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**A Retrospective Study of Feeding Practices and  
Growth of Preterm Infants Admitted to the Special  
Care Baby Unit at Whangarei Hospital**

A thesis presented in partial fulfilment of requirements for the  
degree of

Masters in Science

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Nutrition and Dietetics

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# Abstract

**Introduction:** Being born preterm places an infant at increased risk of post-natal growth faltering. The immature development of the gastro-intestinal system often in conjunction with feeding difficulties can result in inadequate nutritional intake. Therefore, close monitoring of feeding and growth during hospital admission in preterm infants is important to enable the provision of adequate nutrition support, with early interventions recommended to support optimal growth.

**Aim:** To investigate feeding practices, monitoring and growth outcomes of preterm infants admitted to the Special Care Baby Unit (SCBU) at Whangarei Hospital, New Zealand.

**Methods:** Retrospective data on feeding and growth outcomes was collected from medical notes of preterm infants admitted to SCBU for a minimum of 3 days between January 2013 and March 2014. Data collection on feeding practices included mode, type and duration of feeding during admission and upon discharge. Growth outcomes included body weight, length, and head circumference which are expressed as Z-scores using UK-WHO data. Days to regain birth weight was a further measure of growth outcomes. Data was collected on the monitoring of feeding practices and growth parameters as well as any referrals to paediatric dietetic services during admission.

**Results:** One hundred infants were recruited, 57 of whom were male. The median age of the infants was 35 weeks (range 25-36 weeks). Fourteen infants were born extremely premature and 86 were of moderate to late prematurity. Median length of SCBU admission was 14 days. Breastfeeding was initiated by 83% of the mothers. Seventy-six infants received enteral feeding with 45 infants commenced on expressed breast milk. On a median day of 9, 54 infants reached full enteral feeding volumes. Of the 79 infants discharged home, 47 regained birth weight prior to discharge. The mean change in z-score between birth and discharge was  $-0.49 \pm 0.16$  with 19 infants decreasing by  $>1$  z-score. During admission only 6/100 infants were referred to dietetic services. On

discharge, 73.1% were receiving some breast milk with 67.1% exclusively breastfeeding.

**Conclusions:** Preterm infants admitted to SCBU had high rates of breast feeding initiation and nearly 3 out of 4 infants were receiving some milk on discharge. However, prior to discharge nearly 20% could be identified at risk of growth faltering. This suggests that improvements could be made to the monitoring of feeding and growth of these infants prior to discharge and more referrals to dietetic services may be warranted.

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# Abbreviations

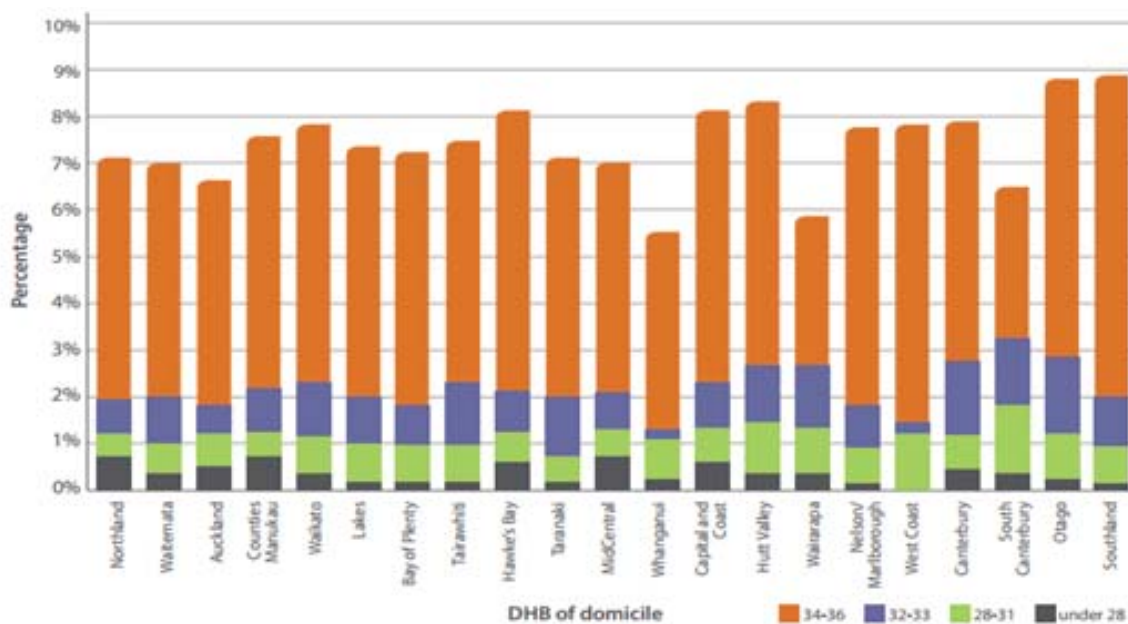
BMI	Body Mass Index
BPD	Broncopulmonary Dysplasia
CRP	C Reactive Protein
DHB	District Health Board
EBM	Expressed Breast Milk
ELBW	Extremely Low Birth Weight
ESPGHAN	European Society of Paediatric Gastroenterology, Hepatology and Nutrition
GDM	Gestational Diabetes Mellitus
GI	Gastrointestinal
LBW	Low Birth Weight
NDHB	Northern District Health Board
NEC	Necrotising Enterocolitis
PNGF	Post Natal Growth Faltering
PPROM	Preterm Premature Rupture of Membranes
RDS	Respiratory Distress Syndrome
SCBU	Special Care Baby Unit
VLBW	Very Low Birth Weight



# Chapter 1: Introduction

Preterm birth is defined as a birth that occurs before 37 weeks' gestation (WHO, 2012). Preterm infants can be further categorised as extremely preterm (born before 28 weeks' gestation), very preterm (28 to 32 weeks) and moderate to late preterm (greater than 32 weeks) (WHO, 2012). An estimated 15 million preterm births occur worldwide and prematurity is identified as the number one cause of death in the first four weeks of life (WHO, 2012).

In New Zealand, it was reported in 2010 that 7.4% of all births were premature (Ministry of Health 2012). Rates of preterm birth within New Zealand District Health Boards (DHBs) have been collated by the recently formed National Maternity Monitoring Group (NMMG) (**Figure 1.1**) (National Maternity Monitoring Group, 2013). The findings show rates of preterm birth vary across different DHBs with the majority consisting of moderate to late premature infants, 34-37 weeks' gestation as shown in **Figure 1.1**.



**Figure 1.1:** Preterm Births within New Zealand DHBs Categorised by Gestational Age adapted from (National Maternity Monitoring Group, 2013).

The high economic and emotional costs associated with preterm birth have been identified (Gilbert, Nesbitt, & Danielsen, 2003; Kirkby, Greenspan,

Kornhauser, & Schneiderman, 2007), and the World Health Organisation has called for action to be taken in priority areas including antenatal care, family planning and research focused on prevention of preterm birth (WHO, 2012). Given the prevalence of preterm birth and the large number of late preterm infants in New Zealand (National Maternity Monitoring Group, 2013), NMMG has also highlighted the need for DHBs to audit all preterm births. Infants born at 34, 35 and 36 weeks' gestation have been highlighted as a group requiring more evidence to improve long term outcomes (National Maternity Monitoring Group, 2013).

