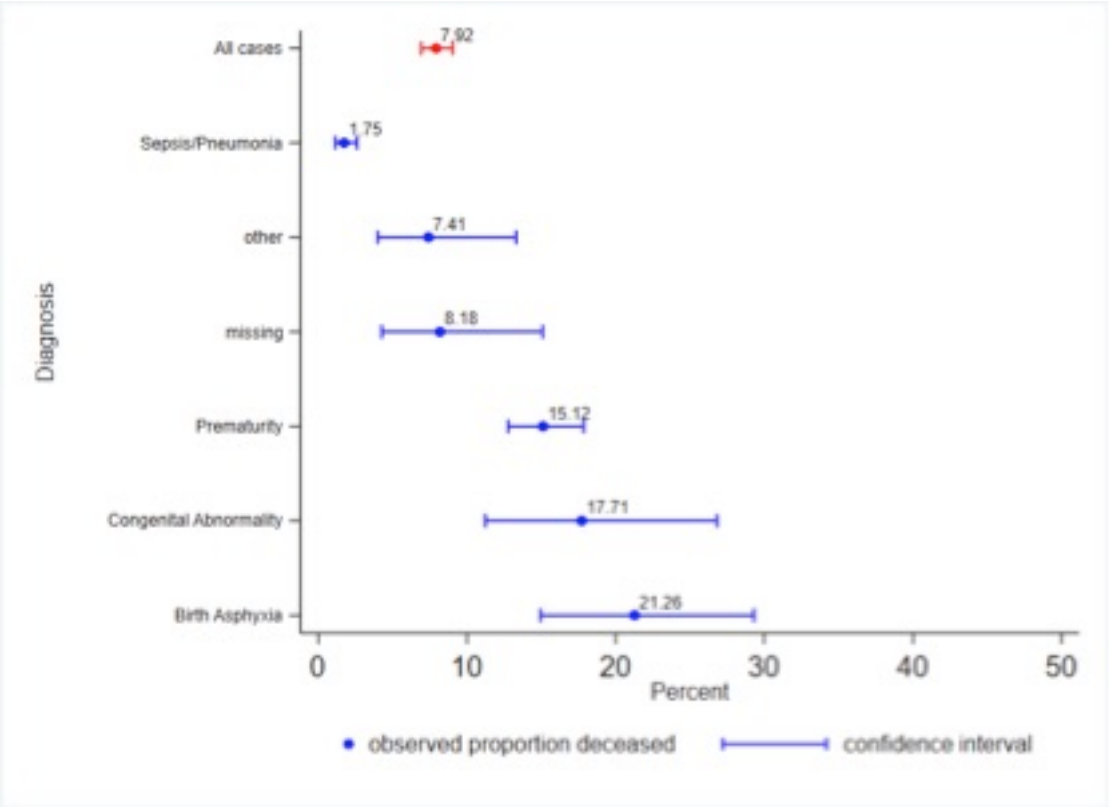


Figure 6.3: Proportion of Deceased Babies Based on Their Diagnosis and Overall Proportion Deceased (Top Bar) at NRH.

6.6 Discussion

In this study, we documented very high still birth rate and perinatal mortality rate in four hospitals with the highest number of deliveries in Solomon Islands, a low-resource Pacific island setting. Perinatal outcomes were significantly worse in provincial hospitals compared with NRH. Mortality rates were twice as high for neonates admitted at a provincial hospital SCN than at NRH; those admitted with birth asphyxia, congenital abnormalities and prematurity had the highest case-fatality rate. This is one of the few studies outlining in detail the perinatal mortality in Solomon Islands, where reporting on stillbirths and newborn deaths is not yet routine.

Although the population attending a provincial hospital may include a greater proportion of higher risk births, the average still birth rate of 29.2 per 1,000 births in the four hospitals in our study is higher than estimates for the entire country of 17.6 per 1,000 [212], and higher than that of other countries in the region (12.2 per 1,000 overall) [213]. This study supports findings from previous reports on Solomon Islands, that identified high perinatal mortality rates in Gizo of 42 per 1,000 births and in Kirakira of 31 per 1,000 births [120, 121, 214]. NRH had the lowest stillbirth rate in this study, despite

receiving most anticipated high-risk deliveries. This finding may reflect greater access to the caesarean section procedure, instrumental deliveries, ultrasound and intrapartum monitoring compared with provincial hospitals where these are less available. Of the provincial hospitals, Kirakira had a lower stillbirth rate than the other hospitals, a possible reflection of its smaller catchment area and better accessibility by road compared with other provincial hospitals. Fresh stillbirth suggests death during the intrapartum period, in the 12 hours prior to delivery[203]. The high rate of fresh stillbirths identified in this study may also reflect misclassification of early neonatal deaths as fresh stillbirths, as has been reported previously [212]. This hypothesis is supported by observations of reduction in fresh stillbirth rates following implementation of resuscitation programs in other countries, likely due to improved recognition [212].

The profile of neonatal morbidity and mortality of Solomon Islands is comparable with that of other low- and low-middle income countries where mortality is highest in low birth weight or preterm neonates, and most deaths occurring in the first days of life are from intrapartum complications [209, 215-223]. Other countries in the region face similar challenges. In Timor Leste, a study of the National Hospital Guideo Valadares, Dili found a mortality rate of 11.4% for hospitalised neonates [221]. The highest risk was from prematurity, birth asphyxia and congenital abnormalities. In Goroka Hospital, Papua New Guinea, very low birth rate, septicaemia and birth asphyxia were the most frequent causes of death for neonates [223]. In Fiji, a study using a perinatal mortality audit showed delays in seeking care, and delay in the provision of adequate care at health facilities contributed to stillbirth and neonatal deaths [222].

The disparity in perinatal and SCN fatality rates between provincial hospitals and the NRH raises questions. Referral bias might lead to higher mortality rates in the tertiary referral hospital, but the opposite findings suggest there are barriers to referral of seriously ill or high-risk neonates, and limitations in quality of care. Limited avenues are available for referral from provincial hospitals due to geographical isolation, transport, cost, communication and unclear referral criteria and pathways. Women from remote health clinics with obstetric emergencies and sick newborns may have experienced delays in reaching a provincial hospital, and hence are in poorer condition on arrival. The delays in problem recognition and seeking care, transport delays and facility delays have been well described [224] as have poorer outcomes in ‘outborn’ neonates in referral centres [209, 217, 218, 225, 226]. This local referral bias, and onward referral obstacles, are likely to partly account for the higher mortality rates in provincial hospitals compared with the

tertiary centre. This is compounded by the issue of limited resources at provincial hospitals: fewer staff with fewer opportunities for continuing professional development and training.

Estimates of perinatal mortality from this study are discordant with the estimated neonatal mortality rates for the country. Solomon Islands was one of several countries in the Western Pacific Region that did not meet more than half of health-related Millennium Development Goal targets, including under-5 mortality rate s[200]. Yet reported estimates of neonatal mortality now place the country as having reached Sustainable Development Goal targets [116, 117]. The Solomon Islands Census, most recently completed in 2009, provided estimates of child mortality; however, questions relating to newborns and stillbirths were absent [110]. Although a health survey in 2015 estimated neonatal mortality rates between 5 and 15 depending on province, very few neonatal deaths and stillbirths were captured in the survey sample, which affects validity of the results [122]. National estimates rely on available data sources (e.g. vital registration, published literature, country consultations and surveys). Global Burden of Disease studies use a diverse range of data sources where available and statistical analysis to determine trends [227]. Caution in interpreting national estimates is required, so that programmatic and funding attention for newborn care is not undermined by underestimates of neonatal mortality rates for the country.

Perinatal mortality is not routinely reported in Solomon Islands and the available data have gaps in demographic and diagnostic details. Most low- and middle-income countries have incomplete, sparse or unreliable data on neonatal deaths and stillbirths [203, 228, 229]. Our findings emphasise the need for improved data collection for mortality rates and causes of death through routine collection systems, standardised with ICD Codes [230]. Facility-based data systems for monitoring newborn outcomes have been recommended to address data gaps where vital registration systems are not in place [201], and these are feasible at large scale in low- and middle-income countries [231-233]. Emphasis is placed on determining the causes of death in the newborn period, to inform programme design and monitoring [234]; however, policy and funding interventions may be limited by gaps in data and subsequent interpretation.

Estimating neonatal mortality is challenging in this setting, given the disbursed health facilities and births and inaccurate reporting of neonatal deaths. A formal process for neonatal mortality auditing was not established until recently at NRH [235]. Neonatal

mortality rate and causes of death are core indicators for Early Newborn Action Plans (ENAP) [196] and for the Sustainable Development Goals. Current reports are based on estimations from a combination of vital registration systems, census or surveys where available [196]. However, reliable civil registration data are not available for 92% of the world's births [4,234]. Where national data collection systems are limited, and newborns have low visibility, audits such as this can provide valuable information on the aetiology of newborn morbidity and mortality.

However, this study has several limitations. The retrospective design allows only the available written records to be analysed, which were incomplete in some fields for more than 10%. No clear distinction was made between some clinical diagnoses, such as whether low birth weight was due to prematurity or intrauterine growth restriction, and therefore, diagnoses of prematurity may have been overestimated. The hierarchical method of death classification used in this study allows an overview of causes of death but does not reflect the complexity of co-existing diagnoses. Neonates who died at home, or in another facility, after leaving hospital would not be identified in these data. Despite being located at the same facility, the SCN and labour wards of each hospital operate distinctly as regards their records, and a linkage between the two has not been established for the outcomes of newborns. This could be addressed by establishing a civil registry, with a unique identifying number for each child allowing greater tracking of births, deaths and causes of death [196]. A better system is needed for vital registration in Solomon Islands, where paper records are unreliable and electronic systems are not yet available.

6.7 Conclusion

High perinatal mortality rates in Solomon Island hospitals highlight the need for programs to improve maternal health and care during the critical intrapartum period and to address challenges in accessing quality care, establishing referral pathways and avoiding delays. Support for improving neonatal quality of care at provincial hospitals, with data collection systems that allow routine analysis are needed. Having a unique identification number system for all births, which would assign a number to be used at every health encounter, would assist accuracy of data and continuity of care.

Chapter 7: Healthcare Worker Knowledge and Skills Following Coaching in WHO Early Essential Newborn Care Program in the Solomon Islands: A Prospective Multi-site Cohort Study

This study is presented as published:

Tosif, S., Jatobatu, A., Maepioh, A., Gray, A., Sobel, H., Mannava, P., & Duke, T. (2020b). Healthcare worker knowledge and skills following coaching in WHO early essential newborn care program in the Solomon Islands: a prospective multi-site cohort study. *BMC Pregnancy and Childbirth, 20*(1), 84.

7.1 Overview

In this study, healthcare worker knowledge and skills in ENC were assessed before and after the WHO EENC training program. Standardised assessments were used to investigate retention of skills and knowledge over time. Healthcare worker demographics and characteristics were investigated for association with knowledge and skill retention.

7.2 Abstract

Background: Newborn mortality in Oceania declined at a slower rate than in other regions in the past 25 years. The World Health Organization (WHO) introduced the Early Essential Newborn Care program (EENC) in 2015 in Solomon Islands, a Small Island Developing State, to address high newborn mortality. We explored knowledge and skills retention among healthcare workers following EENC coaching.

Methods: Between March 2015 and December 2017, healthcare workers in five hospitals were assessed: pre- and post-clinical coaching and at a later evaluation. Standardised written and clinical skills assessments for breathing and non-breathing baby scenarios were used. Additionally, written surveys were completed during evaluation for feedback on the EENC experience.

Results: Fifty-three healthcare workers were included in the evaluation. Median time between initial coaching and evaluation was 21 months (IQR 18 – 26). Median written score increased from 44% at baseline to 89% post-coaching ($p<0.001$), and was 61% at evaluation ($p<0.001$). Skills assessment score was 20% at baseline and 95% post-coaching in the Breathing Baby scenario ($p < 0.001$). In the Non-Breathing Baby scenario, score was 63% at baseline and 86% post-coaching ($p < 0.001$). At evaluation, median score in the Breathing Baby scenario was 82% a reduction of 13% from post-coaching ($p < 0.001$) and 72% for the Non-Breathing Baby, a reduction of 14% post-coaching ($p < 0.001$). Nurse aides had least reduction in evaluation scores of -2% for the Breathing Baby and midwives -10% for the Non-Breathing Baby respectively from post-coaching to evaluation.

Conclusions: EENC coaching resulted in immediate improvements in knowledge and skills but declined over time. Healthcare workers who used the skills in regular practice had higher scores. Complementary quality improvement strategies are needed to sustain resuscitation skills following training over time.

Trial Registration: Australia New Zealand Trial Registry, Retrospective Registration (12/2/2019), registration number ACTRN12619000201178.

Keywords: Neonatal resuscitation, neonatal training programs, low- and middle-income countries, Small Island Developing States

7.3 Background

The Oceania region (excluding Australia and New Zealand) experienced the slowest rate of reduction in neonatal mortality compared with other developing regions during the period of the Millennium Development Goals [6]. Like other lower-middle income Small Island Developing States (SIDS) [236], the small health workforce in Solomon Islands faces enormous accessibility issues, including dispersed populations, challenging geographies and environmental vulnerability to natural disasters.

Many gaps exist in the health facility care of common causes of neonatal mortality: intrapartum-related complications, complications of prematurity and severe infection [42, 196]. Neonatal resuscitation training in facilities can reduce early deaths [9, 196, 237]. Supportive interventions in the immediate newborn period, such as skin-to-skin contact, early and exclusive breastfeeding and temperature control, have been shown to improve outcomes [56]. A combined approach that including early essential newborn care, resuscitation and basic care of common neonatal problems could address the most common causes of perinatal mortality [10].

Continuing professional development for health care workers in Solomon Islands presents challenges due to few opportunities to learn or refresh knowledge and skills, and this is a barrier to improving newborn quality of care. The World Health Organization (WHO) Early Essential Newborn Care (EENC) program focuses on developing skills and knowledge for the management of "Breathing" and "Non-breathing" babies. It addresses the critical first moments and days of newborn care for healthcare workers in health facilities, where over 95% of births take place in the Western Pacific [12, 46, 238]. Key content areas are neonatal resuscitation and basic newborn care, with emphasis on thorough drying, delayed cord clamping, skin-to-skin contact, reduction of harmful practices and support for exclusive breastfeeding. Whilst these measures do not require sophisticated technology, they rely on healthcare worker skills and knowledge to reduce risk of infection or death around the time of birth [42].

The aim of this study was to determine the impact on skills and knowledge amongst healthcare workers following EENC training and to characterise the healthcare provider attributes that effect retention and practice in the unique healthcare context of Solomon Islands.

7.4 Methods

7.4.1 Description of intervention

EENC was implemented as the country-level program for newborn care in Solomon Islands. The Ministry of Health and Medical Services (MHMS) rolled out the program across the nine provinces in the country from 2015 onwards. Following a national training, a newborn nurse coordinator (AJ) delivered subsequent trainings at the National Referral Hospital (NRH) and provincial hospitals assisted by 2-3 nurse or midwife co-facilitators. The 2-day EENC program consisted of onsite coaching, with a low participant to facilitator ratio (6:1) [46]. The venue for training was the delivery room, or, where not possible, a room setup with a similar arrangement. The coaching approach was participatory in style without didactic teaching. In small groups, a participant would first demonstrate normal practice. The facilitators then explored the reasons why certain actions were taken, with discussion of the evidence for correct practice as well as the evidence that some practices are unnecessary or potentially harmful (e.g. unnecessary routine suctioning, early washing of the baby and separation of the baby and the mother). Participants were invited to share feedback in a supportive way, pointing out correct actions or if improvement was required. Each participant then took part in repeated practice whilst the facilitator used the EENC skills checklist as a reference. At the end of the coaching, the establishment of a quality improvement team within 3 months was planned at each site, with relevant guidance was provided from EENC modules.

7.4.2 Setting

Solomon Islands shares many geographical and demographic characteristics with other low- and middle-income countries in Oceania and SIDS globally. A population of almost 600,000 is dispersed amongst nine provinces and more than 900 islands. For this study, the Solomon Islands MHMS purposively selected five hospitals which together serve 80% of the national population: the NRH, Gizo Hospital, Kil'ufi Hospital, Makira Hospital, and Good Samaritan hospitals.

7.4.3 Study Design and Participants

We conducted a pre and post, multiple-site, facility-based study between March 2015 and November 2017. Eligible participants were health care workers who attended EENC coaching and were evaluated prior to refresher training.

The primary outcome measures were knowledge and simulated skill scores according to standardised assessments contained in EENC, as have been used in the implementation of EENC throughout the Western Pacific region [44], and are available online [46]. Baseline scores for knowledge and skills were established from pre-coaching assessment of one random participant in each group. Assessment of all participants occurred immediately following EENC coaching, and prior to a refresher (see Figure 7.1 for the timeline). Timing of refresher was aimed for 12 months post coaching.