The complications associated with preterm birth are now classed as the second most common cause of death in children under the age of 5 years old after pneumonia (Liu *et al.*, 2014). The health consequences secondary to preterm birth can affect development of vital organ systems including the pulmonary, cardiovascular, and the gastrointestinal systems (Liu *et al.*, 2012). Physical complications can include visual impairment associated with retinopathy, hearing impairment, chronic lung disease and cardiovascular disease (Shapiro-Mendoza *et al.*, 2006). There is also a range of mild to severe complications associated with preterm birth including necrotising enterocolitis, anaemia of prematurity, respiratory distress syndrome, hypothermia, and hypoglycaemia (Ward & Beachy, 2003). Stabilising the medical condition of the preterm infant and minimising short and long term consequences should be a priority within clinical settings. Nutrition is an essential aspect in decreasing preterm complications and promoting optimal health and growth (Olsen, Richardson, Schmid, Ausman, & Dwyer, 2005).

Once the infant is medically stable, the focus of care moves towards nutrient provision and optimisation of growth as well as development. Preterm infants are at increased risk of nutrient deficiencies due to reduced nutrient accretion *in utero* as well as the presence of health complications (Agostoni *et al.*, 2010). Failure to achieve optimal nutrition can result in physical and neurological delays including inadequate growth, increased risk of infection, necrotising enterocolitis, immature gastrointestinal systems and long term neurological delays resulting in poor academic achievement (Berseth, Bisquera, & Paje,



2003; Engstrom, Niklasson, Wikland, Ewald, & Hellstrom, 2005; Lucas, Morley, & Cole, 1998). Prevention of preterm birth is a priority, but due to the complex aetiology of preterm birth; prevention is unlikely to be resolved easily. Optimisation of nutrition practices beginning immediately after birth carrying through to beyond hospital discharge is vital to minimise short and long term consequences for preterm infants.

## **1.1 Nutritional Support for Preterm Infants**

Providing optimal nutrition to the preterm infant is not without difficulty due to their physiological immaturity, especially underdevelopment of the gastrointestinal tract and metabolism. The gastrointestinal tract develops throughout gestation but only matures during the last trimester (Neu, 2007). Even the late preterm infant has a less developed gut compared with that of a term infant resulting in delayed peristaltic movement and decreased sphincter control in the stomach and oesophagus. Therefore, the immature gastrointestinal and metabolic system can lead to impaired nutrient digestion and absorption (Engle *et al*, 2007). These infants often have problems with suckling, swallowing and co-ordinating motor movements which can present as feeding difficulties (Agostoni *et al.*, 2010; Glover, Waldon, Manaene-Biddle, Holdaway, & Cunningham, 2009). Feeding difficulties may also delay the early establishment of co-ordinated breastfeeding.

An inability to establish feeds may lead to dehydration, inadequate nutrient intake and hypoglycaemia resulting in weight loss and poor growth in an infant with already low nutrient stores at birth (Harding *et al.*, 2013). Due to the health complications impacting upon the feeding and growth of preterm infants, it is important to assess how well recommendations are being adhered to and identification of areas for improvement to enable optimal nutritional care for preterm infants.

### **1.1.1 Breastfeeding**

Breast milk is considered the gold standard for nutrition for term and preterm infants. Consuming breast milk is associated with improved neurological

development, lower rates of sepsis, and necrotising enterocolitis (Simmer *et al*, 2008). Breast milk provides the preterm infant with an array of nucleotides, oligosaccharides and other bioactive compounds not all of which can be added to infant formula (Simmer *et al*, 2008). Despite advocacy of breastfeeding in clinical settings, research has shown that rates are below optimal for preterm infants upon discharge. An Australian audit demonstrated that 62% of preterm infants and only 27% of very low birth weight infants were being breastfed at hospital discharge (Simmer *et al*, 2008). Auckland District Health Board (ADHB) reported that 60% of infants received breast milk at some point during admission to NICU (Neonatal Intensive Care Unit) in 2012 with infants of greater prematurity (infants less than 28 weeks' gestation) less likely to be breastfed at discharge (Pot, Sadler, McDougall, Harilall, & Battin, 2012).

The low rates of breast feeding at discharge for preterm infants of earlier gestations have been put down to lengthy hospital admission resulting in an inability for mothers to maintain their milk supply (Pot *et al.*, 2012).

### **1.1.2 Enteral Feeding**

Preterm infants may require enteral feeds via nasogastric or orogastric routes due to underdeveloped gastrointestinal systems or immature swallowing and suckling responses which may delay breastfeeding initiation (Hay, 2008). Enteral feeding is also used as a strategy to provide additional nutrition support for weight gain and growth of preterm infants (Krishnamurthy, Gupta, Debnath, & Gomber, 2010). Early enteral feeding has been associated with reduced hospital admission and advanced growth within neonatal units (Leaf *et al.*, 2012). Studies have demonstrated reduction in necrotising enterocolitis and gut atrophy (Berseth *et al.*, 2003; Henderson, Craig, Brocklehurst, & McGuire, 2009; Leaf *et al.*, 2012). Due to the benefits of enteral feeding investigation into practices within neonatal units is key to ensure guidelines are being adhered to and to ensure infants receive optimal nutrition support.

### **1.1.3 Growth**

The main goal for growth in preterm infants is to replicate the growth of a full term infant that would have occurred *in utero* (Agostoni *et al.*, 2010). This is difficult to achieve due to physiological immaturity resulting in feeding difficulties

and the inability to successfully replicate the nutrients provided *in utero* (Marriott & Foote, 2003).

The nutrient deficit that accumulates in the early weeks post-delivery when the preterm infant is clinically unstable is difficult to recover. An inability to gain sufficient weight prior to discharge has been associated with an increase the rates of infection and re-admission to hospital (Engle, Tomashek, & Wallman, 2007). Consistent monitoring allows for the identification of infants at risk of growth faltering who require additional nutritional support to meet growth recommendations.

#### **1.1.4 Dietetic Referral**

Monitoring of growth and nutrition are important methods of identifying infants requiring additional support during hospital admission. Research has shown that clinical records of feeding practices are inadequate and inconsistent with current guidelines (McInnes, 2008). This finding has been supported by previous hospital audits showing inadequate data on methods of feeding during hospital admission, lack of information regarding breastfeeding, and the method of nutrition an infant is receiving (breastfeeding, formula or enteral) upon discharge (McInnes, 2008). A review of the literature draws the conclusion that nutrient deficits are not being recorded or acted upon resulting in nutrient deficiencies which are not being recouped during hospital admission (Embleton, Pang, & Cooke, 2001).

Considering the importance of dietetic involvement to improve growth and reduce hospital readmission rates, the lack of referrals to a dietitian is of concern within neonatal units (Olsen *et al.*, 2005). It is essential to determine whether infants who are at risk of nutritional inadequacies and growth faltering are referred to specialist care including dietitian referral.

## **1.2 Summary**

Preterm infants require close medical management as well as intensive nutrition support to decrease risk of adverse short and long term consequences. Insufficient nutrient intakes have been linked with immediate health complications, neurological deficits and poor growth outcomes. There is a gap in our knowledge outlining current nutrition practices and their impact on growth

outcomes in regional New Zealand neonatal units. This study will be focused on feeding practices, growth outcomes and dietetic referrals for preterm infants within a New Zealand neonatal unit. The results may provide evidence that current feeding protocols and monitoring could potentially be improved with enhanced dietetic involvement resulting in improved neonatal outcomes.

### 1.3 Location and Situation Analysis

The following research was undertaken within SCBU at Whangarei hospital, Northern District Health Board. Northland is comprised of 157,420 residents and is one of the most deprived areas in New Zealand with 35% of the population falling in the low deprivation index (Bailey, 2013). The majority of the areas are also rural, with Whangarei being the closest urban town centre. **(Figure 1.2).**The Northland SCBU is located within Whangarei hospital.

**Figure 1.2** illustrates the travel distance between other towns and Whangarei which can make healthcare for preterm infants difficult to access.