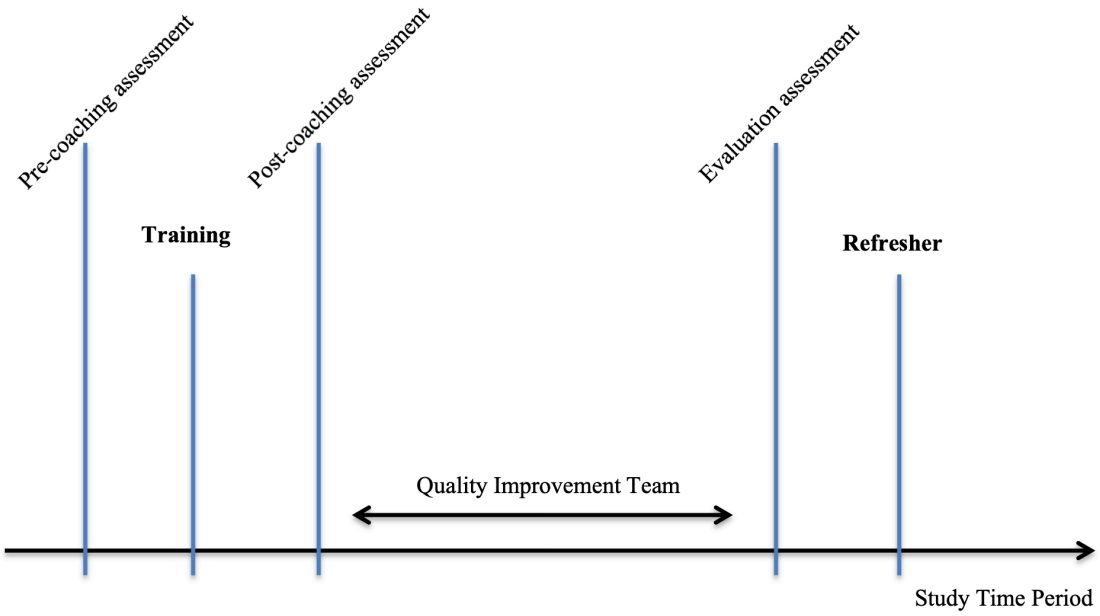


Figure 7.1: Study Timeline

Knowledge was assessed with a written test, with questions on the themes of routine newborn care, breast-feeding and resuscitation. The skills assessment tested skills in managing a mother and newborn in two scenarios, the delivery of a "Breathing" and "Non-breathing" baby. The written test and scenarios were carried out in a room set-up for the purpose under examination conditions.

Demographic data was collected using a confidential written questionnaire including questions on experience, qualifications, work location and attendance at other neonatal training. We asked participants about their satisfaction of the content of EENC using a 5-point Likert scale (1 = Too complicated, 2 = A little complicated, 3 = Just right, 4 = A little simple, 5 = Too simple). Opportunity was given to clarify questions using Solomon Islands Pigin during the written component, and skills assessment scenarios were carried out in Solomon Islands Pigin or English according to participant preferences. The

assessment team consisted of a midwife (AM), newborn nurse coordinator (AJ) and visiting paediatrician (ST).

7.4.4 Analysis

Data were summarised with frequencies or percentages for categorical values, or means and standard deviations (SD) or medians and interquartile ranges (IQR) for continuous variables. Difference testing between pre-coaching and post-coaching groups was performed using Mann-Whitney U test. Comparison between pairs of scores from health care workers between post-coaching to refresher was performed using the Paired Sign Test. Testing for differences of continuous variables between groups was performed using the Kruskal-Wallis test.

Written and skill assessment scores were manually entered from data collection forms into Excel before cleaning and analysis in STATA (Version 15.0). This study was approved by the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1). This study adheres to STROBE guidelines for reporting observational studies [239].

7.5 Results

A total of 53 participants were included. Pre-coaching baseline scores were established from 25 participants in the Breathing Baby scenario, and 15 participants in the Non-Breathing Baby scenario. Median time for participants between coaching and evaluation was 21 months (IQR 18 – 26). There were 23 nurses, 15 doctors, 8 midwives and 7 nurse aides. The average healthcare worker was 36 years of age (±12 years), and had 9 years experience in neonatal care (±7 years). Six-per cent (3/53) of healthcare workers participated in a quality improvement activity following training. Thirty-one per cent (16/53) of healthcare workers had worked in two or more health facilities in the last 5 years. Forty-seven per cent (25/53) of healthcare workers had past neonatal training, none had received a refresher or follow up training previously. Past trainings was in Integrated Management of Childhood Illnesses, World Health Organisation Hospital Care for Children, Mother Baby Friendly Hospital Initiative, University based or other visiting programmatic trainings in newborn care

7.5.1 Evaluation of written scores

All healthcare workers participated in the written test (n = 53) (Figure 7.2). There was a significant increase in written scores immediately following coaching. Median written scores increased 45% from 44% (IQR 33 – 56) to 89% (IQR 78 – 94) (p <0.001). At the time of the evaluation, median scores were 61%, (IQR 50 – 72) a reduction of 28% (p <0.001) from post-coaching levels but still 17% higher than at baseline.

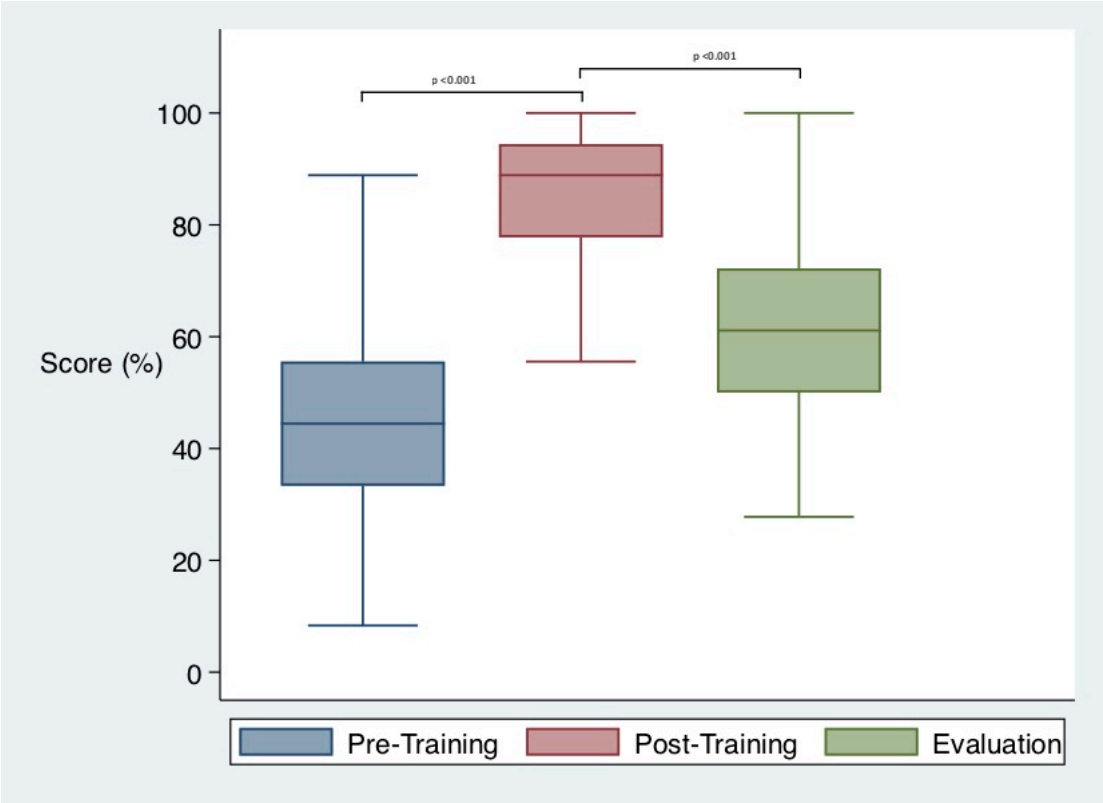


Figure 7.2: Written Score Assessment Results by Period

7.5.2 Evaluation of skills

Median scores in the Breathing Baby scenario went from 20% (IQR 11 – 32) pre-coaching, to 95% (IQR 91 – 95) post-coaching, and 82% (IQR 66 – 91) at time of evaluation (p < 0.001) (Figure 7.3). Median scores in the Non-Breathing Baby scenario were 63% (IQR 45 – 73) pre-coaching, 86% (IQR 86 – 88) post-coaching and 72% (IQR 63 – 81) at evaluation (p < 0.001) (Figure 7.4). In the Breathing Baby scenario, health care workers who received past training did not have better retention than those who had not received training (-20% and -14%

respectively, p = 0.291), and had poorer performance in the Non-Breathing Baby scenario (-13% vs -22%, p = 0.040).

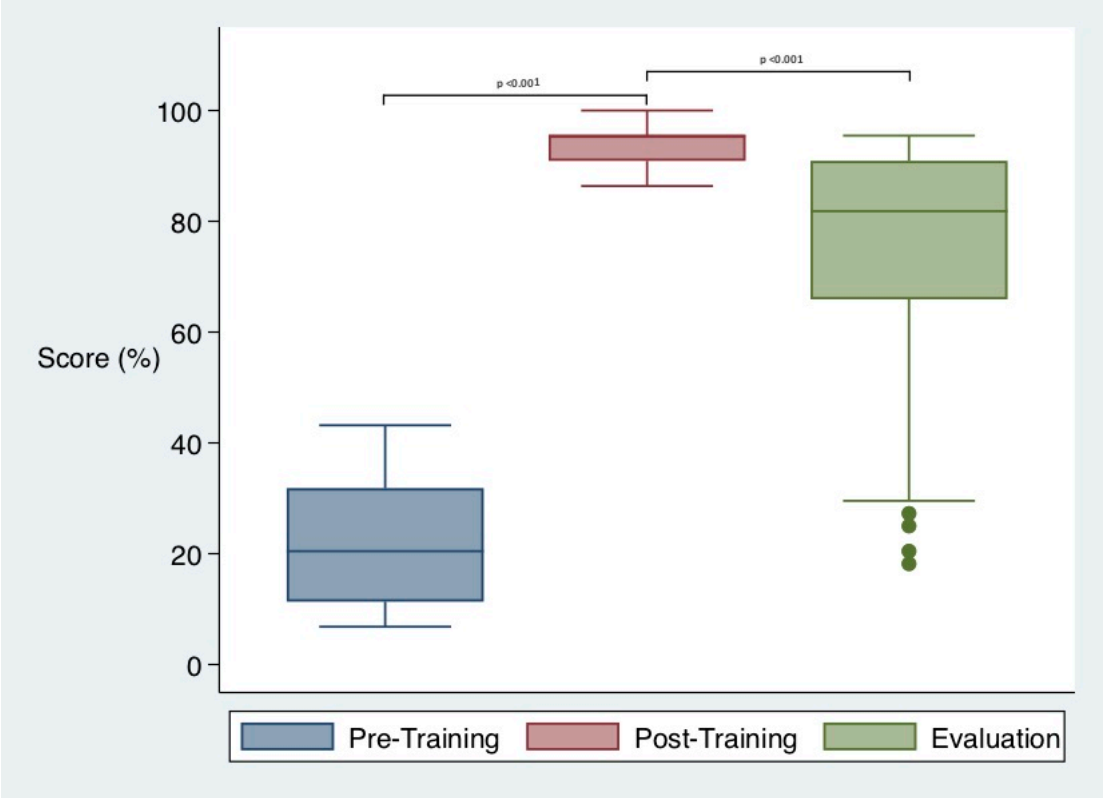


Figure 7.3: Skill Scores in Breathing Baby Scenario by Period

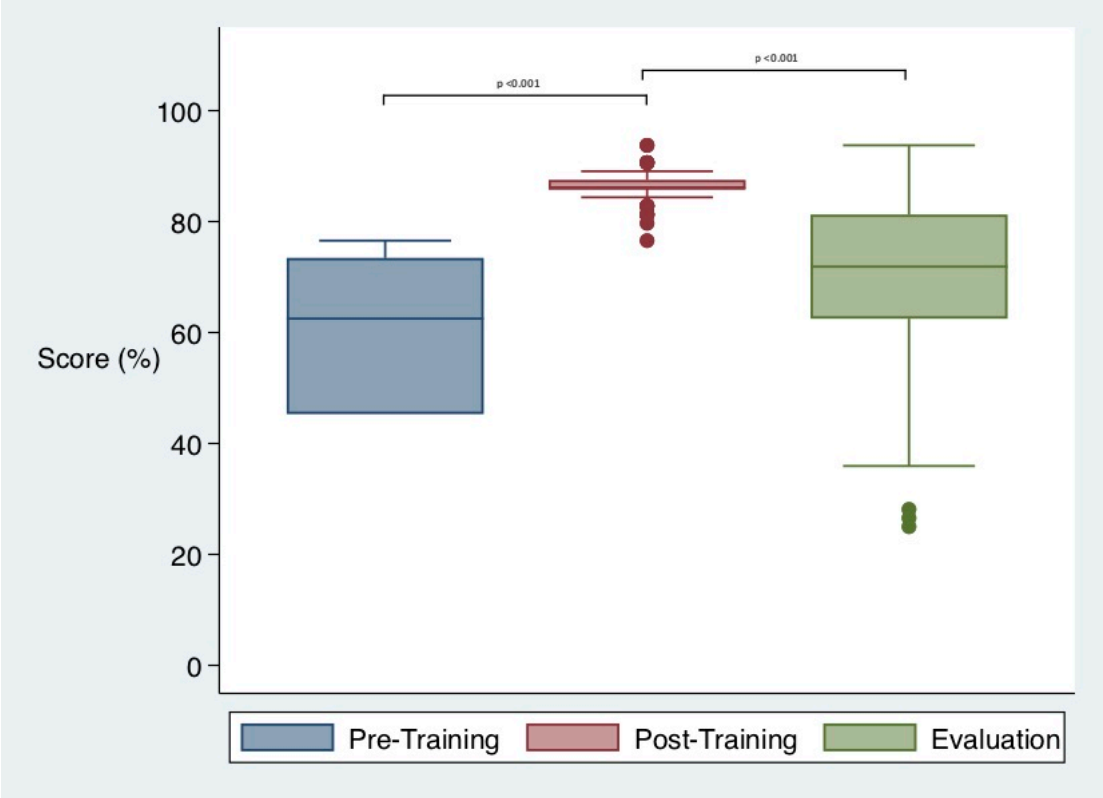


Figure 7.4: Skill Scores in Non-breathing Baby Scenario by Period

In the Non-Breathing Baby scenario, mean scores for neonatal resuscitation skills were lower than routine pre-birth preparations, immediate newborn care, and post-partum care: 66% vs 80%, 72% and 74% respectively (see Table 7.1).

Table 7.1: Skills Checklist Scores in Non-breathing Baby Scenario

Skills Checklist	% Correct Demonstration (n = 53)
Pre-birth preparations	
Checked room temperature; turned off fans	80
Washed hands (first of two)	84
Dry cloth placed on mother's abdomen	78
Prepared the newborn resuscitation area	82
Checked whether bag and mask are functional	78
Washed hands (second of two)	78
Wore two pairs of clean gloves	89
Put forceps, cord clamp/ties in easy-to-use order	71
Mean	**80**
Immediate newborn care	
Call out time of birth (hours, minutes, seconds)	73
Started drying within 5 sec after birth	80
Dried the baby thoroughly (wiped the eyes, face, head, front, back, arms and legs)	82
Removed the wet cloth	66
Placed baby in direct skin-to-skin contact	68
Covered baby's body and head with dry cloth	64
Mean	**72**
Neonatal resuscitation	
Called for help	51
Removed first pair of gloves	47
Quickly clamped and cut cord	85
Moved baby to resuscitation area	69
Covered baby quickly during and after transfer	67
Positioned head correctly to open airways	72
Applied face mask firmly over chin, mouth & nose	67
Observed chest rise within 1 minute of birth	60
Squeezed bag to give 30–50 breaths per minute	57

Maintained good chest rise throughout or took steps to improve ventilation	64
Stopped mechanical ventilation once baby was breathing well	89
Mean	**66**
Immediate postpartum care	
Returned to skin-to-skin contact, covered baby	90
Checked for another baby	69
Gave oxytocin to the mother	77
Delivered placenta	53
Counselled mother that baby is ok and on feeding cues	83
Mean	**74**

7.5.3 Skill Retention by cadre

When separated by cadre of healthcare worker, nurse aides showed the best skill retention in the breathing baby scenario, and midwives in the non-breathing baby scenario when post-coaching and evaluation scores were compared (Figures 7.5 and 7.6). In the breathing baby scenario, nurse aides had a median score reduction of -2% (IQR -18 to 2), midwives -10% (IQR -16 to -1), nurses -11% (IQR -43 to 0) doctors -18% (IQR -31 to -4) ($p = 0.237$). In the non-breathing baby scenario, midwives had a median score difference of -8% (-13 to 0), nurses -13% (-30 to -5), doctors -19% (IQR -27 to -6) and nurse aides -22% (IQR -27 to 0) ($p = 0.440$).