**Figure 1.2:** Travel Distance Between Towns in Northland (adapted from Bailey, 2013).

Whangarei hospital is classed as a tertiary care facility for the Northland region accepting referrals from Northland district hospitals including Kaitaia, Bay of Islands and Dargaville. Northland consists of 35% Māori residents and Whangarei hospital incorporates Treaty of Waitangi principles into provision of patient care and promoting health and wellbeing for all people of Northland (Northland District Health Board, 2012a) .

The Special Care Baby Unit in Whangarei is an intensive care unit specialising in the care of ill or premature infants. SCBU is classed as a low dependency unit whilst a neonatal intensive care unit (NICU) is classed as a high dependency unit. Therefore, infants  $\leq 32$  weeks' gestation requiring intensive care are referred to NICU at Auckland District health Board (ADHB). Within SCBU there is a mean ratio of one nurse to every 1-4 infants. The unit contains 8 cots with an adjacent maternity area for mothers to establish breastfeeding and develop a bond with their new baby.

### ***1.3.1 Current Nutrition Policies within SCBU***

Many of the protocols used within SCBU originate from NICU protocols developed by National Women's Hospital at Auckland DHB. These include policies around breastfeeding initiation and enteral feeding. Within the breastfeeding policy, breastfeeding codes are outlined which classifies the progression of breastfeeding on an A-F scale according to signs of latching, suckling and duration of breastfeeds are used. Policies around enteral feeding practices including enteral feeding initiation, achieving full enteral feeding volumes, and indications to remove the naso or orogastric tube are similar to ADHB.

As Whangarei is a Baby Friendly Hospital breastfeeding is promoted within the SCBU but enteral and bottle feeding are also supported. Term and preterm formulas are on a 4-6 monthly rotation and clear directives for when preterm formula is required are indicated with the feeding protocols. Parenteral nutrition defined as the provision of nutrients intravenously (ASPEN, 2012), is not undertaken within SCBU and infants requiring this form of nutrition are transferred to NICU at ADHB or to Counties Manukau NICU.

## **1.4 Purpose of this Study**

The initial concern raised by Paediatric Dietetic Services at NDHB was the lack of referrals for preterm infants during their admission to SCBU (or requests to follow up infants following discharge from the unit) despite clear evidence that these infants are at risk of postnatal growth faltering during this period (Cooke, Ainsworth, & Fenton, 2004).

This research investigated feeding practices occurring in the SCBU over a minimum of a calendar year. Data were collected during admission and at discharge on feeding practices including modes, types, and duration of feeding. Data on growth parameters of the preterm infants during admission and at discharge were also collected, including anthropometric measurements and days to regain birth weight. Z-score analysis was utilised to calculate the change in growth between birth and discharge and to identify infants at risk of postnatal growth faltering (PNGF).

The collection and analyses of data were completed in close collaboration with Mary McNab (Senior Paediatric Dietitian) who was the clinical supervisor for the student throughout data collection. Consultation and engagement with SCBU staff was also undertaken prior to data collection to ensure all SCBU staff was aware of the study and to create interest in the results which will be presented. The results of this study were to highlight recommendations to improve nutritional practices and monitoring in line with neonatal nutrition recommendations. The study will provide important data about nutritional practices in preterm infants during admission to SCBU.

## **1.5 Aims and Objectives**

### ***1.5.1 Aim***

To retrospectively assess the feeding practices, growth outcomes and monitoring of feeding in preterm infants admitted to SCBU at Whangarei hospital, New Zealand.

### **1.5.2 Objectives**

1. To determine the proportion of preterm infants for whom breastfeeding was initiated during SCBU admission and the number of days to establish full breastfeeds.
2. To determine the proportion of preterm infants who receive enteral nutrition (expressed breast milk and/or formula milk) during admission to SCBU, and to determine the number of days to establish full enteral feeding volumes.
3. To determine the proportion of preterm infants that are breastfed, formula fed, or receive mixed feeding (breast and formula feeding) at discharge from SCBU.
4. To establish the proportion of preterm infants admitted to SCBU who regain birth weight prior to discharge, and to identify the number of days to regain birth weight during admission.
5. To compare growth Z-scores with UK-WHO data and to identify infants at risk of growth faltering.
6. To assess frequency of recording anthropometric measurements in clinical documentation.
7. To determine the number of preterm infants during the study period who were referred to dietetic services.

### **1.6 Hypotheses**

1. The initiation of breast feeding will be delayed in preterm infants when compared with term infants.
2. The current protocol for enterally feeding preterm infants within SCBU will not be adequately adhered to.

3. Breastfeeding rates will be low at discharge in comparison with term infants.
4. Birth weight will not be regained within the 2 -3 week recommended period, or prior to being discharged home from SCBU.
5. A decline in Z-scores between birth and discharge will be observed.
6. Anthropometric measurements will not be recorded as per the SCBU.
7. Low rates of infant referral to dietetic services will be observed.

## **1.7 Thesis Structure**

Chapter one the Introduction sets the scene and clearly outlines the aims and objectives as well as justification of the study. A review of the literature then follows in chapter two. This looks at recommendations for feeding practices and growth in preterm infants and also looks into past and current research to reveal the gaps in current literature. Chapter three presents the methods, including justification of the study design used for collection of data. In chapters four and five, the results and discussion are presented which will use all the findings to argue, to prove, and to challenge the research question. Limitations and strengths of the study will also be acknowledged following the discussion.

The final conclusion chapter (chapter six) shows how the findings relate to the research within this specific field of knowledge, and how they contribute to the wider scientific knowledge. In the conclusions outlined in chapter six, it states clearly what the findings imply. Recommendations are made based on the findings, as are suggestions for future research to improve the nutrition and growth outcomes for preterm infants admitted to, and discharged from SCBU.



## 1.8 Contribution of Authors

**Table 1.1:** *Researchers Contribution to the Study*

<b>Researcher:</b>	<b>Contribution to the Research:</b>
Ashleigh Share MSc Nutrition & Dietetic Student	Wrote the research proposal, HDEC ethics application, data collection, literature review, statistical analysis, explanation of results, editing and final preparation of thesis manuscript.
Dr. Cathryn Conlon Primary Academic Supervisor	Supervised the progression of the research from research protocol through to finalisation of the thesis including assistance with research design. Supervision of ethics documentation and finalising all chapters.
Mary McNab Professional Supervisor	Identification of the problem. Supervised data collection within a clinical environment, assisted in gaining access to clinical documentation, supported the HDEC ethics application, reviewed final thesis.
Dr. Cheryl Gammon Academic Co-supervisor	Provided advice on statistical analysis and feedback on the final chapters of the thesis.

## **Chapter 2: Literature Review**

### **2.1 Preterm Birth: Definitions, Rates, Causes and Complications**

#### ***2.1.1 Definition of Preterm Birth***

A birth before 37 weeks' gestation is defined as premature (WHO, 2012). A preterm infant can further be categorised as extremely premature (<28 weeks' gestation), very premature (28 to <32 weeks' gestation) or moderate to late premature (32 to less than 37 weeks' gestation) depending on their gestational age at birth (WHO, 2012). Being born preterm is associated with an increased risk of mortality and morbidity, with increasing risk with greater prematurity. Recent research has highlighted that late preterm and near term infants are also at increased risk of new-born morbidity in comparison to a full-term infant, due to their physiological and developmental immaturity (Engle *et al.*, 2007; KolÅS, Nakling, & Salvesen, 2000).