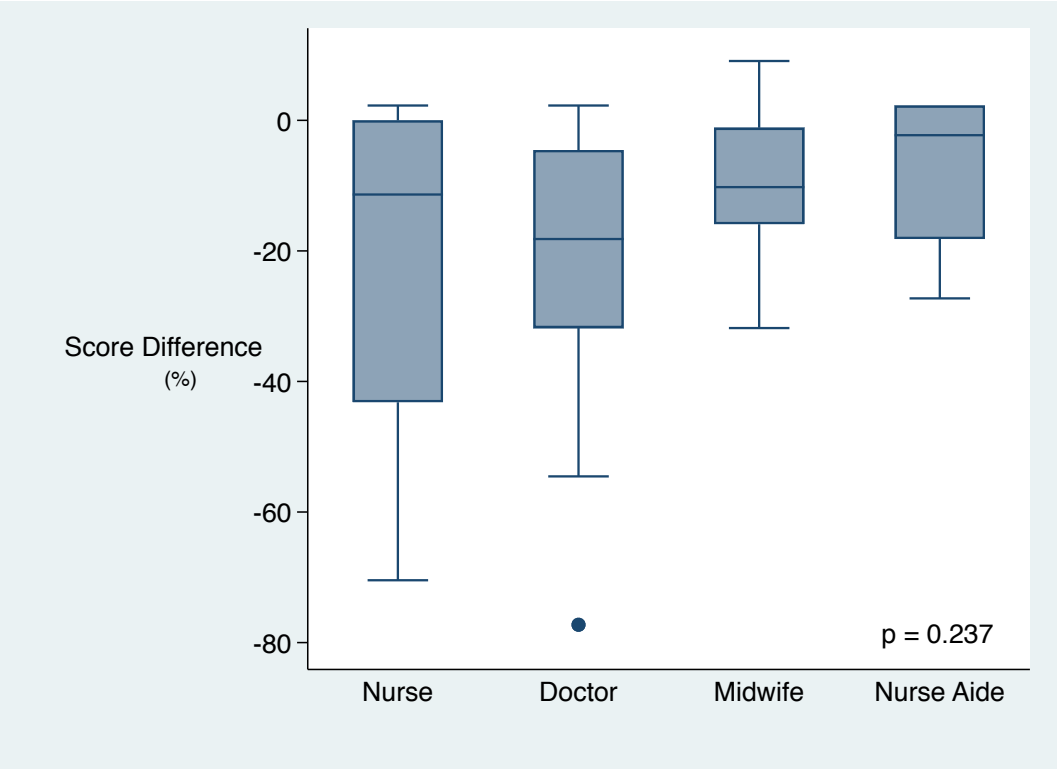


Figure 7.5: Score Difference (Post-coaching vs. Evaluation) in Breathing Baby Scenario by Cadre

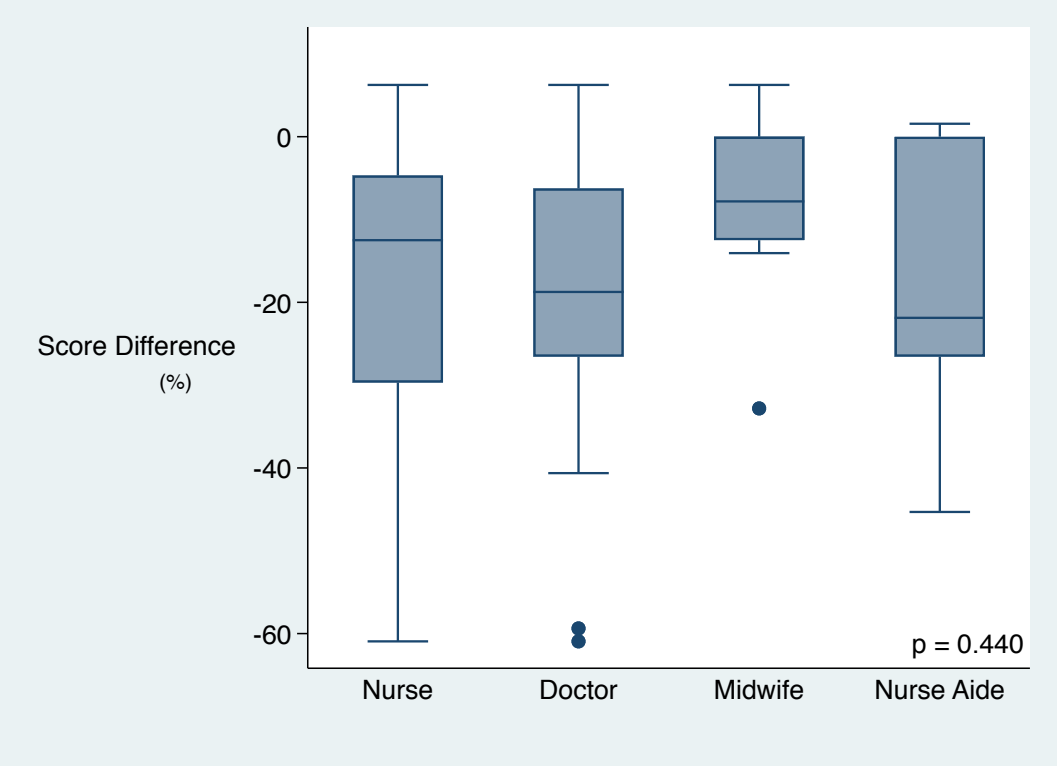


Figure 7.6: Non-breathing Baby Scenario Score Difference (Post-training vs. Evaluation) by Cadre

7.5.4 EENC feedback

Most participants found the content in the EENC program "just right" (83%). 7% found the course "a little too complicated", 5% "a little simple", and 5% "too simple". The mean Likert Scale score response was 3 (SD 0.5) equating to "just right".

7.6 Discussion

The 2-day EENC coaching intervention, delivered by a small team of Solomon Islands Ministry of Health staff in a low-resource Pacific Island setting, increased knowledge by 45% and skills by 75% (Breathing Baby) and 23% (Non-Breathing Baby) respectively. At evaluation after a median of 21 months post-training, skills experienced a modest reduction to 82% (Breathing Baby scenario) and 72% (Non-Breathing Baby). Skills related to pre-birth preparation and immediate post-partum care were better retained than those for neonatal resuscitation. Nurse aids and midwives who were engaged in providing routine neonatal care had least reductions in scores at evaluation. Health professionals who did not use the skills routinely had greater reductions in scores at the time of evaluation, but still remained significantly above baseline. The EENC program content was well received by participants.

These findings may have implications for the design and implementation of newborn training in other similar settings. The EENC program uses a practical, coaching methodology with a focus on two practical scenarios using minimal resources, without didactic or excess content over a two-day training period. Case based learning and clinical simulations with frequent repetition have been shown to be effective educational methods for health care worker training [240]. Short training periods limit time away from clinical posts and are less expensive. This program was implemented through the actions of a small team dedicated to a large geographical area with little opportunities to follow up. More strategies for implementing programs in such settings with limited resources are needed.

Our study found better retention of skills and knowledge in midwives and nurse aides compared with other cadres, reflective of other studies where birth volume and associated frequent clinical practice was associated with better retention [241]. Of concern was the relatively higher drop-off of scores for doctors in both scenarios. Doctor's skills are often deferred to in resuscitation or for the care of critically ill neonates. For health care workers

who infrequently attend deliveries, periodic refreshers and regular practice with portable simulators can maintain skills [153, 242]. Consideration needs to be given to strategies that fit the local context, particularly those that have feasibility in the confines of geography and financial limitations. These could include requirements for continuing education, strengthening local rather than national coordinator roles or providing incentives.

High post-coaching scores in this study demonstrate effectiveness of the training approach in improving knowledge and skills, a result similar to those of other studies, which range from improvements of between 7 to 89% from baseline [58]. Knowledge and skill improvements are also reflected in national surveys identifying higher rates of adherence to skin-to-skin initiation and duration [243]. The higher Non-Breathing Baby pre-coaching scores compared with Breathing Baby scores are likely due to a boosted score, from this assessment taking place second, with participants incorporating newly learnt skills from the first scenario. Knowledge and skills fall-off occurred in half of 10 studies identified in a systematic review on this theme, with three showing no fall-off and two with a range of retention according to cadres of birth attendants and prior training exposure [58]. Knowledge and skills fall-off in the range described in our study has been reported following neonatal training programs [58, 165, 244] and has led to the addition of quality improvement approaches [245] that incorporate various strategies, such as daily bag and mask skills practice, peer review and weekly skills checklist to improve retention [246]. Whilst establishment of a quality improvement team within 3 months of coaching was recommended with relevant guidance in the EENC modules, they were not utilised at the hospital level in contrast to other countries in the region using EENC where quality improvement implementation occurred in up to half the facilities [54, 243]. This was likely due to the small training team in Solomon Islands not being available to facilitate, mentor and support participants from remote geographical locations, with visits occurring not more than once per year due to financial and logistical challenges.

Further analysis of the skills demonstrated showed that resuscitation skills, specifically those related to bag-and-mask ventilation, were retained less than skills for routine care. This may be due to the lower frequency of resuscitation events in practice, and the greater degree of technical expertise required. An analysis of facilitator and learner perceptions from a neonatal resuscitation program across two low- and middle-income countries found additional training was required to establish resuscitation skills and recommended continued learning and active mentoring to establish this practice [62]. An intervention

for Helping Babies Breathe in Nepal, used a neonatal resuscitation protocol whic focused on bag and mask ventilation and included training, daily skill checks, preparation for resuscitation at every birth, self-evaluation and peer review [246]. Skills and competencies in care of high-risk babies improved following supportive supervision and monitoring in Uganda [247]. Through additional exposure, these additional measures may assist in resuscitation through familiarisation with a typically stressful, low-frequency event of higher complexity.

This study has some limitations. There was no comparison group, and time between coaching and evaluation varied due to logistics and accessibility. Only one participant from each coaching group was assessed at baseline. This reflected a pragmatic approach, where limited resources and time for the coaching were balanced with research needs. Some of the participants in this study had prior neonatal training but none had additional newborn training other than EENC during the study period. Our study used knowledge and simulation to assess healthcare worker skill performance. Ideally, evaluation of training programs would be through measuring impact on neonatal morbidity and mortality, and neurodevelopmental outcomes [238]. However, in practice, these outcomes are difficult to measure because due to sample sizes required and a research infrastructure that is out of reach of small teams on low budgets. Assessments of knowledge and skills provide indirect information on effectiveness of neonatal resuscitation programs [238], and a systematic review identified four out of five studies with a positive correlation between simulated test scores and clinical behaviour [58]. Other training programs have used similar assessment time points in assessing knowledge and skills [248].

7.7 Conclusion

The EENC coaching program was implemented by a small team and resulted in improved knowledge and skills, especially among those who performed immediate newborn care routinely; however there was a fall-off within 18 months especially among those who did not use the skills routinely. Routine newborn skills were sustained more than resuscitation skills. Complementary strategies are needed to sustain resuscitation skills following coaching over time with novel methods required to reach remote health workers who have infrequent opportunities for resuscitation practice.

Declarations

Ethics approval and consent to participate

This study was approved by the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1). Written consent was obtained from all participants to participate in this study.

Consent for Publication

Not applicable

Availability of data and materials

According to the regulations of the University of Melbourne, the dataset generated and analysed during the study cannot be made public. However, the data are available from the corresponding author (ST) for inspection upon reasonable request.

Competing interests

Dr Howard Sobel and Ms Priya Mannava are employed by the World Health Organization.

Funding

The authors received no funding for the design, interpretation or composition of the manuscript.

Authors' contributions

Conception of the study: ST, TD; data collection: ST, AJ, AM; data analysis and interpretation: ST, AJ, AM, TD; drafting the article: ST; critical revision of the article: AJ, AM, HS, PM, TD; final approval of the version to the published: ST, AJ, AM, HS, PM, TD.

Acknowledgements

The authors would like to thank all the healthcare workers, the staff at the Department of Paediatrics at the National Referral Hospital Honiara and Ministry of Health and Medical Services.

Chapter 8: Implementation Lessons from a Multifaceted National Newborn Program in Solomon Islands: A Mixed Methods Study

This study is presented as published.

Tosif, S., Jatobatu, A., Maepioh, A., Gray, A., Gilbert, K., Hodgson, J., & Duke, T. (2020). Implementation Lessons from a Multifaceted National Newborn Program in Solomon Islands: A Mixed-Methods Study. *The American Journal of Tropical Medicine and Hygiene*, *102*(3), 667-675.

8.1 Overview

This study presents the findings from a mixed methods evaluation of the multifaceted neonatal quality of care implementation. The implementation design and process, as well as timeline of the evaluation, are described. The study draws on quantitative and qualitative analysis to identify barriers and enabling factors to the implementation. The experience of healthcare workers in caring for newborns and their attitudes towards the intervention are highlighted.

8.2 Abstract

Multifaceted interventions are important in improving neonatal quality of care and health outcomes. This study describes the implementation of an intervention to improve quality of newborn care in Solomon Islands, a Small Island Developing State and lower-middle-income country in the Western Pacific. Inputs included training, equipment provision and healthcare system organisational changes. For evaluation, we used a mixed methods design, utilising quantitative (audits of health facility equipment, structure and organisation) and qualitative (semi-structured interviews and focused group discussions with healthcare workers) methods. Participants highlighted the practical, interactive, coaching style of training and its short duration as positive features in establishing skills. Training had indirect effects through improving culture of the workplace, and the evaluation provided a valuable opportunity for reflection on the implementation process for healthcare workers. Facility limitations owing to equipment deficits and poor condition of clinical areas had implications by limiting provision of quality care as well as contributing to healthcare workers feeling undervalued. Resuscitation of a non-breathing baby was a stressful experience for many health workers, compounded by geographic isolation and feeling unsupported. Our findings highlight the importance of training methodology, impact from structural limitations and experience of resuscitation for the healthcare worker. Attention to these factors may help the design and implementation of newborn care programs in similar contexts.

8.3 Introduction

Implementation strategies that target multiple areas of the health system are needed for improvements in clinical care in low-income countries. [155] The development, implementation and monitoring of national packages to improve neonatal quality of care has been a longstanding priority in global health to improve morbidity and mortality [249, 250]. In addition to describing the outcomes of multifaceted interventions, explaining the impact of these interventions within the health system context is essential in understanding the factors that support or inhibit quality care [101, 251].

Previous studies exploring implementation of programs for maternal and newborn care have highlighted broad, important contextual factors, such as impact of structural and cultural barriers in Namibia [252], family preferences and service availability in Laos [253], performance incentives in Malawi [254] and the impact of opinion leaders and funding in three countries in Asia [255]. Fewer descriptions of implementation strategies are available from low- and middle-income countries as compared with high-income countries[155], and we found no reports of implementation strategies describing the experience in the unique context of Small Island Developing States (SIDS) [128].

Solomon Islands is a low-middle-income country and one of the SIDS in the Western Pacific. Calculated estimates suggest neonatal mortality rates were 13 per 1,000 live births in 2013 [256]. However, these estimates are incongruous with reports of high perinatal mortality rates [6, 119-122] and the higher rates of mortality observed in neighbouring countries in the Western Pacific that have similar health and demographic profiles [6, 232]. The country is attempting to improve neonatal quality of care through a national rollout of a package of tailored interventions through the framework of the Action Plan for Healthy Newborns in the Western Pacific [12, 44]. The package consists of the implementation of healthcare worker training in newborn care with the World Health Organization's Early Essential Newborn Care (EENC) program, provision of equipment according to minimum standards for newborn health as well as health system organisational changes.

Similar to other low- and middle income countries, in Solomon Islands most neonatal deaths occur owing to complications of preterm birth, intrapartum-related complications and sepsis [205, 257]. Essential newborn care and basic neonatal resuscitation are interventions that have the most impact on reducing preventable neonatal deaths and stillbirths [258]. Essential newborn care practices include clean birth processes, thermal

considerations through skin-to-skin contact and ambient temperature control, support and initiation of exclusive breastfeeding and hygienic cord care, as well as reduction of potentially harmful practices, such as early bathing and unnecessary suctioning [41, 42, 46]. Previous assessments have recommended strategies to improve neonatal quality of care during and immediately after birth to include these measures [12].

8.4 Description of Intervention

The Ministry of Health, through a collaboration with Solomon Island paediatricians, WHO and United Nations International Children's Emergency Fund developed and implemented a multifaceted intervention to improve the quality of newborn care using three approaches: (1) coaching in WHO EENC, (2) supply of basic equipment and (3) healthcare service delivery changes (see Table 8.1 for intervention details). For this evaluation, the conceptual framework by Austin et al. was used [31], which builds upon the Donabedian framework [37], for its specific relevance to understanding the drivers behind facility-based quality care. Quality of care components were mapped to the framework for the intervention (see Figure 8.1). The framework was useful for considering the three levels of health system (community, province and national facilities), of specific relevance to the physically isolated and disparate health facilities in Solomon Islands, with a historically high facility-based birth rate [12].

Figure 8.1: Conceptual Framework for Intervention Adapted from Austin et al. [31]

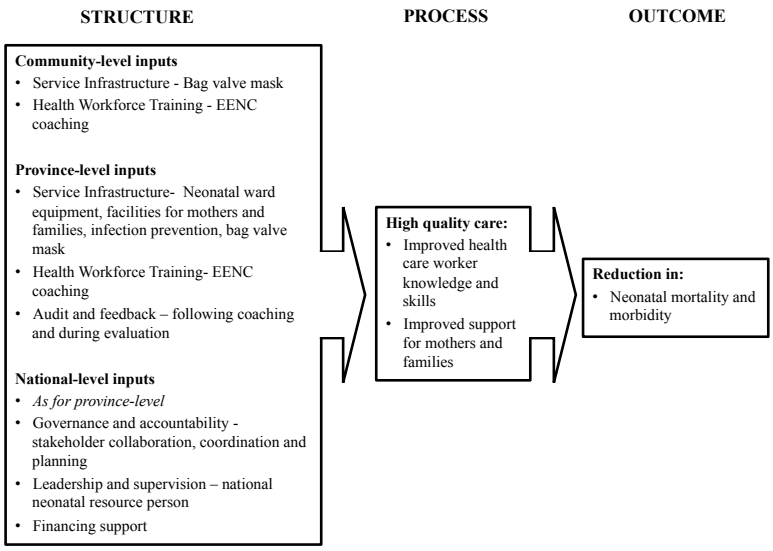


Table 8.1: Description of Intervention According to Effective Practice and Organisation of Care Taxonomy [259]

Barrier Identified	Feature of Intervention	Description
Organisational and workplace culture barriers	Healthcare system culture and organisational engagement, change and support	We facilitated stakeholder involvement in policy decisions and a local consensus process through a Newborn Steering Committee. We involved local opinion leaders in Ministry of Health, paediatric and obstetric departments. We consolidated efforts across stakeholder agencies to avoid programmatic duplication. A focal person for newborn care was appointed as the main coordinator and resource person for neonatal training and support.
Structural issues: basic equipment, organisation and maintenance	Equipment provision, training and technical support	We supplied additional equipment to reach minimum standards and provided training on use and basic technical aspects (see Appendix N). The Special Care Nursey layout was altered to position resuscitation

		equipment close to delivery areas. We ensured equipment was entered onto the national registry for medical assets and technical support.
Healthcare worker knowledge and skill gaps	Newborn care training and supportive supervision	We implemented a training program and distribution of educational materials (EENC pocketbook) through educational outreach visits to each province. Small group EENC coaching sessions occurred at all provincial hospitals with healthcare workers from each province.

The intervention was preceded by a baseline analysis [205] and followed by a regional implementation plan [12] that incorporated EENC implementation guidelines [46]. The intervention was adapted using a participatory planning process to local needs, through regular meetings with key stakeholders and site visits.

This present mixed methods study was embedded within the intervention with the aim of describing the barriers and facilitators of the implementation of a multifaceted intervention for newborn care and identifying avenues for future successful scale-up.

8.5 Methods

8.5.1 Study design

Data were collected between 2014–2017 using quantitative and qualitative methods (see Appendix 1). Quantitative sources included facility equipment and supply audits. Qualitative sources included semi-structured interviews (SSIs) and focus group discussions (FGDs) with frontline healthcare providers, and is described using the Consolidated Criteria for Reporting Qualitative Research [260].

8.5.2 Setting and context

Solomon Islands is a lower middle-income country with an estimated population of 599,419 (2016) across six major islands and over 900 smaller islands [261]. The country is recovering from the civil conflict between 1998 and 2003, during which its health services, infrastructure and economy experienced widespread disruption [15]. Over the past 10 years, the country has suffered casualties and damage from floods (in 2014) and earthquake and tsunami (in 2007, 2013 and 2016). The national population is young and entering reproductive age, and 41% are less than 15 years of age [110].

This study was conducted at the National Referral Hospital (NRH) and the four largest provincial hospitals (Gizo Hospital, Kilu'ufi Hospital, Makira Hospital and Good Samaritan Hospital). The chosen study sites provided a purposive sample based on accessibility, and representation of the most populated provinces in the country (see a previous study or descriptions [205]).

8.5.3 Quantitative methods

We used a standardised assessment tool for quality of hospital care by the World Health Organization (WHO) modified for Solomon Islands [180] and used in neighbouring Papua New Guinea [262], which aligned with the WHO essential devices List For Reproductive, Maternal, Newborn And Child Health [263] and the WHO *Pocket Book of Hospital Care for Children* [264]. Using this tool, provincial hospitals were audited for 44 items in the domains of equipment and supplies, ward organisation, infection control and staff providing neonatal care. Data from the audit were compiled into a summary descriptive table of 14 essential structural items at evaluation.

8.5.4 Qualitative methods

The qualitative design used an inductive approach, with iterative analysis conducted simultaneous to data collection enabling the main themes to be refined following subsequent data collection [119, 172].

The interview guide and FGD questions were developed to align with domains and constructs of the Theoretical Domains Framework [171]. Experienced qualitative researchers reviewed the guide (AG and JH), and after the country team trialled it (AJ, AM, ST), the researchers adjusted it to ensure that the language and terminology were appropriate to the local context. Probe questions were included in the protocol to allow interviewers to follow threads of inquiry as required (see Table 8.2).

Table 8.2: Interview Questionnaire

Domain	Question	Probe
Professional role and identity	What role do you have in providing newborn care?	
Social norms	Who else works with you in caring for newborns? How have you found your working relationship with others	What works/doesn't work?

	when providing newborn care?	
Beliefs about capabilities	How do you feel when looking after newborn babies? What are the challenges you experience when caring for newborns? What do you think needs to change for better newborn care?	Can you describe your confidence, skills and knowledge? Structural/equipment/skills/resources Examples of change
Skills, knowledge and emotion	In Solomon Islands, some babies are born that don't breathe, or are born 'flat'. Have you experienced this? What did you do?	Did you use a bag/mask? How did you feel during, and after? Did you feel comfortable using the bag/mask?
Beliefs about consequences	How would you prioritise future activities for newborn care in Solomon Islands? What would you like to see changing in newborn care in the next 2 years	Probe: Training, resources, personnel, equipment
Environmental context and resources	What training have you had in newborn care? Did you observe any difference between these trainings? What has the greatest impact on your clinical practice and why? Has newborn care changed in the past three years?	How have you found the EENC coaching method compared with previous training methods? How has it changed? What has/hasn't helped?
Goals	What has been the biggest challenge to newborn care? What do you think will make the most difference in improving newborn care	Training, resources, personnel, equipment

Participants were selected to reflect the varying cadres of healthcare workers and their roles and responsibilities in the program implementation. Eligible study participants were doctors, nurses, midwives and nurse aides who were involved in the provision of neonatal care during the study period and who had attended EENC training.

Two female Solomon Islander midwife researchers (AJ and AM) and one male paediatrician from Australia (ST) trained in qualitative methods conducted the interviews and FGDs. Interviews were conducted at the familiar location of the hospital's postnatal or training area and conducted in English and Solomon Islands Pigin according to the preference of the interviewee(s). No observers or non-participants attended the interviews or FGDs.

Interviews were audio recorded using a portable electronic device, and field notes were made during and immediately after interviews. Audio recordings were transcribed verbatim (ST) and translated into English where required.

8.5.5 Data analysis

Interview transcripts were entered into NVivo software (QSR International Pty Ltd. Version 12, 2018) for storage, coding and analysis. Three researchers coded the first four transcripts independently to check for consistency. Further rigorous inductive analysis was undertaken to facilitate development of common themes. Qualitative were then triangulated with quantitative findings, to areas of convergence or divergence.

8.5.6 Ethical considerations

Ethics approval for this study was obtained from the Solomon Islands Health Research and Ethics Review Board (project number HRE033/16) and the University of Melbourne Human Research Ethics Committee (HREC number 1646267.1). Written informed consent was obtained prior to interviews and FGDs. This study adheres to the Standards for Reporting Implementation Studies framework.[265]

8.6 Results

8.6.1 Health facility audits

Results of the facility audits at baseline and at the end of the study period are shown in Table 8.3. Barriers to equipment delivery were logistical difficulties, long delays in delivery and lack of technical expertise in installation. The number of bag-and-mask devices did not change substantially during the implementation despite additional units supplied, which were likely passed onto smaller clinics in greater need. However, compared with baseline, all these devices were assembled and within reach of the resuscitation area at the end of the study period. Neonatal monitoring devices were

available, but not in routine use owing to challenges with set-up and troubleshooting technical errors. Infection control improvement was mixed, with improvement in two hospitals (Kirakira and Good Samaritan) and problems arising from refill of hand hygiene dispensers. Oxygen concentrator availability increased slightly, and two new concentrators were in use at NRH and one at Kilu'ufi Hospital. Multiple pieces of equipment (e.g. oximeters and concentrators) were affected by simple technical problems for which servicing was unavailable, thus rendering them unusable. Many hospital buildings remained in a poor state of repair, apart from in Gizo, where a new hospital had been completed in 2012 following a tsunami and earthquake.

Table 8.3: Equipment, Organisation and Supplies at Baseline and Final Audit

	Kilu'ufi		Kirakira		Gizo		GS		NRH	
Assessment	**Baseline**	**Final**	**Baseline**	**Final**	**Baseline**	**Final**	**Baseline**	**Final**	**Baseline**	**Final**
Self-inflating resuscitation bags	3	2 (-)	2	3 (+)	2	1 (-)	2	3 (+)	4	3 (-)
Bag and mask assembled and within reach of resuscitation area	No	Yes (+)	No	Yes (+)	No	Yes (+)	No	Yes (+)	No	No
	1	1	1	1	0	0	1	1	1	1
Oxygen Concentrator	0	2 (+)	0	0	1	1	1	1	2	3 (+)
Oximeter with neonatal probes	1	1	1	0 (-)	1	1	1	0	1	1
Overhead warmer	1	1	0	2 (+)	2	2	0	1 (+)	3	6 (+)
Phototherapy system	1	2 (+)	1	1	2	2	1	1	3	1
Designated resuscitation area	Yes	Yes	No	Yes (+)	Yes	Yes	No	Yes (+)	Yes	Yes
Overcrowding	No	No	Yes	No	No	No	Yes	No (-)	Yes	Yes
Wash basin, soap, water	No	No	No	Yes	No	Yes	No	No	No	No

Alcohol hand gel dispenser and filled	Yes	Yes	No	Yes	Yes	Yes	No	Yes (+)	No	Yes (+)
State of building repair and maintenance	Satisfactory	Poor (−)	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor
Continuous electricity supply	No	Yes (+)	Occasional interruption	Occasional interruption	Yes	Yes	Yes	Yes	Occasional interruption	Occasional interruption
Continuous running water	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

GS = Good Samaritan Hospital

NRH = National Referral Hospital

8.6.2 Qualitative results

A total of 33 individuals (female: 31; male: 2) from five hospitals participated in the study. Recruitment continued until data saturation was evident, that is, until no new themes emerged from data [266], which occurred after eight FGDs and five SSIs. All the healthcare workers we contacted agreed to participate. Median age was 38 years (IQR 36–43) and median years of experience was 12 (IQR 8–20).

Three main themes were identified from participant attitudes towards the implementation process and newborn care: (1) Training methods empower learning and confidence. (2) Resuscitation can be a stressful experience. (3) Participation in research and non-training intervention components is valued.

8.6.2.1 Training methods empowered learning and confidence

- *Coaching methods*

Coaching methodology was identified as a positive feature of the intervention, and participants associated it with better retention of knowledge and skills in clinical care. They described the difference in the coaching methodology and its practical approach as compared with previous training styles experienced. They expressed a sense of fatigue from didactic methods. They spoke of the benefits of having the training modules in existing workspaces and felt that it brought an added sense of reality to the simulations:

> The hands-on style is best, [better] than looking at the slide lectures, it's nice that we did the hands-on [training]... So, I think that style should be continued with every training. (Midwife, FGD)

- *Program duration and practical approach*

Participants highlighted the short duration of the program and practical approach as compared with past training programs, which had a duration of up to a week and included more theory. The higher degree of repetition and hands-on learning was identified as having greater relevance to daily duties:

> I find it very useful… it's a short period of time and a lot of information given, it is very useful, easily remembered as compared to other workshops [where] more theory takes longer. (Neonatal Nurse, SSI)

- *Enhanced communication between cadres*

Participants recognised a healthcare cultural change from the program and its impact on communication. The training provided a universal language and expected standard for newborn care. Since all staff at each facility received the training together, cross-disciplinary interaction was possible, and participants of all cadres trained with the same expectations, a feature not common to previous trainings since these trained midwives and nurses separately from doctors:

> It [is] good because we are speaking the same language and everyone [knows] what to do next especially [in] resuscitations; everybody knows each other, so, if they need help they know exactly what should come next. [It] is [a] certain procedure they know, it helps the anaesthetists, surgeons, paediatricians [and] obstetricians to work together. (Neonatal Nurse, SSI)

- *Increased confidence*

There was a common expression of increased confidence in management of the non-breathing newborn following training. This was reflected in both a practical sense for skills acquisition as well as competency through knowledge gains. Participants recounted examples of instances where their confidence had enabled autonomy and earlier recognition, and intervention in caring for a non-breathing newborn:

> I see most of the staff [have] gain[ed] more confidence in resuscitating the newborns. Whenever they prepare the area for the second stage, they prepare for the newborns. (Midwife, FGD*)*

8.6.2.2 Stressful nature of resuscitation experience

Participants commonly found resuscitation of a non-breathing neonate to be stressful and challenging. The 'high-stakes' moment affected adherence to skills and knowledge that participants felt they otherwise would be able to perform. Often, these feelings were compounded by a sense of isolation, lack of support and not having anyone for assistance. When resuscitation occurred after hours with fewer staff and lack of amenities, such as electricity, stress was amplified:

> Even though we are trained… in those situations sometimes we will panic, and then we forget something we must or have to do, but later on we just think about it. (Neonatal Nurse, FGD)

- *Reflection on positive resuscitation experiences*

Several participants described a successful resuscitation where they reflected on the application of their skills and making a difference. At times, these moments were associated with surprise that a rare, positive outcome for the baby could be achieved through their actions, reflecting the pre-existing lack of expectation of success for intervening with non-breathing babies. When successful, these high-stakes moments imbued a sense of satisfaction and trust in their own skills:

> Yes, everyone was surprised, and when I told the mother the baby was breathing again, she was very happy, because someone said, the other doctors said, 'Oh, your baby is not breathing, you might lose the baby'. So I just continued [to] bag… and the baby picked up, so I just learnt from that, when I do that I just help the baby breathe, and I feel happy too because it's a miracle for me. (Midwife, SSI)

- *Improved autonomy with training*

Following training, participants felt increased autonomy during resuscitation, especially the midwives. Interviewees felt a reduced reliance on doctors and more confident in their own skills:

> I think the EENC really helps us to, to build our skills and feel confident, not like before we used to call the doctors every time there was born a flat baby and we go panic. (Midwife, FGD)

- *Need for ongoing practice*

Participants expressed lack of practice, because of the infrequent nature of resuscitation, as a challenge for maintaining skills. The majority of participants felt that more regular training and refreshers of short duration would be beneficial. In-house training of regular frequency, to occur monthly or weekly, was frequently cited:

> We should do it on our own, like once a week we practice, or fortnightly we do that practice on how to do the resuscitation. That would remind us. (Nurse Aide, FGD)

8.6.2.3 Valuing participation in evaluation

Participants expressed they valued the opportunity to reflect and analyse their experience through the process of the evaluation interviews and group discussions. They said that they had not received feedback from previous evaluations. There were differing opinions

about where responsibility for future evaluation of newborn care should lie. Some participants felt that external evaluation would hold them to greater accountability and would identify gaps, but others felt that there was a need to take ownership of this process:

> Can we just say that if you compile everything, then it would be good for us to have our feedback as well? Then, we will know where the gaps are. Just last week we had a meeting and we sort of talked it over, about our nurses in our ward, [that] they should have a team where they do their own evaluation on how they do things. But I think it's better for us to have an external evaluation team as well, so that maybe if we look at ourselves then we think we are all good, but maybe there are gaps that we have, so it's good that you people are coming to do the external evaluation for our program. (Midwife, FGD)

8.6.2.4 Non-training intervention components

- *Structural impact on quality of care processes*

When asked to prioritise future needs, many interviewees cited equipment and structural improvements over training priorities. Problems with physical conditions, such as the state of buildings and conditions, were identified. Oxygen supply interruptions and equipment technical issues were highlighted as limitations of the intervention. These structural limitations often affected what healthcare workers knew to be best practice and frustrated their ability to provide quality care in their patient's interests:

> For me, the training is good, is best, but facilities are the one, the training is already there, but because there is not enough facilities, like rooms/beds, we don't follow 90 minutes [of skin-to-skin contact], as long as mother is delivered and baby is lying there, we just go [to the postnatal ward]. We need more beds. (Midwife, FGD)

- *Impact of structural elements on healthcare worker attitudes*

A sense of personal and professional value was imbued when resources were available. This affected practical elements in providing care as well as imparted a sense of valuing of the healthcare worker's role and purpose:

> Previously, when we didn't have the pulse oximeter, the neonate they were already cyanosed because we didn't have a machine to check. But after they delivered it, the staff they feel they're working very well. (Midwife, FGD)

- *Healthcare organisation limitations*

Participants cited challenges that were not addressed by the intervention, such as few staff, limited support after hours and feeling unsupported, particularly when assistance of seniors was required. The process of contacting doctors by mobile phones and requesting attendance for emergencies was often protracted, and doctors cited delays due to transport and communication issues:

> Sometimes, when there is a lot of mothers that come for delivery, then I myself or only one nurse is attending to the newborn, so it's a little bit hard. (Midwife, SSI)

8.7 Discussion

In this mixed methods study of the implementation experience of healthcare workers of a multifaceted intervention to improve neonatal quality of care, participants describe the challenge of newborn resuscitation in remote settings. They describe it as an infrequent, high-stakes occurrence compounded by feeling unsupported. They expressed that the interrelation of facilities (structure) and skills (process) affected their ability to provide care, both practically through limited space and poor conditions, as well as through a sense of their physical environment reflecting value of their professional role. The practical coaching methodology without didactic methods and with short training periods was a strength of the program. Increased recognition of the need to practice skills between formal trainings was expressed, although opportunities to implement this were limited.