#### ***2.1.2 Classification by Birth Weight***

Birth weight can also be used to classify preterm infants and indicate their degree of prematurity. The World Health Organisation defines infants born at less than 2500 grams as low birth weight (LBW), infants less than 1500 grams as very low birth weight (VLBW) and infants less than 1000 grams as extremely low birth weight (ELBW) (WHO, 2012). Term infants may be classed as low birth weight but they are not necessarily preterm.

Gestational age and birth weight are important classification systems and can be used as a guide for nutrition interventions and supplementation practices in neonatal units.

#### ***2.1.3 Global Rates of Premature Birth***

Premature birth is a global issue with 15 million preterm births per year with rates ranging between 5-18% globally (WHO, 2012). Countries that have the highest premature birth rates include Brasil, United States, India, Nigeria and the Sub-Saharan Africa all of which have a rate of greater than 15% (WHO, 2012). Sixty percent of premature births occur in Africa and South Asia (WHO, 2012). The average rate of preterm birth in low income or developing countries

is 11.8% compared to 9.4% in high income countries (Lawn *et al.*, 2013). Lower rates of preterm birth has been associated with improved antenatal monitoring, improved access to health facilities for individuals with pregnancy complications and changes in obstetric practices by reducing unnecessary induced labours (WHO, 2012).

#### **2.1.4 New Zealand Rates of Premature Births**

In 2010, 3771 infants (7.4%) were born <37 weeks' gestation with a higher rate of preterm birth occurring in socioeconomic deprived areas (Ministry of Health, 2012). Preterm birth was also higher in mothers of Māori ethnicity (8.1%) and the lowest rates were seen in Pacific and Asian mothers (Ministry of Health, 2012). A more recent report from the New Zealand identified that that late preterm birth has the highest prevalence at 5-7% compared to 1-3% extremely premature infants (National Maternity Monitoring Group, 2013).

The economic costs associated with preterm birth are estimated to be more than triple the costs for a full term infant. Costs within New Zealand are not available but in the USA, the estimated cost per lifetime for a preterm infant is US\$51,600 (Galson, 2008). Early preterm infants require intensive medical monitoring and extended hospital admissions which contribute significantly to health costs. Late preterm births also make a significant contribution to health costs due to the higher prevalence of these infants within New Zealand (Gilbert *et al.*, 2003; National Maternity Monitoring Group, 2013). Optimising monitoring and care of moderate to late preterm infants in neonatal units is likely to improve health outcomes which will have a significant effect on reducing health costs associated with preterm births (Engle *et al.*, 2007; Tomashek *et al.*, 2006).

#### **2.1.5 Causes of Preterm Birth**

Preterm births are mostly spontaneous; however, preterm delivery has been associated with inappropriate medical interventions via labour induction or caesarean section (Davidoff *et al.*, 2006). Other causes include maternal pregnancy complications, maternal demographics, and the social and environmental status of the mother which can increase the risk of spontaneous rupture of membranes or increase the need for induction (Ministry of Health, 2012).

### *2.1.5.1 Spontaneous Premature Birth*

Spontaneous births can be a result of a spontaneous rupture of intact membranes (SPOM) or can occur due to preterm premature rupture of the membranes (PPROM) occurring one hour before the onset of contractions (Steer, 2005). The causes of PPRM are often difficult to ascertain but has been shown to be associated with maternal demographics, medical status, nutrition status, previous obstetric history and pregnancy complications (Ferguson, Smith, Salenieks, Windrim, & Walker, 2002; Kyrklund-Blomberg & Cnattingius, 1998; Mercer *et al.*, 1999).

### *2.1.5.2 Medical Intervention via Labour Induction*

Preterm birth rates can also be a result of stimulation of labour via pharmaceuticals or surgical intervention, which stimulates birth prior to full term gestation (Slattery & Morrison, 2002). Reasons for induction or caesarean section operations include fetal distress syndrome, placental abruption, intrauterine growth restriction, infection of the uterus and oligohydramnios (Davidoff *et al.*, 2006). Caesarean sections are commonly used in multiple pregnancies but does not prevent intrauterine growth restriction, Though growth restricted fetuses are commonly delivered preterm to prevent stillbirth (Davidoff *et al.*, 2006). Caesarean sections are also used in maternal pregnancy complications including gestational diabetes mellitus (GDM) and pre-eclampsia for postnatal health of infant and mother (Ananth, 2006). These advancements in medical care have allowed for reductions in still birth and fetal morbidity. However, an increase in preterm birth between weeks 34-36 weeks' gestation has increased largely due to labour induction and caesarean sections (Joseph, Demissie, & Kramer, 2002). Early management of pregnancy complications and monitoring of fetal growth are important in reducing early inductions (Nohr *et al.*, 2007). Greater research is required in weighing up the benefits of induction with the risks of preterm delivery (Joseph *et al.*, 2002).

### *2.1.5.3 Pregnancy Complications*

Maternal pregnancy complications and risk factors have been documented as a significant contributor towards spontaneous births resulting in a premature

delivery (Davidoff *et al.*, 2006). Infection, often subclinical, is the most common cause of spontaneous preterm birth and also contributes to the pathogenesis of PPRM (Steer, 2005). Further vaginal bacterial infections may explain 50% of premature deliveries (Goldenberg, Culhane, Iams, & Romero, 2008). Due to the infection eliciting an inflammatory response, it has been linked to chronic lung disease and cerebral palsy resulting in increased health issues in preterm infants following birth (Goldenberg *et al.*, 2008). Other common causes of preterm births can be due to inflammation, utero-placental ischemia, haemorrhage and other immune defences (Steer, 2005). Medical complications during pregnancy contribute significantly; however, maternal demographics and environmental influences cannot be ignored as contributing to preterm births.

#### *2.1.5.4 Maternal Demographics Contributing to Preterm Birth*

There is a strong association between previous preterm birth and future preterm delivery with 15 to 50% chance of a preterm reoccurrence in concurrent pregnancies (Goldenberg *et al.*, 2008). Multiple gestations contribute significantly to preterm delivery with 60% of twin births being preterm. Forty percent of these twin births being spontaneous (Goldenberg *et al.*, 2008).

#### *2.1.5.5 Maternal Social and Environmental Determinants*

Maternal environmental and social factors have been shown to influence the risk of premature birth. Nutrition status is one of the determinants of pregnancy outcome. Nutrients are essential during pregnancy for nutrient accretion to support the growth of the fetus and to support lactation. Maternal nutrient stores are essential to support the fetus during growth and development *in utero*. Under nutrition especially deficits in iron and folate in the maternal diet enhances the risk of preterm births as well as promotes intrauterine growth restriction (King, 2003).

Maternal weight further contributes to pregnancy outcomes with a Body Mass Index (BMI) of less than 17 resulting in a 7% rise in risk of a preterm birth (King, 2003). Overweight women have high rates of preterm birth secondary to complications experienced during pregnancy (McDonald, Han, Mulla, & Beyene, 2010). Maternal social factors can also contribute to premature births including

stress, depression and poor socioeconomic status as these factors are hypothesised to increase C-reactive proteins (CRP) inflammatory factors resulting in spontaneous births (Goldenberg *et al.*, 2008).

Tobacco and alcohol exposure during pregnancy has been shown to increase preterm birth by 6.4-6.8% (KolÅS *et al.*, 2000). These findings illustrate the importance of educating mothers on health prior to pregnancy and during gestation in an attempt to reduce preterm delivery and the complications that follow.