We found the pedagogical approach of training to be an enabling feature in influencing change in practice and attitudes from the intervention. As part of this study, EENC used a brief (two-day) scenario-based coaching approach with an interactive coaching supervisor for small groups. Neonatal training programs in low- and middle-income countries vary significantly in content, methods and duration. Previous studies of shorter 1-day duration programs have also shown impact [267]. The use of coaching methodology, and absence of didactic teaching, were features absent in previously reported neonatal training programs [165, 241, 244]. Indirect effects of the coaching method were workforce cultural changes through improved collaboration and communication between cadres.

Through qualitative data analysis, a sense of anxiety regarding resuscitations and a lack of confidence were identified, with successful resuscitation experiences being a welcome exception rather than the norm. Few studies have documented the qualitative experience of resuscitation for healthcare workers in low- and middle-income countries [104, 105,

268, 269]. Further, although many studies and guidelines outline the equipment, algorithms and approach, these lack sufficient description of the challenging nature of a resuscitation event and its subsequent weighing on the mind of the healthcare worker. Support in dealing with stressful experiences is an important component of a well-performing and motivated workforce [270]. Providing geographically isolated health care workers avenues for post-resuscitation debriefing and reflection is important for wellbeing and provides a training moment.

Interrelation between structure and process components reinforces the implementation framework and the drivers for quality care. Lack of physical resources leads to a sense of frustration for healthcare workers and is a barrier to providing basic newborn care [107]. Structural limitations that impede process improvements, such as implementation of skin-to-skin contact because of space limitations, have been experienced in other settings [271]. In countries with small, disbursed populations, health facility infrastructure is costly and maintenance and technical support is challenging, given the many facilities spread across a large geographical area.

Several studies have evaluated the impact from implementation of programs for newborns and children and have highlighted the impact of context on intervention delivery [90, 168, 253, 272]. Multifaceted or 'packaged' interventions were not found to have a strong evidence base, and were highlighted as a priority area for research on strategies that make scale-up feasible [101]. Multifaceted studies vary significantly in terms of components, and direct comparisons are difficult. In this study, we found the concomitant training, attention to structural changes and equipment implementation synergistic. Neonatal training could occur with new equipment, in familiar settings. This concept supports the idea of an 'enabling environment' through equipment, supplies, medications and transportation for referral [273]. The opportunity to combine various intervention components (e.g. equipment delivery and training) owing to infrequent opportunity to travel to remote sites, and the associated time and funds needed, further underscored this approach.

The unique combination of economic, climate and geographical challenges facing low-middle-income SIDS presents a challenge to implementation of timely high-impact health interventions, which have been possible in other regions. The Oceania region contains 20 SIDS and has had few opportunities to evaluate the impact of neonatal interventions within its unique context. Barriers to delivering appropriate supplies and equipment

include servicing geographically disbursed populations, high costs for transportation that consume a limited financial budget [274] and disruption to services from weather events. Some countries have needed to import health services and support medical travel for access to healthcare services, although this has high associated costs and requires significant coordination and oversight [132]. Themes arising from both qualitative and quantitative sections of this study reflect the impact of geographic isolation and lack of supports, underscoring the need for relationships between community, provincial and national hospitals to be supported [31]. Training methods must support increased autonomy where support and expertise may not be available.

The limitations of this study include sampling methods, which depended on the participation of staff at the study sites on the days of the refresher training. Several healthcare workers were unable to participate since they lacked transport to reach the provincial hospital, and hence, only a minority of the participants were from outside these facilities. Therefore, the views represented need to be interpreted with caution, beyond the settings of provincial hospitals. Second, the participants knew some of researchers from the intervention. Although this may have effected expression of criticism of the implementation, thus limiting validity of this study, triangulation from across the study sites and healthcare workers yielded consistent themes. This approach occurred out of pragmatic necessity owing to access and timing of visits to the provincial hospitals, and limited available individuals with experience of this thematic area and the context of implementation, a challenge experienced by similar studies in low- and middle-income countries [253].

8.8 Conclusion

This implementation experience provided important lessons that could be targeted by future iterations of newborn care programs. Practical, coaching-based training methods enabled improved confidence in healthcare workers and communication between various cadres of these workers. Challenges include the stressful nature of resuscitation, structural limitations and few opportunities for ongoing skills practice. These findings may be used to shape future interventions for improving newborn quality of care in similar settings.

Acknowledgments:

This work would not have been possible without the support of the Ministry of Health and Medical Services, Dr Divinal Ogaoga, the paediatricians and registrars at the National

Referral Hospital: Dr Titus Nasi, Dr Carol Titiulu, Dr Steven Lumasa, Dr Janella Solomon and Dr Rami Subhi.

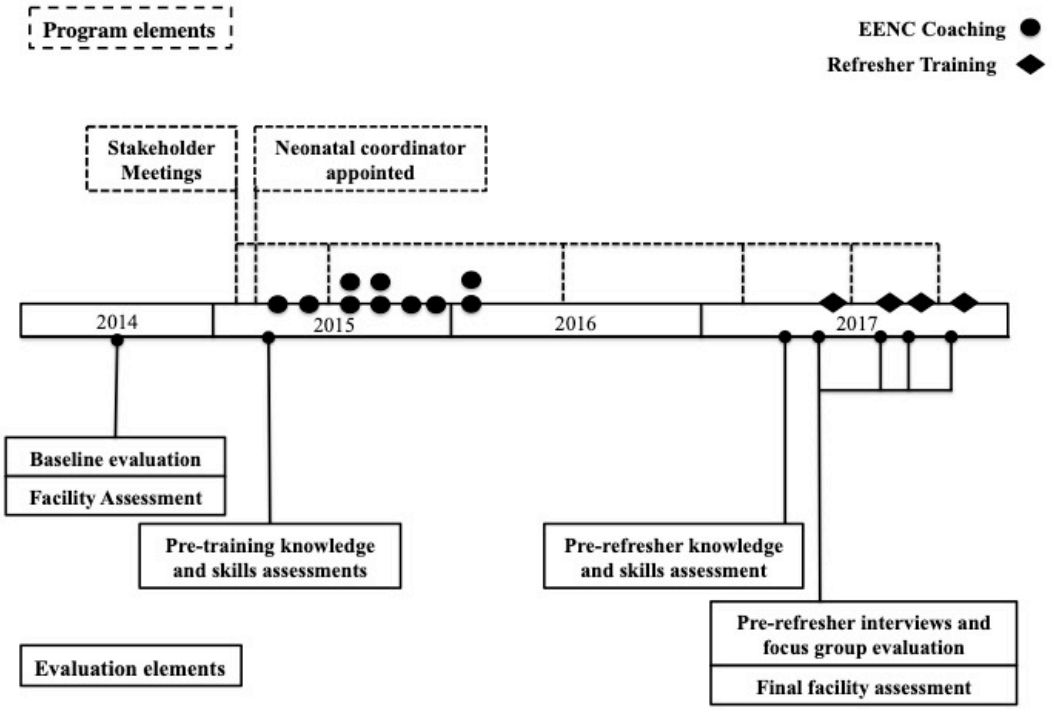
Financial Support:

The authors received no financial support to undertake this research.

Disclosures:

Anita Maepio, Anna Jatobatu and Shidan Tosif were involved in the implementation activities of the newborn care program in Solomon Islands.

Appendix 1: Timeline of Program and Evaluation Elements



Chapter 9: Discussion

9.1 Introduction

This thesis described newborn quality of care in Solomon Islands, the burden of perinatal mortality and the contextual factors that were barriers or enablers to improving quality of care. Utilising the findings from these assessments, a multifaceted intervention was implemented and its impact on knowledge and skills of healthcare workers was assessed. Finally, the strengths and limitations of the implementation were examined to inform future programs for improving newborn quality of care in similar settings

The literature review (Chapter 2) highlighted the role of quality improvement in behaviour change for newborn care and pedagogical aspects of training design. The broad approaches taken in low- and middle-income countries to enhance newborn quality of care reflect the consideration of context in design and implementation of programs. Specific considerations, such as training methods, and the need for a cross-discipline approach to establishing quality improvement programs were highlighted.

This thesis utilised qualitative and quantitative methods to address the key research questions in a stepwise process, beginning with a baseline assessment of quality of care for newborns (Chapter 5), an audit of perinatal mortality (Chapter 6) and assessment of impact on healthcare worker knowledge and skills from the training intervention (Chapter 7). The final study described the implementation experience, identifying barriers and enablers to improving newborn quality of care within the Solomon Islands health service delivery context (Chapter 8).

These studies were undertaking in a health systems context unique to Small Island Developing States and Western Pacific Island Nations. Low health expenditure, a dispersed population with few healthcare workers and the challenge of distance and terrain posed barriers to implementation. Almost 250 facilities delivered newborns, making training coverage an ongoing challenge. The implementation team was small, consisting of three members who experienced logistical barriers and high costs associated with travel to the remote provinces. During the period of the intervention, there was a significant flooding event in the capital, a hospital fire in Gizo that resulted in loss of some study records and significant movement of staff between facilities, which limited the pool of healthcare workers that were eligible for evaluation.

The aim of this final chapter is to describe the key findings in relation to the research aims of the thesis and provide recommendations for future policy and practice.

9.2 Newborn Quality of Care in Solomon Islands

This study identified perinatal morality rates much higher than previously estimated for the country and highlighted a disparity between outcomes for the national and provincial hospitals. These findings raise concern about underestimation of neonatal mortality in national estimates, which have shown a steady trend of improvement over the past 10 years. The poor availability of data highlights the need for improved routine data collection systems. Such systems are needed to accurately describe the morbidity and mortality in this population, to highlight the true healthcare burden and to track progress over time.

The structured neonatal assessment described in Chapter 5 utilised the quality of care measures and framework outlined in the methods and provided important baseline findings for the thesis. The structured facility assessments provided an insight into limitations to quality newborn care in the existing health system context. Key findings were health workforce limitations, namely, insufficient numbers of health workers, and few specialised staff and resources outside of NRH. There were significant structural barriers related to equipment availability, maintenance and organisation of equipment. None of the hospitals assessed had a bag and mask within reach of the birth areas and had frequent stock outs of essential supplies. Lack of infection control measures, specifically for hand hygiene emerged, related to stock outs and ordering problems.

The assessment included healthcare worker perspectives on challenges and priorities in newborn care, which helped shape and provide support for the intervention. Healthcare workers described their priorities in newborn care as follows: (1) improving facilities and equipment, (2) improving healthcare workforce numbers, (3) training in newborn care, with a preference for practical training methods and better coordination of training. Limitation in resuscitation skills was identified as a specific challenge.

The current assessment provides a comparison with an assessment of child health services 11 years prior in 2003 in Solomon Islands [15]. The current assessment re-iterates many of the challenges present in 2003, although there are some positive gains during the period between the studies. For instance, Gizo Hospital was rebuilt following major damage sustained in an earthquake and tsunami in 2007. However, apart from minor renovations,

no hospital buildings had significantly changed, and Kilu'ufi and Kirakira Hospitals remained in a poor state. Electricity and oxygen supplies were more consistent in the current assessment, although Kirakira continued to face interruptions. A positive finding of our study was that essential drugs were available in all hospitals, as compared with deficiencies in two of the five hospitals examined in 2003.

Basic equipment supply and maintenance of facilities to a minimum standard is an area of need. Maintaining or building new physical structures for a large number of health facilities where babies are born is out of reach for Solomon Islands since it has limited funds for health infrastructure and needs to allocate most of the health budget towards providing basic services. The Japanese Government funded and built Gizo Hospital, but had it not been irreparably damaged from the tsunami and earthquake of 2007 it may not have been rebuilt. To health workers, these facilities reflect their sense of professional value, and poor conditions lead to frustrations with the systems within which they work.

More health care workers are needed in Solomon Islands. A shortage of skilled child health nurses identified in 2004 and a deficit in province-based paediatricians continues, as shown in the current assessment. A program has more recently commenced in 2017 at the Solomon Island National University for child health nurses, and more paediatric trainees and qualified paediatricians are based at NRH. However, even once trained, Solomon Islands face challenges in retaining staff, particularly in provincial areas, an experience common to many Pacific Island nations [275]. More recent challenges include a large influx of Solomon Islands medical school graduates from Cuba and Taiwan who have needed additional training and support before entry into the workforce. Coordination and management of the health workforce and organising placements throughout the country often falls upon busy clinicians who have limited administrative supports and funds.

9.3 Causes and Rate of Perinatal Morbidity and Mortality in Solomon Islands

In Chapter 6, the findings of an audit of three years of perinatal data relating to early neonatal deaths and stillbirths was described. This study found a surprisingly high perinatal mortality rate (35.9 per 1,000 births) across all the hospitals, with rates 30% higher in the provincial hospitals compared with NRH. Moreover, 62% of stillbirths were 'fresh' stillbirths, reflecting on the perinatal period as a time of risk. At NRH, neonatal

conditions associated with the highest case-fatality rates were birth asphyxia (21.3%), congenital abnormalities (17.7%) and prematurity (15.1%). Most neonatal deaths occurred in the first three days of life and Special Care Nurseries in provincial hospitals had a higher mortality rate overall compared with NRH.

This study also highlighted the need for routine data collection for perinatal deaths in the absence of vital registration and regular neonatal mortality auditing. Basic newborn data such as birthweight and Apgar scores, or outcomes of stillbirths and neonatal deaths were absent from MHMS data collection processes. Data relating to stillbirths and neonates even at the hospital level were limited, with some data parameters incomplete in more than 10% of admissions. Comparison of morbidity and mortality rates to other countries in the region suggested a similar profile. Morbidity and mortality rates are higher than more developed nations, although these statistics are not directly comparable to settings where routine antenatal ultrasound, screening measures and management of congenital abnormalities would yield a different denominator to these rates.

National stillbirth and neonatal mortality rates for Solomon Islands remain unknown. However, this study presents findings that are consistent with other reports of high perinatal rates in the country [121, 214]. Of note, the results contradict national estimates for Solomon Islands and raise concern regarding the calculated rates used in global estimates that suggest consistent progress in newborn mortality [276]. Subsequent to this study, neonatal deaths are now represented in routine reporting under the direction of the current Solomon Islands child health plan. In addition, more regular child health audits have been conducted over recent years, which present an opportunity to identify modifiable factors [235].

These findings have implications for future research in this area. Accurate and timely data collection is needed to delineate perinatal outcomes, to identify specific areas of need and track progress from interventions. The geographic distance between facilities and few deliveries at each site present a challenge to data collection. Electronic information systems are available and have been implemented in low-resource settings [232]. The improved internet connectivity from the proposed Coral Sea Cable System may allow increased utilisation of online platforms and better communication between health facilities. To address poor data entry, providing opportunities for local data review rather than a one-way supply of information to the MHMS may motivate healthcare workers to be more comprehensive in their approach.

9.4 Impact of the Early Essential Newborn Care Coaching Program

Data generated from the baseline assessments and analysis of perinatal outcomes were used in shaping an intervention to address the contextual needs of Solomon Islands. The implementation of the EENC coaching program was the first national newborn program for this country, and the study described in Chapter 7 is the first to describe its impact in the Western Pacific region where it has been recommended as the primary training approach by the WHO [12]. Specific gaps which had been identified from the baseline analysis of knowledge and skills gaps in resuscitation, and equipment needs (bag and mask) were addressed through the educational approach.

One of the unique findings of this thesis compared with those of previous studies was the significant immediate impact from a short training program of two days. The relatively short training period has benefits, such as minimising costs and the time healthcare workers are away from their posts. Although some reduction in skills and knowledge were observed at the time of evaluation assessment, a median of 21 months following training, this study found better retention in cadres of health workers who used the skills more frequently. This finding reflects the important differences arising from the daily application of knowledge and skills by healthcare workers. It highlights the need for providing avenues for practice, such as through regular scenario-based refreshers for all healthcare workers, to ensure skills are maintained.

Previous studies that have successfully implemented a quality improvement program alongside a training intervention have found better retention of knowledge and skills [277, 278]. However, although guidelines for a quality improvement team and resources were supplied during the training period in our study, these did not eventuate into action. One possible cause for this was that the training time did not allow for time to discuss or practice the intended quality improvement activities. Other studies have shown that establishment of quality improvement complementary to training requires significant investment of time and effort, in addition to the training [246]. Sustaining ongoing quality improvement activities presents a challenge in Solomon Islands where funds and availability of support staff is limited. Dedicating more time in the training to the importance of this aspect is needed. Remote support, encouragement and a sense of community have been developed through group-based cross-platform messaging services (e.g. Viber and WhatsApp Groups) in other settings where healthcare workers are geographically dispersed (e.g. Fiji).

Results from this study strongly support the pedagogical and implementation approach of the EENC program in the Solomon Islands settings. Compared with the EENC coaching program, the WHO Essential Newborn Care Course also offered by the WHO is longer and made complex by the six guides and workbooks for participants and facilitators [279]. This study shows that a short training time, focused on a particular outcome, can have impact and may suit other settings where opportunities for training are limited by distance and cost. Staged introduction of skills, through sequential focused trainings, may have greater impact than longer trainings with more content. In addition, many training programs rely on a large contingent of external support to implement. Another novel aspect of the EENC training is that the training was conducted by one or two MHMS nurses and midwives, who had portable teaching resources (MamaNatalie^{TM} and NeoNatalie^{TM}), without ongoing external support or oversight.

9.5 Implementation Experience from the Multifaceted Intervention

In Chapter 8, the implementation experience from a multifaceted intervention was described. This study triangulated qualitative and quantitative data gathered throughout the period of the intervention utilising an exploratory design. The qualitative data gathered in this study through semi-structured interviews were used to evaluate the implementation approach and highlight the strengths and weaknesses of the intervention. The quantitative analysis found few significant structural improvements throughout the period of the intervention, although, of note, there was important organisational change in preparing for births, such as through ensuring bag-and-mask availability at all delivery areas. Healthcare workers described the short training period, as well as the practical and interactive style, as positive features of the training.

Notably, the training lead to improved workplace culture by bringing together usually distinct cadres of healthcare workers through the training process and providing a standardised approach to care. Participants also highlighted the stressful nature of the resuscitation experience, which was compounded by geographic isolation and few supports for healthcare workers. The healthcare workers who had few opportunities to evaluate their learning experience in neonatal trainings previously valued the experience of participating in the evaluation

Evaluations of the implementation experience of ENC programs have not been reported, although these are proposed for a current HBB program [280]. The implementation experience helps readers understand the elements of the intervention specific to the

context and consider how they may be used in their own circumstances. In this way, the results of the intervention become more relevant and meaningful rather than a reflection of impact on skills or mortality alone.

Future implementation of ENC programs should prepare health care workers for the emotional component of newborn resuscitation in addition to improving technical expertise. Facilities and equipment should be maintained to a standard to allow provision of quality care and their impact on a sense of value they imbue in health care workers should be recognised. Practical coaching without didactic methods, shorter training periods and a program of follow-up to practice skills continuously is essential to maintain knowledge and skills.

9.6 Study Strengths and Limitations

The duration of the study over three years enabled data collection from at least two time points from every location. This was important because it allowed observation of impact over time, at the provincial hospitals in particular. The pairing of skills results for the same healthcare worker over time was a strength, and it improved internal validity. The small sample size of participants limited detailed statistical analyses, particularly by demographic factors such as cadre, since small sub-group analysis did not reach statistical significance. The small numbers of perinatal deaths reported would potentially be affected by small random differences in numbers leading to larger changes in overall rates.

This study examined the quality of newborn care and impact of EENC training at the NRH and provincial hospitals only. Therefore, these findings may not be generalisable to the entire population of Solomon Islands. Moreover, the number of births captured in these facilities constitute around 50% of all births in the country, but there is likely to be heterogeneity in quality of care among facilities where babies were born. Most of these are nurse aide posts, or area health clinics where different challenges and approaches to those described in this study are possible. Cumulatively, these facilities deliver a substantial number of newborns and present a challenge to implementation and evaluation that is not addressed in this thesis.

This was a multifaceted intervention occurring in the context of evolving health services with factors outside this study, which may have had an impact. These included updating national guidelines, implementing database systems for data collection at NRH and

Kilu'ufi Hospitals and other trainings for child health, such as the WHO *Pocketbook of Hospital Care* for children. These factors may have affected internal validity of the study.

Doctors and MHMS staff in Solomon Islands are often overwhelmed by a constant flow of requests by governmental, non-governmental, domestic and international educational institutions for their time. There is also the educational support needed for trainees, medical students and elective medical students locally. These competing interests for time are associated with administrative requirements for which there is no additional support. Prioritising attempts to improve quality of care in the newborn period among these other competing interests is a challenge. These limitations may have limited implementation fidelity.

This intervention focused on improving care in the early neonatal period. However, the main causes of neonatal morbidity and mortality identified in this study (prematurity, birth asphyxia and infection) are also a reflection of the quality of care in the pre-natal, intrapartum and late neonatal period. Assessment of causes of stillbirth and potential interventions is an area of critical need. Future interventions may benefit from addressing causes of morbidity and mortality across the continuum of care for mothers and newborns, of which ENC is one important component.

Chapter 10: Conclusions

In this thesis, the quality of newborn care in Solomon Islands, perinatal outcomes and the impact from an intervention to improve healthcare worker knowledge and skills in ENC are described. The experience for the healthcare workers and the barriers and enabling factors for successful implementation were explored. The findings of this thesis provide important considerations for ENC and its implementation in Solomon Islands and similar settings.

It has been shown that improving newborn quality of care requires consideration of healthcare worker needs and the context in which a program is implemented. At the core of the intervention were the healthcare workers, who responded to practical training approaches that provided targeted content. The WHO EENC training had a significant impact on knowledge and skills and was delivered by a small MHMS team despite the challenges of distance and limited funds. Maintaining healthcare worker knowledge into the future is a challenge compounded by accessibility and funding issues in the Solomon Islands context.

ENC has an important role in the continuum of perinatal care that includes the health and wellbeing of the mother and newborn. ENC establishes safe and supportive practices to ensure the best start for the neonate. The high numbers of stillbirth and significant proportion of late neonatal deaths identified reflect the complementary need of maternal and perinatal care, as well as care into the later neonatal period.

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Appendices

Appendix A: Declaration for a Thesis with Publication

Removed for online publication

Appendix B: Declaration for a Thesis with Publication

Removed for online publication

Appendix C: Declaration for a Thesis with Publication

Removed for online publication

Appendix D: Declaration for a Thesis with Publication

Removed for online publication

Appendix E: Literature Review Protocol

1.1 Background

Systematic reviews[1-4] on newborn training programs have found knowledge and skills falloff, with modest or inconclusive impact on neonatal mortality reduction. Contextual factors and complementary activities were not described in detail in these reviews. This may be in part owing to narrow methodologies, which were unable to capture studies where multifaceted interventions were described, or a framework for exploring the complexity of programs was not used. Recent studies have shown promising outcomes when training programs are combined with a continuous quality improvement approach[5,6]. Newborn training programs when paired with a continuous quality improvement approach, need to be regarded as a complex intervention[7], as there are many interacting components, multiple behaviours are targeted and there are many contextual factors.

1.2 Review question/objective

For health care workers in low- and low-middle-income countries where neonatal training has been combined with a continuous quality improvement program, how do newborn care programs improve outcomes

1.3 Inclusion criteria

1.3.1 Types of participants

The study must have included health care workers who received training in newborn care in a low- and low-middle income country.

1.3.2 Types of interventions

The study must involve a training program, addressing newborn care in the first 24 hours of life (e.g. resuscitation, management of birth asphyxia or prematurity) **together with** implementation of a continuous quality improvement program. The continuous quality improvement program must be consist with Effective Practice and Organization of Care (EPOC) definition for continuous quality improvement[8].

> An iterative process to review and improve care that includes involvement of healthcare teams, analysis of a process or system, a structured process improvement method or problem solving approach, and use of data analysis to assess changes. [8]

Examples include a quality improvement cycle, health facility strengthening, supportive supervision or other planned and concurrent intervention in addition to the training. Studies that conducted a single episode intervention, or quality improvement program were not included.

1.3.3 Types of outcomes

Outcomes sought were the effectiveness of interventions in retention of knowledge or skills by healthcare workers or impact on perinatal mortality, quality improvement strategies and methods used and their efficacy and implementation methods. Other outcomes were methods of training delivery (e.g. pedagogy, training delivery method and setting, duration, participants (e.g. midwife, doctors, nurses), choice of training package (e.g. HBB, IMCI, EENC)). Of specific interest were the training approach (e.g. pedagogical theory, practical aspects, simulation, written, supported supervision), method and timing of evaluation of participants learning (e.g. written score, delivery room documentation, simulated skills, video) and description of how the training was received by the participants (e.g. feedback, satisfaction scores).

1.3.4 Types of studies

All evaluative study types from low- and middle-income countries were considered. Training in non-low- and middle-income countries was not considered.

1.4 Search strategy

The search strategy aimed to find both published and unpublished studies. A three-step search strategy was used in this review. An initial limited search of MEDLINE and CINAHL was undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe article. A second search using all identified keywords and index terms was then undertaken across all included databases. Thirdly, the reference list of identified reports and articles was searched for additional studies. Studies published in English were considered for inclusion in this review.

The databases searched included:

- MEDLINE
- EMBASE
- Cochrane
- CINAHL
- Pubmed

Grey literature: British Library, WHO, The New York Academy of Science and Google Scholar

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Appendix F: Assessment of Neonatal Care in Hospitals

This assessment tool can be used to evaluate services for neonates in provincial and district hospitals in PNG.

The assessment covers the following areas:

- Neonatal ward layout and facilities
- Facilities for mothers and families
- Infection prevention facilities
- Basic standards
- Infection prevention standards
- Ward statistics
- Ward staffing, training and experience
- Supplies and equipment
- Essential medicines
- Laboratory tests
- Referral guidelines and resources for referral
- Neonatal case management

There are 2 parts:

Part 1 – Survey of facilities, practices and standards
Part 2 – Assessment of facilities, practices and case management

- The information gathered during the assessment will then to be used to prioritise interventions and as a baseline for detecting improvement over time.

The standards assessed in the tool are based upon standards documented in the PNG Standard Treatment Manual eighth edition, *Pocket Book of Hospital Care for Children* (WHO, 2005) and the Minimal Standards of Neonatal Care in PNG.

BASIC INFORMATION

Hospital	
Assessors	
Dates of assessment	

Part 1

NEONATAL WARD LAYOUT AND FACILITIES

Is there a separate neonatal ward?	Y ☐ N ☐
If no, where are sick neonates cared for?	
Up to which age are babies admitted to the neonatal ward?	
There is good access from labour ward, operating theatre and post-natal mothers area to where neonates are cared for?	Y ☐ N ☐
How many cots/beds are available for neonates? *(*includes incubators/warmers)*	
What is the average distance between cots / beds used for neonates?	____ metres
Are out-born babies or babies who have been home already admitted in the same area as babies born in the hospital?	Y ☐ N ☐
• If so, are they admitted in a separate room?	Y ☐ N ☐
Is there an isolation room that is used for babies / mothers with highly infectious conditions?	Y ☐ N ☐
Is there an emergency (resuscitation) management area (cot / table) in the ward?	Y ☐ N ☐
Are high-risk or very sick babies cared for in an area with closer nursing observation than other less sick babies?	Y ☐ N ☐
Is there a separate area for storing equipment and supplies?	Y ☐ N ☐
Is there a separate area for preparing medicines and iv fluids?	Y ☐ N ☐
Is there a separate area for storing and preparing milk formulas?	Y ☐ N ☐

NEONATAL WARD LAYOUT AND FACILITIES

Is there a separate area for cleaning dirty and contaminated equipment?	Y ☐ N ☐
• If yes, describe	
Is electricity supply continuous?	Y ☐ N ☐
• If no, in general how many hours supply out of 24?	
• If no, is it backed up by generator?	Y ☐ N ☐
Is there continuous running water?	Y ☐ N ☐
• If no, describe situation	
Is there a means for communicating between the ward and other ward areas (maternity, OT, laboratory etc) – ie a telephone or radio or other?	Y ☐ N ☐
• If yes, describe	
Are there air-conditioners or fans on the ward?	Y ☐ N ☐
• If yes, how are babies protected from AC / fan?	
What is the current ambient temperature on the ward? (take it)	_____ ^{o}C
Is there a wall thermometer on the ward?	Y ☐ N ☐
Is there a wall mounted clock on the ward that is readily visible?	Y ☐ N ☐
Is there a fridge for storing medications and vaccines on the ward?	Y ☐ N ☐
Are food stuffs also stored in the fridge/s?	Y ☐ N ☐
Do all babies' cots have mattresses?	Y ☐ N ☐
Do the cots have bed linen (supplied by hospital)?	Y ☐ N ☐
Are the cots clean?	Y ☐ N ☐

FACILITIES FOR MOTHERS AND FAMILIES

Do mothers have 24 hour access to their babies?	Y ☐ N ☐
If no, describe times of access	
Is there a rooming-in facility for mothers of babies who will soon go home or who are expressing milk or breastfeeding regularly?	Y ☐ N ☐
Is there a private place for mothers to express and or feed their babies?	Y ☐ N ☐
• Is there a hand-washing facility near by?	Y ☐ N ☐
• Does it contain a comfortable chair/s?	Y ☐ N ☐
• Does it contain washing up facilities with hot water for cleaning containers?	Y ☐ N ☐
Is there a place for mothers / families to wash babies' clothes / linen on or close to the ward?	Y ☐ N ☐
Is there a private place on the ward for counselling parents or for parents to be together with their babies after they are deceased?	Y ☐ N ☐

INFECTION CONTROL FACILITIES

How many taps and wash basins are there on the ward?	
Is a tap and wash basin facility readily available as staff / visitors enter the ward?	Y ☐ N ☐
Are hand-washing facilities readily accessible to staff / visitors in ALL areas of the nursery?	Y ☐ N ☐
• If no, describe	
Are the taps all functioning?	Y ☐ N ☐
How are the taps operated? (Hand, foot, elbow, other)	
Is soap available in each hand-washing basin?	Y ☐ N ☐
Is the soap on a draining rack or sitting on the basin?	Y ☐ N ☐
What facility exists for drying hands? towel ☐ paper-towels ☐ none (air-dry) ☐ other ☐ If other, describe	
Are alcohol gel dispensers are available in each area of the nursery?	Y ☐ N ☐
Are there sharps disposal containers at all points of sharps use including portable containers for bedside use?	Y ☐ N ☐
Are there easily accessible toilets available for parents?	Y ☐ N ☐
Are there hand washing facilities in these toilets?	Y ☐ N ☐
Are there easily accessible toilets available for staff?	Y ☐ N ☐
Are there hand washing facilities in these toilets?	Y ☐ N ☐

WARD STATISTICS

Are all admissions and discharges recorded in the ward admission record book?	Y ☐ N ☐
Are all admissions and discharges recorded in the Paediatric Hospital Reporting System?	Y ☐ N ☐
Are there regular ward mortality / morbidity meetings?	Y ☐ N ☐
• If yes, what is frequency of meetings?	

WARD STAFFING

Indicate the number of staff available	**day**	**night**
Paediatricians		
Other doctors		
Paediatric nurses per shift		
Midwives per shift		
Other nurses per shift		

Other comment ……
……..
……
…..……
…….
Who is available during the weekend? ……..
If senior staff is not available all the time, how are they called for an emergency? ……
……..
On average, how long does it take for the senior doctor to arrive after being called for an emergency after hours? .....minutes from time of call

STAFF TRAINING AND EXPERIENCE

Survey as many staff as possible, print off a separate form for each person

Describe what training you received in neonatal care (weeks or months, practical experience if any) ……

……

……

…….