### **2.1.6 Complications Associated with Preterm Birth**

Despite improvements in neonatal and perinatal care, the prevalence of medical complications in his population remain high with 1.08 million preterm complications in 2010 alone (Liu *et al.*, 2012). The short and long term consequences affect a wide range of vital organs systems including pulmonary, cardiovascular, gastrointestinal, nervous and immune systems (Huppi *et al.*, 1996; Siggers, Siggers, Thymann, Boye, & Sangild, 2011). Physical effects include visual impairment associated with retinopathy, hearing impairment, chronic lung disease and cardiovascular disease. Acute conditions can also range from mild to severe complications including necrotising enterocolitis, anaemia of prematurity, respiratory distress syndrome, hypothermia, and hypoglycaemia (Liu *et al.*, 2012; Wang, Dorer, Fleming, & Catlin, 2004). Underdeveloped immune systems place premature infants at greater risk of infection, with 0.83 million premature infants affected by infection worldwide (Melville & Moss, 2013).

Immature nervous systems can result in long term neurological development delays and behavioural disorders. This includes mild disorders of executive functioning to moderate to severe developmental delay (WHO, 2012). The result of these complications can cause psychosocial, emotional and economic burdens on individuals, families and communities.

The immature gastrointestinal tract can result in feeding difficulties. The gastrointestinal tract is involved in absorption and processing of nutrients but also holds key roles in endocrine and exocrine functions. In preterm infants, impaired intestinal motor function is due mainly to incomplete maturation of

enteric neuroendocrine plexus (Neu, 2007). Furthermore the excretion of digestive products such as hydrochloric acid is inadequate resulting in a high pH with immaturity of the mucosal barriers which can lead to bacterial overgrowth and premature infants at greater risk of intestinal infection (Neu, 2007).

## **2.2 Feeding the Preterm Infant: Breastfeeding**

### ***2.2.1 Breastfeeding Recommendations***

Breastfeeding provides the infant with the optimum source of nutrients and is defined as a child feeding from the breast of the mother (Renfrew *et al.*, 2010). In healthy term infants, breastfeeding should be initiated within the first hour following birth (Epsy & Senn, 2003), and exclusive breastfeeding continued until 6 months of age (WHO, 2012). Breast milk provides the infant with non nutritional factors such as immunoglobulin's which reduces the risk of infection and enhances survival rates when breastfeeding is initiated immediately after birth (Leung & Sauve, 2005). Although breastfeeding is also promoted as the optimal source of nutrition for preterm infants, there are concerns that its composition may not meet the increased nutrient requirements of these infants. Breast feeding also requires co-ordination and skill which are undeveloped in preterm infants and therefore other methods of nutrition support may be required (Lucas *et al.*, 1998).

### ***2.2.2 Benefits of Breastfeeding***

#### *2.2.2.1 Immunity*

Breast milk assists in immune modulation by providing antimicrobial substances including macrophages, neutrophils, lymphocytes, cytokines and growth factors (Field, 2005). These factors elicit an inflammatory response to respond to infections whilst also reducing exaggerated inflammation (anti-inflammatory infection) that can cause gut damage and infection (Field, 2005). A significant reduction has been illustrated in necrotising enterocolitis (NEC) a condition in preterm infants where parts of the bowel necrotise or die. Studies have shown NEC to be reduced by 79% in preterm infants fed breast milk compared to infants fed formula (Arslanoglu, Ziegler, & Moro, 2010). Infants breastfed for six months or beyond have also been shown to have reduction in long term dietary



allergies, food intolerance, asthma, dermatitis and eczema up to two years of age (Kull, Wickman, Lilja, Nordvall, & Pershagen., 2002).

#### *2.2.2.2 Neurological Development*

Preterm infants fed breast milk have a five point lead (using the psychomotor development index) in development than preterm infants fed infant formula (Vohr *et al.*, 2006). In addition a follow up of preterm infants at 7 - 8 years of age, showed those that were fed standard formula rather than breastfed had a significantly lower IQ of less than 85 and verbal development was also delayed (Lucas *et al.*, 1998). These studies support the importance of preterm infants receiving breast milk for cognitive development.

#### **2.2.3 Breast Milk: Meeting the Needs of the Preterm Infant**

The benefits of breast milk are well documented (Hay, 2008; Vohr *et al.*, 2006; Xiao-Ming, 2008); however, there is concern that breast milk is inadequate to meet certain nutrient needs of premature infants (Schanler, 2007). Nutrients of concern for the preterm infant include calcium, phosphorous, iron, vitamin D, protein and energy (Schanler, 2007). Preterm infants fed fortified breast milk compared to infants fed unfortified breast milk have better weight gain and increases in head circumference and length (Mukhopadhyay, Narang, & Rama, 2007; Senterre & Rigo, 2012) .

Calcium and phosphorous have been shown to be inadequate in breast milk resulting in a rise in serum alkaline phosphatase contributing to metabolic bone disease and insufficient growth (Lucas, Brooke, Baker, Bishop, & Morley, 1989). Improvements in growth measures including improvements in head circumference and length with fortification of 3.4 g/kg/day of protein has been reported in studies (Arslanoglu *et al.*, 2010).

Current protocols in New Zealand recommend fortification of breast milk for all infants <32 weeks' gestation and <1800g at birth (Auckland District Health Board National Womens, 2012). These infants will always be clinically assessed and care given on that basis regardless of protocols. These protocols guide clinical practice in preterm infants.



## **2.2.4 Factors Affecting Breastfeeding Initiation in Preterm Infants**

### *2.2.4.1 Physiological Underdevelopment Affecting Ability to Breastfeed*

Preterm and low birth weight infants have been shown to be at greater risk of poor breastfeeding initiation during admission to intensive care units (Smith, Durkin, Hinton, Bellinger, & Kuhn, 2003; Trajanovska, Burns, & Johnston, 2007; Wright, Parkinson, & Scott, 2005). One of the main determinants is the delayed physiological development of preterm infants resulting in an inability to breastfeed. This includes poor lip seal, delayed motor skills resulting in poor suckling ability and delayed development of swallowing reflexes (Nyqvist, Sjöden, & Ewald, 1999). Due to these undeveloped systems, breastfeeding a premature infant may place the infant at risk of medical deterioration including aspiration pneumonia, hypothermia, apnoea and slow growth including delayed weight gain (Donath & Amir, 2008). Interestingly there is evidence that infants at greater risk of medical fragility are more likely to be fed infant formula to support needs during medical treatment (Chong & Gould, 2009). Therefore degree of prematurity, development and medical status are all factors that affect the initiation and rates of breastfeeding during hospital admission.

### *2.2.4.2 Feeding Complications Related to Late Preterm Infants*

More recently, research has focused on the consequences of late preterm birth population (National Maternity Monitoring Group, 2013) and has highlighted the feeding issues which this population experience. Although late preterm infants may have similar birth weights to term infants as well as transitioning well after birth, they often fail to maintain this stability (Wang *et al.*, 2004). In comparison to term infants, late preterm infants have been shown to be more prone to feeding difficulties and poor feeding related to uncoordinated motor skills and early fatigue during feeds leading to hypoglycaemia (Engle *et al.*, 2007). One study found that late preterm infants were more likely to be readmitted to hospital for feeding difficulties compared to term infants (Jain & Cheng, 2006). Therefore late preterm infants are at risk of feeding difficulties with subsequent higher risks of readmission to hospital.

#### *2.2.4.3 Maternal Factors impacting on Breastfeeding*

A mother's intention to breastfeed is a strong determinant of breastfeeding initiation and duration of breastfeeding (Trajanovska *et al.*, 2007). Mothers are more likely to breastfeed if they are of older age, married and have previously breastfed other children (Furman, Minich, & Hack, 1998; Smith *et al.*, 2003). In New Zealand mothers aged 30-34 years were more likely to exclusively breastfeed (72%) compared to mothers less than 20 years (61.1%) (Ministry of Health, 2012).