	When (year and how long for)	Where / by whom	Any follow-up	Do you still feel confident in your skills from this training?	Any comments about the experience or need for more training?
Neonatal Resuscitation					
Neonatal Care – general					
Breastfeeding counselling					
Infection prevention					
Other relevant training. List: - - -					

NURSERY SUPPLIES AND EQUIPMENT

	Available? Y/N	**Clean and in good working order?** Y / N	**Comments** right size? replaceable parts? any other relevant comment
Weighing scales for babies (electronic, bucket)			
Oxygen source (piped, cylinder, concentrator) including at least one portable device			
Oximeter with neonatal probes			
Apnoea monitors			
Incubators			
Radiant / overhead warmers			
Resuscitation table with overhead warmer			
Phototherapy system			
Spare lamps or bulbs for phototherapy units			
Portable suction machines – electric or mechanical			
Suction catheters size 6, 8, 10, 12, 14F			
Self inflating resuscitation bags (250-400mls)			
Round face masks for ambubag - size 0 and 1 (term and preterm)			
Appropriate humidification for oxygen			
Nasal catheters/prongs			
Portable ‘resuscitation box’ or trolley			
Laryngoscope handles and straight neonatal blades (sizes 0 and 1)			
Spare laryngoscope bulbs and batteries			
Endotracheal tubes sizes 2.5, 3.0, 3.5, 4.0			

Wire or plastic introducers for ETT			
Magill's forceps			
Syringe drivers (50ml, 20ml, 10ml)			
Intravenous fluid giving sets			
Intravenous fluid burettes			
Blood giving sets / filters			
Short linking tubing (cannula to iv line)			
'3 way' taps			
Cannulas sizes 25, 22, 21, 20, 18G			
Needles sizes 25, 21, 16G			
'Butterfly needles' 25, 21G			
Syringes sizes 1, 2, 5, 10, 20, 50cc			
Lancets for taking heel prick samples			
Arm or foot boards (home made or ready to use) for strapping cannulas			
Umbilical catheters			
Thermometers			
Stethoscopes			
Glucometer			
Glucose strips			
Urine dipsticks			
Urine containers			
CSF needles			

Chest tubes (sizes *check), drainage bottles, connecting tubing*			
Light which can be used for illuminating pneumothorax			
Nasogastric tubes sizes 6, 8, 10, 12F			
Breast pumps (manual / electric)			
Cups and / or spoons for feeding babies			
Milk freezer and / or fridge			
Containers for collecting and storing expressed milk			
Autoclave or steam steriliser			
Sharps disposal boxes			
Portable procedure trolley			
Clean gowns for staff for procedures			
Sterile drapes for procedures			
Sterile gloves			
Face masks			
Sterile minor procedure kits or equivalent contents			
Paper towels for hand-drying			
Waste disposal containers (for non-infectious and infectious waste)			
Contaminated laundry receptacle			
Cleaning items (broom, mop, buckets, brushes)			

AVAILABILITY OF ESSENTIAL MEDICINES

	In hospital ward / nursery	Comments
Adrenaline		
Aminophylline or theophylline		
Ampicillin for injection		
Benzylpenicillin		
Benzathine Penicillin		
Cefotaxime or Ceftriaxone		
Chloramphenicol inj / oral		
Cloxacillin for injection		
Gentamicin for injection		
Isoniazid oral		
Metronidazole for injection		
Nystatin drops		
Phenobarbitone		
Potassium chloride for injection		
Ranitidine for injection		
Tetracycline eye drops or ointment		
Vitamin K for injection		
Vaccinations BCG, polio		
Sterile water for dilution		
Normal saline		
Dextrose 10%		

Blood products (packed cells, whole blood, platelets)		
Milk formulas (specify types)		
Fridge for medications		
Soap for handwashing		
Alcohol hand rub or spray		
Chlorhexidine solution		
Providone iodine solution		
Sodium hypochlorite solution for disinfecting		
CLEANING AGENTS - detergent - list types		

AVAILABILITY OF LABORATORY TESTS

	Available Y/N	**Comments**
Acid-base		
Blood sugar / dextrostix		
Bilirubin – unconj and conjugated		
Blood group and antibodies screen (Coombs)		
Cross match		
Haemoglobin		
Blood smear for malaria		
Syphilis serology (specify which)		
CSF protein glucose		
CSF culture		
Blood culture		
Na, K, urea, Cr, Ca^{++}		
Liver function tests		
Urine analysis		
Xray (chest, abdomen)		
Ultrasound – brain		
Ultrasound heart		

REFERRAL GUIDELINES AND FACILITIES

In the last 6 months, how many neonates have been referred to another health facility?	
Which hospitals are neonates referred to? (list) How long does it take (hours) to reach these? (list the usual mode of transport)	
Does the hospital provide transport for referred patients?	Y ☐ N ☐
If no, are patients assisted in finding transport?	
Are referred patients accompanied by a trained health-worker	Y ☐ N ☐
Is there a system for follow-up of referred neonates?	Y ☐ N ☐
If yes, please describe.	
Is there a system for communicating with other hospitals (phone, radio etc…)	Y ☐ N ☐
Are there referral guidelines for neonates on the ward?	Y ☐ N ☐
Are these guidelines being used?	Y ☐ N ☐

PART 2

Using the information from the above survey, indicate whether the following standards are "Good" or "To be improved", providing some comments for each.

BASIC STANDARDS

- Facilities for newborn care are available
- Maximal contact between mothers and their babies is promoted
- Hygienic services are available for mothers and families.
- Nursery organisation promotes best care for inpatients.

Standards and criteria	Good	To be improved	Comments
Facilities for newborn care are available			
• Clean running water is regularly available			
• Electricity is regularly available			
• Rapid communication is possible in emergency situations			
• Refrigeration is available			
Maximal contact between mothers and their babies is promoted			
• Mothers are encouraged to be together with their babies as much as possible			
• Adequate facilities for mothers are available for mothers to encourage them to spend as much time as possible with their babies.			
Hygienic services are available for mothers			
• Toilets are adequate & easily available.			
• The mother has access to running water and to an appropriate space, near the ward, to wash.			

• A clean and private area with hot water facilities is available for mothers to express and feed their babies			
Nursery has is organised in such a way as to promote best care for inpatients			
• The nursery is organised in a way to minimise the risk of cross-infection of babies (isolation policies, distance between cots)			
• The most seriously ill infants are cared for in a section near the nursing station for direct observation.			
• An emergency resuscitation area is available on the ward			
• Babies are protected from draughts			

INFECTION PREVENTION

Standards and criteria	Good	Needs to be improved	Comments
Hand-washing standards are promoted and adhered to			
▪ Adequate facilities for hand-washing and disinfecting are readily accessible to both families and staff on the ward.			
▪ There is a hand-washing facility readily accessible when staff / visitors enter the ward			
▪ A hand-washing protocol is displayed and readily visible on the ward.			
▪ All staff wash or disinfect hands upon entering the ward, before and after handling each and every baby			
▪ All parents / visitors receive instruction on the importance of correct hand-washing the first time they enter the nursery.			
Sharps practises are safe			
▪ Safe sharps disposal containers are available for point of use access on the ward and are emptied in a timely fashion			
▪ Staff practice correct sharps handling and disposal			
Safe waste disposal protocols are followed			
▪ Infectious and non-infectious waste are disposed of safely and separately.			
▪ Parents are instructed in safe washing, handling and disposal of soiled bedding and clothing.			
Aseptic technique is adhered to for procedures including blood transfusion			
▪ The ward has ready access to supplies necessary for aseptic procedures.			

▪ Aseptic technique is always used for invasive procedures (including cannula insertion, accessing iv lines to give medications and blood sampling)			
▪ Blood products are handled and disposed of using universal precautions.			
Safe cleaning and disinfecting procedures are practised			
▪ Ward protocols exist for correct clearing, disinfecting and sterilising of equipment and re-usable supplies and protocols are adhered to.			
▪ Equipment and supplies necessary for clearing, disinfecting and sterilising are present on the ward.			
▪ Equipment used for more than one patient (eg thermometers and sthethoscopes) are disinfected correctly between patients.			
▪ Disposable supplies are not re-used alter first use (esp. Suction tubing).			
Housekeeping			
▪ Regular clearing of the ward (surfaces, floors etc) is practiced			
▪ The ward is clean.			
▪ A protocol for cleaning and disinfecting of large item equipment exists on the ward and is adhered to.			
▪ All large items of equipment are visibly clean.			

REFERRAL

Standards and criteria	Good	Needs to be improved	Comments
There is an effective referral system, including good transport facilites, attendance during transport by a trained health worker, and effective follow-up of referred neonates.			
There are clear referral guidelines on the ward used by staff.			

NEONATAL CASE MANAGEMENT

Source of information:

Collect information by a combination of the following:

a) Observing the treatment and care of babies with the relevant condition
b) Interviewing staff and carers
c) Reviewing case notes of patients with the relevant condition
d) Case scenarios can be presented to staff if there are insufficient cases

The following conditions/aspects of care are covered:

- Neonatal resuscitation
- Respiratory distress
- Birth Asphyxia
- Very low birth weight
- Sepsis
- Severe jaundice
- Essential newborn care
- Monitoring and supportive care
- Care during procedures

NEONATAL RESUSCITATION

Standards and criteria	Good	Needs to be improved	Comments
Functional equipment and supplies are available for resuscitation			
▪ There is a clean resuscitation place with heating ready for immediate use on the ward.			
▪ A complete set of resuscitation equipment is readily available for use, and is clean and functional			
▪ At least 2 functioning self-inflating bags with term + preterm size masks are available on the ward.			
Resuscitation guidelines are available and staff are trained in their use PBp42-6; P1			
• All staff have been trained in neonatal resuscitation			
• Written guidelines for neonatal resuscitation are available and clearly visible on the ward.			
• A senior health professional can be efficiently contacted for resuscitation, if required.			
Resuscitation is performed according to guidelines PBp42-6; P1			
• If a neonate is not breathing, ventilation by self-inflating bag is started according to WHO guidelines (includes stimulation, positioning, suctioning and administration of oxygen).			
• Neonates are kept warm during resuscitation			
• Following resuscitation, equipment is correctly disinfected and replaced ready for use.			

RESPIRATORY DISTRESS

Standards and criteria	Good	Needs to be improved	Comments
Basic facilities for managing respiratory distress are available			
• Equipment for safely delivering oxygen is available on the ward			
• Functional equipment for monitoring oxygen saturation is available			
• CXR is available in a timely fashion for neonates with severe respiratory distress			
Management of respiratory distress PB p52			
• Neonates with respiratory distress receive appropriate antibiotics			
• Neonates with cyanosis or severe respiratory distress are given oxygen			
• Pulse oximetry is used and oxygen therapy is adjusted accordingly			

ASPHYXIA

Standards and criteria	Good	Needs to be improved	Comments
Management of neonates with birth asphyxia PB page 48			
• Babies with convulsions are managed correctly – consideration to airway, breathing and anticonvulsants			
• Phenobarbital is the first line drug for convulsions; it is given in correct doses			
• IV fluids are administered for the first 12-24 hours at no more than 60ml/kg/hr			
• If the baby is unable to suck, milk is administered by NGT			
• If apnoea is present the baby is treated with oxygen and bag and mask resuscitation and blood sugar is checked			
• Blood sugar is monitored until the baby is clinically stable			

VERY LOW BIRTHWEIGHT

Standards and criteria	Good	Needs to be improved	Comments
Fluids and feeding **PB pages 51-5**			
• Guidelines for volumes and rates of intravenous fluids and milk feeds for VLBW babies (according to age and birthweight) are available on the ward (eg. Standard Treatment Guidelines or Pocketbook)			
• If iv fluids are given, they are recorded and monitored safely and precautions are in place to prevent fluid overload.			
• Milk feeds are begun, and intravenous fluids reduced as soon as possible (normally on day 2 of life)			
• If IV fluids are used beyond day 3, sodium is added to Dextrose 10%			
• All efforts are made to give mother's milk to VLBW babies.			
• If babies are unable to suck, mothers are instructed and assisted to express breast-milk			
• If babies are unable to suck or swallow safely, expressed breast milk is given by cup and spoon (using correct technique) or fed by nasogastric tube in adequate amounts according to age. Intake is monitored			
• Frequent feedings (at least 8 x per day) are provided and intake is monitored			
• Blood glucose is regularly monitored in VLBW babies			
• If NGT is used, it is safely strapped and position is correctly checked prior to use			
• Weight gain is monitored by weighing using correct technique on functional scales			
Thermal protection **PB page 54**			

• Kangaroo mother care is used to minimise heat loss for VLBW babies not nursed in incubators or radiant warmers			
• All VLBW babies (including those in warming devices) have their axillary temperature recorded regularly			
• A protocol for managing hypothermia exists on the ward			
• VLBW babies with hypothermia have their glucose checked			
Managing apnoea and oxygen therapy PB pages 52, 55			
• Apnoea monitors are available and used on appropriate newborns			
• VLBW babies with apnoea are treated with regular aminophylline			
• When saturation monitoring is available, VLBW babies receiving oxygen therapy have their oxygen saturation monitored to keep saturations between 85-90%.			
• VLBW babies with apnoea have their glucose checked			

SEPSIS

Standards and criteria	Good	Needs to be improved	Comments
Diagnosis and investigation of neonatal sepsis **PB pages 47-50**			
• Protocols for the investigation and management of sepsis are on the ward and in use (eg. Standard Treatment Guidelines or Pocketbook)			
• Risk factors for bacterial infection are recognized including: - Maternal peripeural fever - Membranes ruptured > 12 hours prior to delivery - Offensive amniotic fluid			
• Investigation of suspected sepsis includes urine microscopy and lumbar puncture			
• Malaria smear is performed on babies who have fever or whose mother is malaria positive			
• Blood glucose is checked if the baby is clinically unwell with suspected sepsis			
Treatment of neonatal sepsis **PB pages 47-50, 16**			
• Antibiotics are given according to age and weight of the baby			
• Babies with shock are managed appropriately with fluid bolus, oxygen, glucose as well as antibiotics and the response to treatment is monitored			

•

- **SEVERE JAUNDICE**
-

Standards and criteria	Good	Needs to be improved	Comments
Recognition and investigation of jaundice **PB pages 58-9**			
• An investigation and management protocol for jaundice is available			
• Bilirubin level is checked in babies suspected of jaundice			
• Babies requiring phototherapy also have blood group, blood film and, if possible, G6PD and thyroid function checked. Their mothers have syphilis serology checked			
Treatment of jaundice			
• Phototherapy and guidelines for when and how to use it and to wean it are available and used.			
• Phototherapy equipment is in good working order.			
• Phototherapy is correctly administered (time in lights is maximised, Br is checked regularly, eyes are protected, adequate hydration is assured and breastfeeding maintained).			
• There are guidelines of when to transfer a child requiring exchange transfusion.			

ESSENTIAL NEWBORN CARE

Standards and criteria	Good	Needs to be improved	Comments
Essential newborn care is assured for all neonates PB page 46			
▪ Neonates are kept in a warm room, with no draught.			
▪ Babies' axillary temperature is monitored regularly.			
▪ Newborns who are stable are bathed or sponged regularly but thermal protection is maintained			
▪ Vitamin K is given to all babies if not administered at birth.			
▪ Hepatitis B, OPV (oral polio vaccine, Sabin) and BCG vacines are given to babies on schedule			
Breastfeeding support			
▪ Exclusive breastfeeding is promoted to all mothers			
▪ Mothers receive additional breastfeeding support from a trained provider as needed.			
Pre-discharge counselling PB page 56			
▪ All mothers receive breastfeeding and complementary feeding advice, advice on keeping the baby warm, preventing infection and danger signs prior to discharge.			
▪ Mothers understand when and where to return for follow-up prior to discharge.			

MONITORING / SUPPORTIVE CARE

	Good	Needs to be improved	Comments
▪ A standard monitoring chart is used			
▪ Vital signs are monitored and recorded by a nurse twice in 24 hours and at least four times for high risk babies			
▪ Critically ill babies are closely observed and are monitored at least hourly until their condition is stable.			
▪ Doctors review critically ill babies regularly (at least once / nursing shift) and hand over the patients between shifts.			
▪ A standard fluids / feeds chart is used			
▪ Times, volumes and bottles are recorded for IV fluids given by the nurse			
▪ IV fluids bags are changed every 24 hrs			
▪ Cannula insertion sites are regularly reviewed prior to injection of medications and during vital signs checks and when changing bags for babies on iv fluids.			
▪ Medications are clearly and correctly prescribed including medication name, dose in mg and mls			
▪ Doses and times are recorded for medications given by the nurse			
▪ Two nurses check iv medications prior to administration			

CARE DURING PROCEDURES

Standards and criteria	Good	Needs to be improved	Comments
Care of baby before and during procedures			
• Protocols for procedures exist on the ward and are followed			
• Wherever possible, procedures are explained to parents beforehand (justification, what will occur, risks)			
• Parents are permitted and supported to remain with their babies whilst procedures are performed			
• Thermoprotection is provided during procedures			
• Aseptic technique is adhered to during procedures			
• Attempts are made to reduce discomfort during procedures where possible (nursing, sucrose, pacifiers)			
• Attempts are made to reduce the frequency of painful procedures			

SUMMARY

From the areas identified in the survey that need to be improved, list the 10 major priorities

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

COMMENTS ON THE SURVEY

……

…..