#### *2.2.4.4 Breastfeeding during Hospital Admission*

Hospital admission can decrease breastfeeding rates due to the high stress environment including noise, lack of privacy and lack of education (Furman *et al.*, 1998). Hospitals internationally have strived to improve rates through policies such as the baby friendly initiative which encourages initiation and continual breastfeeding during and following hospital admission (Broadfoot, Britten, Tappin, & MacKenzie, 2005). An audit of the baby friendly initiative in Scotland and the UK showed a 11.4% increase in breastfeeding initiation over a 7 year period (Broadfoot *et al.*, 2005). The baby friendly initiative in Europe showed higher overall breastfeeding rates in NICU's with the programme favouring preterm infants (Bonet, Blondel, & Agostino, 2010). This shows that the support provided by hospital staff can significantly enhance breastfeeding initiation and duration.

#### *2.2.4.5 Ethnicity impact on Breastfeeding*

Breastfeeding is influenced by beliefs, values and cultural norms (Griffiths, Tate, & Dezateux, 2005). In New Zealand Māori mothers have been shown to have lower breastfeeding rates at birth compared to mothers of European descent (Ministry of Health, 2012). This inequality has been suggested to be created and maintained through poor antenatal education, conflicting advice and concern over breastfeeding in public for Māori mothers (Glover *et al.*, 2009). Māori mothers also have shorter breastfeeding durations with breastfeeding not continued up to 6 months due to lack of cultural specific practical advice and also lack of Māori /Pacific midwives or health practitioners who would

understand their cultural norms (Glover *et al.*, 2009). These findings emphasise the need for strategies to increase breastfeeding that incorporate cultural beliefs and targets groups that are at risk of poor initiation or continuation.

### **2.2.5 Breastfeeding Initiation Rates during Hospital Admission**

Delayed initiation of breastfeeding can result in a 2.4 fold increase in risk of mortality with breastfeeding recommended to be initiated optimally within the first hour after birth (Edmond *et al.*, 2006). Studies have shown breastfeeding to initiate within 22 to 74 minutes after birth in healthy term infants (Walters, Boggs, Ludington, Price, & Morrison, 2007). Mothers of preterm infants are at greater risk of not initiating breastfeeding soon after birth due to medical instability and the physiological underdevelopment of preterm infants (Colaizy & Morriss, 2008; Edmond *et al.*, 2006). Lower breastfeeding rates in early preterm infants has been demonstrated with infants <27 weeks' gestation having the lowest breastfeeding initiation rates due to medical instability and underdeveloped physiology (Bonet *et al.*, 2010). A study showed infants <34 weeks were less likely to breastfeed during NICU admission in comparison with early preterm infants (Colaizy & Morriss, 2008).

Rates of breastfeeding initiation for preterm infants varies between countries and studies ranging from 49% to 98.7% (**Table 2.1**). There are limited studies or reports identifying breastfeeding initiation rates within New Zealand DHBs with majority of clinical indicators reporting on breastfeeding at discharge.

**Table 2.1:** Summary of International Studies Reporting on Initiation and Discharge Breastfeeding Rates for Preterm Infants

<b>Reference</b>	<b>Study Design</b>	<b>Country</b>	<b>Number of Preterm Infants</b>	<b>Breastfeeding Initiation Rates</b>	<b>Breastfeeding at Discharge Rates</b>
(Colaizy & Morriss, 2008)	Observational Study investigating breastfeeding in infants admitted to NICU compared to infants not admitted.	United States of America	138,359	70% Initiated BF within NICU. Infants <34 weeks' gestation less likely to initiate breastfeeding than infants of later gestation.	<32 weeks' gestation was 40% more likely than late preterm infants to breastfeed on discharge.  32-34 weeks were 13% less likely to breastfeed on discharge compared with infants <32 weeks.  35-37 weeks were 22% less likely to breastfeed on discharge than infants <32 weeks.
(Donath & Amir, 2008)	Longitudinal Cohort Study on all infants admitted between March 2003-February 2004.	Australia	10,000	(35-36 weeks) were less likely to initiate breastfeeding (88.2%) when compared with late preterm infants (37 weeks) (92%). Breastfeeding was initiated in 93.8% of term infants	Not specified
(Trajanovska et al., 2007)	Retrospective Audit on all infants admitted between 2001-2003.	Australia	1163	Not Specified	56% received EBM. Infants where older with shorter hospital stay compared with formula fed infants.

<b>Author</b>	<b>Study Design</b>	<b>Country</b>	<b>Number of Preterm Infants</b>	<b>Breastfeeding Initiation Rates</b>	<b>Breastfeeding at Discharge Rates</b>
(Murray, Ricketts, & Dellaport, 2007)	Population observation assessing breastfeeding in all infants born between 2002-2003 in 9 hospitals.	United States of America	4544	85% initiated breastfeeding in NICU	Not Specified
(Edmond <i>et al.</i> , 2006)	Cluster-randomized, placebo controlled trial. Included all singleton infants born between July 2003- June 2004 in a Ghana hospital.	Ghana	10,947	Day one: 71% initiated breastfeeding. By day seven: 98.7% initiated breastfeeding	Not Specified
(Blackwell <i>et al.</i> , 2005)	Observational Cohort. Infants between 30-35 weeks admitted to NICU in Massachusetts.	United States of America	450	52% of the infants initiated breastfeeding whilst admitted	42% of the infants were discharged breastfeeding
(Epsy & Senn, 2003)	Retrospective Analysis. All infants <34 weeks' gestation admitted to a US tertiary NICU between 1997-1998.	United States of America	361	49.7% preterm infants initiated breastfeeding in hospital	Not specified

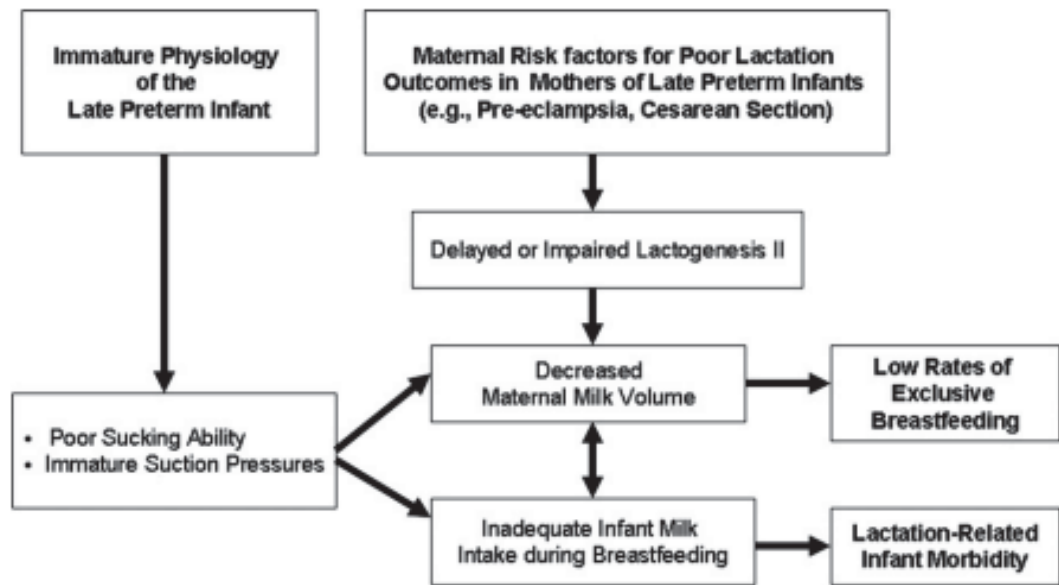
<b>Author</b>	<b>Study Design</b>	<b>Country</b>	<b>Number of Preterm Infants</b>	<b>Breastfeeding Initiation Rates</b>	<b>Breastfeeding at Discharge Rates</b>
(Smith <i>et al.</i> , 2003)	Retrospective follow up study of 361 mothers of preterm infants born between 1991-1993.	United States of America	361	60% initiated breastfeeding during admission	52% breastfeeding
(Furman <i>et al.</i> , 1998)	Retrospective descriptive study of admissions to a tertiary NICU between January 1 to June 30 1995.	United States of America	97	Not specified	49% mothers who initiated breastfeeding continued on pump whilst 42% transitioned to breast.
(Gunn, 1991)	Observational Audit of preterm infants admitted to NICU at St Helens Hospital in Auckland.	New Zealand	49	Not specified	88% intended to breastfeed with 92% actually breastfeeding at discharge.