……

…..……

…….

Appendix G: Plain Language Summary

Plain Language Statement

Department of Paediatrics

Project: Helpim Pikini

Dr. Tosif (Responsible Researcher)
Tel: +61 413484876 Email: tosifs@student.unimelb.edu.au

Introduction

You are invited to participate in the above project, which is being conducted by Professor Trevor Duke (Supervisor) and Dr Shidan Tosif (PhD student) of the Department of Paediatrics at The University of Melbourne.

Purpose of the research

The aim of this study is to investigate *newborn care in the Solomon Islands.* This research has been approved by the Health Sciences Research Committee.

What will I be asked to do?

Should you agree to participate, you will be asked to contribute by answering questions about your experience in newborn care, specifically with regards to newborn care training.

How long is my participation expected to take?

We estimate that the time required is 30 minutes.

How will my confidentiality be protected?

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, subject to any legal requirements. Your name and contact details will be kept in a password-protected computer file, separate from any data that you supply. The data will be kept securely in the Department of Paediatrics for 5 years from the date of publication, and will be destroyed after this time.

Do I have to take part?

Participation is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

What happens after the project is finished?

The research findings will be presented to the Ministry of Health and Medical Services. A brief summary of the research findings will be made available to you by email. It is possible that the results will be published and presented at academic conferences.

Where can I get further information?

If you would like more information about the project, please contact the researchers; Dr Shidan Tosif.

What if I have any concerns about the project?

Should you have any concerns or complaints about the conduct of the project, please contact Ms Kate Murphy, Manager, Human Research Ethics - Office for Research Ethics and Integrity, the University of Melbourne VIC 3010. Tel: +61 3 8344 2073 or HumanEthics-complaints@unimelb.edu.au.

How do I agree to participate?

If you would like to participate in this project, please indicate that you have read and understood this information by completing the accompanying consent form and returning it in the envelope provided.

Appendix H: Participant Consent Form

Consent Form

Department of Paediatrics

THE UNIVERSITY OF MELBOURNE

Project: Multifaceted intervention into Newborn Care

Primary Researcher: Dr Shidan Tosif

Additional Researchers: Dr Trevor Duke

Name of Participant: _____

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that the purpose of this research is to investigate the impact of interventions into newborn care.
3. I understand that my participation in this project is for research purposes only.
4. I acknowledge that the possible effects of participating in this research project have been explained to my satisfaction.
5. In this project I will be required to participate in a n interview
6. I understand that my interviews may be taped
7. I understand that my participation is voluntary and that I am free to withdraw from this project anytime without explanation or prejudice and to withdraw any unprocessed data that I have provided.
8. I understand that the data from this research will be stored at the University of Melbourne and will be destroyed after 5 years.
9. I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements; my data will be password protected and accessible only by the named researchers.
10. I understand that after I sign and return this consent form, it will be retained by the researcher.

Participant Signature: _____ **Date:** _____

Appendix I: Written Survey and Test

Consent Form

Department of Paediatrics

Project: Multifaceted intervention into Newborn Care

Primary Researcher: Dr Trevor Duke

Additional Researchers: Dr Shidan Tosif

Name of Participant: _____

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that the purpose of this research is to investigate the impact of interventions into newborn care.
3. I understand that my participation in this project is for research purposes only.
4. I acknowledge that the possible effects of participating in this research project have been explained to my satisfaction.
5. In this project I will be required to participate in an interview about my experience with newborn care.
6. I understand that my interviews may be taped
7. I understand that my participation is voluntary and that I am free to withdraw from this project anytime without explanation or prejudice and to withdraw any unprocessed data that I have provided.
8. I understand that the data from this research will be stored at the University of Melbourne and will be destroyed after 5 years.
9. I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements; my data will be password protected and accessible only by the named researchers.
10. I understand that after I sign and return this consent form, it will be retained by the researcher.

Participant Signature: _____ **Date:** _____

WRITTEN SURVEY

(CONFIDENTIAL)

Location:_____ Date:

_____

Participant name: _____ Age:

_____

1. Your Background

1) What is your role? (please circle)

Nurse Nurse aide Midwife Intern

Resident Registrar Consultant Other_____

2) What are your qualifications? _____

3) How many years of work experience do you have? _____

4) What is your current place of work? (please circle)

NRH Gizo Kirakira Good Samaritan Kilu'ufi

5) How long have you worked at your current place of work? _____ months _____ yrs

6) List the places you have worked in the last 5 years: _____

_____

2. Neonatal Experience

1) How many births have you attended in the **last four weeks**: _____

2) How many non-breathing babies did you resuscitate with bag and mask in the **last four weeks**: _____

3) How many non-breathing babies do you resuscitate with stimulation only in the **last four weeks**: _____

4) Have you had EENC training? (please circle) No Yes

5) When did you have you had EENC training? Year _____ Month _____ Location _____

6) Have you had EENC refresher training before? (please circle) No Yes Year _____ Month _____

7) Have you participated in EENC Health Facility Strengthening? No □ Yes □ Year _____ Month_____

8) Have you had any other neonatal training before: No □ Yes □ (circle below and write year)

IMCI Year _____ WHO (Blue) Pocketbook Year _____ SINU Year _____

MBFI Year _____ MBF Year _____ Other_____ year _____

PLEASE CIRCLE YOUR CHOICE OF a, b, c, d, or e

1) How confident are you in **resuscitating** a non-breathing baby? (please circle)
   a. not confident at all
   b. slightly confident
   c. moderately confident
   d. very confident
   e. extremely confident

2) How important do you think health care worker **skills** are in resuscitating newborns?
   a. Not important
   b. Slightly important
   c. Moderately important
   d. Very important
   e. Extremely important

3) How important is **equipment** (e.g. bag and mask, warmers) in providing newborn care?
   a. Not important
   b. Slightly important
   c. Moderately important
   d. Very important
   e. Extremely important

4) How important is the quality of your **facility** (building, cleaning, power, water etc.) in providing newborn care?
   a. Not important
   b. Slightly important
   c. Moderately important
   d. Very important
   e. Extremely important

5) How important is your **pay and work conditions** (your income, work hours, nurse:patient ratio) in providing newborn care?
   a. Not important
   b. Slightly important
   c. Moderately important
   d. Very important
   e. Extremely important

6) How important are **guidelines** in providing newborn care?
   a. Not important
   b. Slightly important
   c. Moderately important
   d. Very important
   e. Extremely important

7) How **concerned** are you regarding the quality of care for newborns provided by your hospital?
   a. not concerned
   b. slightly concerned
   c. moderately concerned
   d. very concerned
   e. extremely concerned

8) Can you name two things that have changed in your practice since **EENC training?**

1._____
2._____

9) For your level of understanding, was the EENC course too complicated, too simple, or just right?

a) Too complicated
b) A little complicated
c) Just right
d) A little simple
e) Too simple

10) What would help you **improve** your newborn resuscitation skills? (please circle)

- More training - Monthly refresher sessions - Daily skills practice for 5 minutes
- Training overseas - Education posters - Better equipment
- Better facility Other ideas _____

Please circle how much you agree or disagree with the following statements

1) I am satisfied with my **workplace conditions** (hours, pay, work expectations, professional development):

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

2) I am satisfied with my **opportunities** for learning in newborn care

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

3) I am **inspired** to meet my goals at work

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

4) I am **determined** to give my best effort every day

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

5) Employees in my hospital take the **initiative** to help other employees when caring for newborns

a) Strongly disagree

b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

6) Employees at this hospital are willing to take on new tasks as needed.

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

1. 7) Employees in my **hospital** willingly accept change

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

8) When caring for a newborn, I feel **supported** and I know there is someone I can always call for help

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

9) I feel that I can provide the care that babies need even if there isn't enough equipment to help me

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

2. 10) My hospital's work help save newborn lives.

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

3. 11) I am satisfied with the culture of my workplace.

a) Strongly disagree
b) Disagree
c) Neutral, neither agree nor disagree
d) Agree
e) Strongly agree

Comments_____
____

Written test

Choose the single best answer:

4. Delivering in the supine position during second stage of labor is best:
    a. True
    b. False

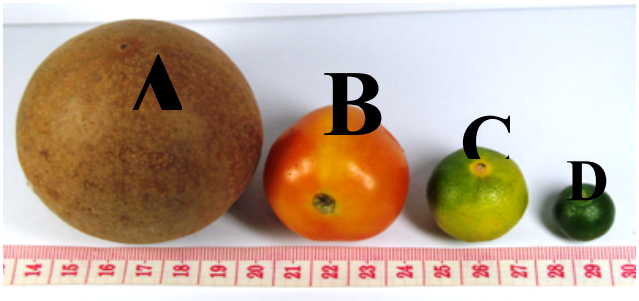
5. Applying fundal pressure is an effective means of supporting labor:
    a. True
    b. False

6. After a baby is born, you should call out the time (accurate to minutes and seconds) of birth, then what?
    a. Clamp and cut the cord
    b. Thoroughly dry the baby
    c. Suction the baby's mouth and nose
    d. Hold the baby upside-down to get out the secretions

7. During thorough drying and stimulation of the baby, your rapid assessment shows she is crying. What is your next action?
    a. Suction the baby's mouth and nose
    b. Clamp and cut the cord
    c. Place the baby in skin-to-skin contact with the mother
    d. Place the baby onto the breast

8. For which reason(s) should the baby's mouth and nose be suctioned?
    a. The amniotic fluid is thickly stained with meconium and the baby is covered in the meconium
    b. The amniotic fluid has a foul odor and the mother has a fever
    c. After thorough drying, the baby is not breathing and the airway is blocked
    d. All of the above

9. What is the approximate capacity of a newborn's stomach?
    Please circle A B C or D



10. A baby has feeding cues indicating they are ready to breastfeed immediately after birth.
    a. True
    b. False

11. List 3 signs that a newborn baby is ready to breastfeed (“Feeding Cues”)

    _____
    _____
    _____

12. List 3 signs a baby has good attachment to the breast

    _____
    _____
    _____

13. A baby required bag and mask ventilation. You note the chest does not rise when the bag is squeezed. List 3 things you can do to improve bag and mask ventilation.

    _____
    _____
    _____

14. When does a baby need bag and mask ventilation? After thorough drying for 30 seconds, the baby is
    a. Not breathing
    b. Having difficulty breathing (gasping respirations)
    c. Limp and very pale or blue in color
    d. All of the above

15. A baby required bag and mask ventilation for 2 minutes. You have stopped bag and mask ventilation. He is now crying and breathing without difficulty, the heart rate is >100 beats per minute and the baby is pink. What should you do now?
    a. Place the baby in direct skin-to-skin contact/do routine newborn care
    b. Keep the baby in an observational area and monitor breathing every 10 minutes
    c. Give oxygen by nasal cannula or mask
    d. All of the above.

Appendix J: Skills Checklist

	ACTIVITY	YES	PARTIAL	NO
	Pre-birth preparations			
1	Checked room temperature; turned off fans			
2	Washed hands (first of two handwashings)			
3	Placed dry cloth on mother's abdomen			
4	Prepared the newborn resuscitation area			
5	Checked that bag and mask are functional			
6	Washed hands (second of two handwashings)			
7	Put on two pairs of clean gloves (if the same attendant handles the cord)			
8	Put forceps, cord clamp/ties in easy-to-use order			
	Immediate postpartum/newborn care			
9	Called out time of birth: hour__, minute__, second__			
10	Drying started within 5 seconds (s) of birth?	<5 s	5–10 s	> 10 s
11	Dried the baby thoroughly (wiped the eyes, face, head, front, back, arms and legs)			
12	Removed the wet cloth			
13	Put baby in direct skin-to-skin contact with mother			
14	Covered baby's body with cloth and the head with dry cloth			
	BREATHING BABY (complete 15-21)			
16	Gave oxytocin to mother within 1 minute of delivery			
17	Removed outer pair of gloves			
18	Checked cord pulsations before clamping, clamped after cord pulsations stopped (usually 1-3minutes)			
19	Place clamp/ties at 2cm, forceps at 5cm, from umbilical base			
20	Delivered placenta			
21	Counseled mother on feeding cues (drooling, mouth opening, tonguing/licking, rooting, biting hand, crawling etc.)			
	NON BREATHING BABY (complete 22-36)			
22	Called for help			
23	Removed outer pair of gloves			
24	Quickly clamped and cut cord			
25	Moved baby to resuscitation area			
26	Covered baby quickly during and after transfer			
27	Positioned the head correctly to open airways			
28	Applied face mask firmly over baby's chin, mouth, nose			
29	Gained chest rise within 1 minute of birth: minutes__; seconds __.			

30	Squeezed bag to give 30–50 breaths per minute			
31	Maintained good chest rise throughout or took steps to improve ventilation			
32	On baby's breathing well, stopped mechanical ventilation			
33	Returned baby to skin-to-skin contact, covered baby			
34	Checked for another baby			
35	Gave oxytocin to the mother			
36	Delivered placenta			
37	Counseled mother that baby is OK and on feeding cues			
	TOTAL SCORE			

Appendix K: Interview Guide

Introduction

1. Purpose of the interview
2. Clarification of topic under discussion is neonatal care
3. Format of the interview
4. Approximate length of interview – 30 minutes
5. Assurance of confidentiality
6. Purpose of digital recorder – ask permission
7. Explain who will listen to the recording
8. Assure participant that he or she may seek clarification of questions, decline to answer a question, Assure participant that there will be opportunity during the interview to ask questions

1. Background and role of interviewee

Question	Probe
1. Can you tell me about your current role, responsibility?	
2. How confident are you in looking after a healthy newborn?	
3. How confident are you in looking after a sick newborn?	
4. Have you resuscitated a newborn before?	What happened? Was it a good outcome or bad outcome?
5. How often do you listen or feel for the heart rate of a newborn if it is not breathing?	Sometimes? Always?

2. Conceptualising newborn care

Question	Probe
1. How have things changed in newborn care in the Solomon Islands?	Examples of how something has changed
2. EENC launched this year; do you see any changes yet?	
3. What has been the best change in newborn care?	
4. What has been the biggest challenge to newborn care?	

3. Emerging issues

Question	Probe
1. What would be most helpful to improve newborn care?	Probe: Training, refreshers, resources, personnel, equipment
2. What would you like to see changing in newborn care in the next 2 years	
3. What regions should be prioritised to receive training?	Probe NRH, Provincial hospitals, AHC, NAP

4. **EENC**

Question	Probe

1. What have been the strengths (good things) of EENC? 2. What have been the weaknesses (not good things) of EENC? 3. How have you found the EENC coaching?	

5. Any other comments or questions?

Additional Notes:
Ask for illustrative examples where possible
Drill down and probe on topics of interest “What do you mean by ***” “Can you tell me *how* they have changed ***”

Appendix L: Solomon Islands Health Research and Ethics Review Board Ethics Approval

Removed for online publication

Appendix M: Health Approval Sciences Human Ethics Sub-Committee Approval

Removed for online publication

Appendix N: Equipment Recommendations

Item Description	Quantity for 10 bed unit (NRH)	Quantity for 6 bed unit (Provincial Hospital)	Quantity for Area Health Clinic/Nurse Aid Post
General			
Resuscitation trolley (radiant warmer, fixed height, drawers, oxygen tank attachment)	3	2	
Phototherapy unit (+Spare Phototherapy bulbs)	3	2	
Newborn self-inflating bag/mask resuscitation device 50ml	6	4	2
Laryngoscope set, neonate	3	2	
Portable electronic suction machine	3	2	
Fridge	1	1	
Neonatal Cots (+Bedding/Blankets)	12	6	1
Wall thermometer	1	1	1
HemoCue Glucose monitors	3	1	1
Electronic Weighing Scale	2	1	1
Oxygen			
Oxygen Concentrator	4	2	
Paediatric oxygen tubing			
Paediatric oxygen cannulae			
Neonatal CPAP	2		
Portable Neonatal/Infant Oximeter (+ probes)	6	3	
Monitoring			
Apnoea monitor	4	2	
ECG machine	1	1	
Neonatal Monitor (HR,SpO2, ECG, RR, Temp)	6	2	
Digital Thermometer	6	3	1
Timing Device/Clock	2	1	1
Miscellaneous			
Neonatal stethoscope	10	6	
Neonatal sphygmomanometer	3	1	
Infusion stand, double hook	6	3	
Mobile examination light	3	1	