### **2.2.6 Breastfeeding in Preterm Infants at Discharge**

Factors which influence breastfeeding continuation are similar to those that influence initiation (medical stability, breastfeeding support, mother's intention to breastfeed and cultural beliefs). At discharge, breastfeeding is also affected by perceived paternal support and the length of time mothers intend to breastfeed (Scott, Landers, Hughes, & Binns, 2001). A decrease of 10-20% between initiation of breastfeeding and at discharge was observed in studies (**Table 2.1**) (Blackwell *et al.*, 2005; Colaizy & Morriss, 2008; Smith *et al.*, 2003).

Early preterm infants have lower breastfeeding at discharge in comparison with later preterm infants (Killersreiter, Grimmer, Bühner, Dudenhausen, & Obladen, 2001). However, late preterm infants have also been highlighted as a population at risk of poor breastfeeding when compared to term infants. Late preterm infants also have higher rates of readmission to hospital due to feeding difficulties or inadequate growth secondary to issues with milk supply or breastfeeding difficulty compared with term infants (**Figure 2.1**) (Gouyon, Iacobelli, Ferdynus, & Bonsante, 2012).

Data is available in New Zealand on breastfeeding rates at discharge for term infants (DHB, 2013; Hutt Valley DHB, 2013). However, statistics on preterm infants breastfeeding rates at discharge is limited. In 2012, 80% of preterm infants discharged from the NICU at ADHB were exclusively breastfed; however, extremely premature infants had lower rates. (**Table 2.1**) (Pot *et al.*, 2012). Research is required within New Zealand DHBs to be focusing on preterm infants especially for late preterm infants given their higher prevalence (National Maternity Monitoring Group, 2013).



**Figure 2.1:** Factors Impacting on Late Preterm Breastfeeding Initiation

Reprinted from the *Journal of Midwifery & Women’s Health*, 52 (6), Meier, P.P., Furman, L.M., Degenhardt, M., *Conceptual framework for poor lactation outcomes in late preterm infants*, 579-587© 2007 with permission from Elsevier.

## 2.3 Feeding the Premature Infant: Enteral Feeding:

### 2.3.1 Enteral Feeding

Enteral feeding is defined as the provision of nutrients into the gastrointestinal tract via a tube, catheter or stoma (Bankhead *et al.*, 2009). This method of feeding may be chosen to administer nutrients to preterm infants who cannot physically breastfeed, bottle feed or cup feed (Agostoni *et al.*, 2010). Enteral feeding also aids in supporting growth in preterm and very low birth weight infants by providing additional nutrients required to achieve growth and development similar to that of a term infant *in utero* (Agostoni *et al.*, 2010). There are benefits but also risks associated with enteral feeding and protocols for administering enteral feeds vary between neonatal units.



### **2.3.2 Early Initiation of Enteral Feeding**

Early initiation of enteral feeding in preterm infants is beneficial for nutrient provision and prevention of faltering growth when infants are unable to breastfeed (Thureen & Hay Jr, 2001). Early initiation of enteral feeds has also been associated with reduced sepsis rates, reduced hospital admission, enhanced growth rates with reduced days to regain birth weight and achievement of full enteral feeds faster (Ehrenkranz *et al.*, 1999). Studies have also shown minimal enteral feeding to be associated with reduced parenteral nutrition which reduces sepsis, cholestatic jaundice and improved discharge weights (Leaf *et al.*, 2012).

### **2.3.3 Risks Associated with Enteral Feeding**

#### *2.3.3.1 Necrotising Enterocolitis (NEC)*

The initiation or advancement of enteral nutrition in preterm infants is often delayed for a number of days to weeks after birth in an effort to reduce the incidence of NEC caused by early enteral feeding or parenteral feeding (ASPEN, 2012). Although NEC has been associated with enteral feeding in preterm infants a clear causal relationship has not been established. The risk of developing NEC is reduced with enteral feeding of EBM and slowly advancing the volume of enteral feeds. (Meinzen-Derr *et al.*, 2009; Sisk, Lovelady, Dillard, Gruber, & O'Shea, 2007).

### **2.3.4 Days to Initiate Enteral Feeding**

Days to initiate enteral feeds is an important measure of nutritional adequacy in preterm infants as delayed enteral initiation has been associated with poor growth outcomes and increased risk of medical deterioration including increased risk of infection and gut atrophy (Leaf *et al.*, 2012). **Table 2.2** summarises international studies which have identified the number of days it takes to initiate enteral feeding in preterm infants requiring intensive medical care. Initiation rates differ significantly across studies ranging from 1 to 12 days. Extremely premature infants are more likely to be enterally fed later than moderately to late premature infants. A recent survey of 124 neonatal units which included 5 countries (UK, Canada, Australia, New Zealand and Scandinavia) showed that overall, 35% of infants <25 weeks' gestation initiated

enteral feeds within the first 24 hours of life compared to 43% for infants 25-27 weeks' gestation and 71% for 28-31 week infants (Klingenberg, Embleton, Jacobs, O'Connell, & Kuschel, 2011). A study in South Africa found similar results identifying that 24% of <25 weeks' gestation infants began enteral feeding within 24 hours compared to 65% of infants commenced within 24 hours in infants 28-31 weeks' gestation (Raban, Joolay, Horn, & Harrison, 2013).

Within a New Zealand context, the Auckland City Hospital audit results displayed in **Table 2.2** shows that enteral feeding was initiated within 1 to 3 days (Cormack & Bloomfield, 2006). New Zealand and Australian NICU units have been shown to initiate enteral feeding within 3 days for infants <25 weeks, 4 days for 25-27 weeks and 14 days for 28-31 weeks (Klingenberg *et al.*, 2011). Enteral feeding initiation rates differ markedly between neonatal units but extremely premature infants appear to be at a greater risk of delayed enteral initiation (Table 2.2).

**Table 2.2: Summary of Initiation of Enteral Feeding and Days to Reach Full Feeding Volumes in Studies**

Reference	Study Design	Country	Number of Preterm Infants	Days to Initiate Enteral Feeds	Days to Reach Full Enteral Feed Volumes
(Krishnamurthy <i>et al.</i> , 2010)	Randomized control trial of preterm infants (<34 weeks) weighing 1000-1499g.	India	100	Not Specified	Slow Enteral Feeding: Mean (Range) 9 (9-11)  Rapid Enteral Feeding:  7 (7-9.5)
(Terrin <i>et al.</i> , 2009)	Retrospective study design of low birth weight preterm infants.	Italy	102	Total Parenteral Group: Mean (Range) 11 (8-12)  Parenteral + Minimal Enteral Feeding:  8 (7-9)	Total Parenteral Group: Mean (Range) 11 (10-15)  Parenteral + Minimal Enteral Feeding:  8 (5-10)
(Blackwell <i>et al.</i> , 2005)		United States of America	382	Mean(Range) 1 (0-2)	Range 7-14
(Cormack & Bloomfield, 2006)	Prospective audit over a 3 month period in preterm infants <1200g or 30 weeks' gestation.	New Zealand	34	1 (1-3)	Mean (Range) 8 (5-28)

Reference	Study Design	Country	Number of Preterm Infants	Days to Initiate Enteral Feeds	Days to Reach Full Enteral Feed Volumes
(Caple <i>et al.</i> , 2004)	Randomized control trial on preterm infants <35 weeks at NICU in Houston.	United States of America	155	Not Specified	Rapid Enteral Nutrition: Mean (Range) 7 (5-48) Slow Enteral Nutrition: 10 (8-17)
(Steward & Pridham, 2002)	Retrospective observational cohort of infants <1000g admitted to 2 NICU's in US.	United States of America	35	Not Specified	Mean (Range) 44 (13-128)
(McClure & Newell, 2000)	Randomized control trial on preterm infants admitted to NICU in Leeds.	United Kingdom	100	Not Specified	Mean (Range) 36.1 (28-44)
(Ehrenkranz <i>et al.</i> , 1999)	Prospective cohort design of infants 501-1500g at birth.	United States of America	424	Mean $\pm$ SD 2.5 $\pm$ 1.8	Mean $\pm$ SD 9.0 $\pm$ 4.7
(Akintorin <i>et al.</i> , 1997)	Prospective randomized control trial of infants <35 weeks admitted between 1994-1995.	United States of America	52	Mean $\pm$ SD 5.3 $\pm$ 2.2	Mean $\pm$ SD 13.1 $\pm$ 3.4

### **2.3.5 Achieving Full Enteral Feeds**

Achieving full enteral feeding is defined as meeting the required fluid volume of 160-200 mls/kg/day which will cover the energy and protein needs of most preterm infants (Agostoni *et al.*, 2010). **Table 2.3** summarises relevant neonatal enteral nutrition audits showing the varying classifications of full enteral feeding rates. The majority of neonatal units aim for a full feeding rate of 161-180 mls per kg per day except for Canadian neonatal units which aim for 140-160 mls per kg per day which potentially falls short of recommendations for protein and energy intake (Klingenberg *et al.*, 2011). Within New Zealand neonatal units, 161-180 mls per kg per day was classed as a full enteral feed in 74% of neonatal units; however, 24% aimed for an intake of 140-160 mls per kg per day (Klingenberg *et al.*, 2011). The ADHB NICU audit showed full feeds to be aimed at 180 mls/kg/day (Cormack & Bloomfield, 2006). Therefore the majority of neonatal units in New Zealand are aiming for higher volumes which are more likely to meet nutrient requirements of preterm infants.

**Table 2.3:** Target for Achieving Full Enteral Feeding Volumes within International Studies

Reference	Study Design	Country	Target Volume of Full Enteral Feed mls/kg/day:%
(Raban <i>et al.</i> , 2013)	Cross sectional web based survey of 238 pediatricians in 147 South African hospitals. Evaluating the differences in neonatal nutritional practices across South Africa.	South Africa	140- 160: 27% 161- 180: 57% 181-200: 16%
(Klingenberg <i>et al.</i> , 2011)	Web based observational survey of 127 tertiary NICU in 5 countries. Evaluating enteral feeding practices in neonatal units internationally.	Canada, New Zealand, Australia, UK and Scandinavia	UK: 140-160: 17% 161-180: 73% 181-200: 10% Canada: 140-160: 93% 161-180: 7% 181-200: 0%  Australia/NZ: 140-160: 22% 161-180: 74% 181-200: 4%  Scandinavia: 140-160: 5% 161-180: 70% 181-200: 25%
(Patole & Muller, 2004)	Self-administered survey for 56 Australian NICU neonatologists to investigate feeding practices occurring in neonatal units.	Australia	150-189: 70%

### 2.3.6 Days to Reach Full Enteral Feeding

There is concern that advancing to full enteral feeds too quickly can cause feeding intolerance resulting in haemodynamically unstable infants, abdominal distension, discolouration, perinatal depression (metabolic acidosis), and pulmonary instability and fluid / electrolyte imbalance (Berseth *et al.*, 2003; Terrin *et al.*, 2009). **Table 2.3**

summarises the days to reach full enteral feeding volumes in neonatal audits. The main concern over rapid enteral feed advancement is the increasing the risk of necrotising enterocolitis (Berseth *et al.*, 2003). Studies have also shown faster achievement of full enteral feeds results in decreased intravenous fluids and shorter hospital stay with no difference in the incidence of feeding intolerance or the development of apnoea's (Krishnamurthy *et al.*, 2010). These findings show the benefits of achieving full feeds at an earlier date; however, concern is still expressed over feed intolerance and incidence of NEC.

## **2.4 Growth**

The nutrient deficit that accumulates in the early weeks post-delivery when the preterm infant is clinically unstable is difficult to recover and can result in long term neurological and developmental delay (Embleton *et al.*, 2001). Anthropometric measurements including weight, head circumference and length are important clinical indicators to monitor growth and nutrient status of infants particularly in SCBU. Interpretation of these clinical indicators allows for adjustment of prescribed nutrient intakes to facilitate optimal growth. Routinely monitoring also allows for early identification of faltering growth or feeding difficulties which may require referral to dietetic services.

### **2.4.1 Recommendations for Growth in Preterm Infants**

Literature and clinical guidelines recommended growth should aim for similar rates of the term infant in *utero* (Agostoni *et al.*, 2010). This would mean a weight gain of approximately 15 - 20g/kg/day until the infant has reached 40 weeks corrected gestational age (Agostoni *et al.*, 2010). Length and weight should also be between the 10<sup>th</sup> and 90<sup>th</sup> percentile to meet growth of the term infant (Cormack, 2012). These guidelines are often difficult to achieve due to the extra uterine environment contributing factors such as temperature and infections causing increased nutrient requirements as well as difficulty in providing exact nutrient supply which would have been achieved in *utero*. Literature has suggested that postnatal growth faltering and malnutrition is inevitable in preterm infants during hospital stay (Mehta *et al.*, 2013). This has been suggested to be put down to an accumulative nutrient deficit occurring after birth as a result of medical staff waiting for medical stability (Embleton *et al.*, 2001). Therefore, it is vital that weights and other growth measures are monitored to identify significant changes in growth which will allow appropriate interventions to be conducted.

### **2.4.2 Achieving Growth Recommendations in Hospital**

Blackwell and colleagues in 2005 showed that out of 450 premature infants, only 2% achieved 15g/kg/day of weight gain (Blackwell *et al.*, 2005). Further findings from this study showed a weight gain of only 6.7g/kg/day of weight gain within the first week after birth (Blackwell *et al.*, 2005). This leads to infants accumulating nutrient deficits during the first 7 days with some infants being discharged without meeting birth weight at all (Blackwell *et al.*, 2005). A further study showed that infants achieved intrauterine growth by achieving 14.4 grams to 16.1 grams per kg per day ;however, infants between 24 and 29 weeks' gestation could not achieve reference growth rates (Ehrenkranz *et al.*, 1999). Steward and Pridham found that in 35 ELBW preterm infants, the mean weight gain velocity was 14.5 g/kg/day; however, by discharge 89% of the infants had a weight of <10 percentile with significantly lower weights than recommended upon discharge (Steward & Pridham, 2002). These observations show that meeting the intrauterine growth recommendations is difficult across all neonatal units especially in moderate to extremely premature infants as well as in extremely low birth weight infants.

### **2.4.3 Days to Regain Birth Weight**

A weight loss of 5-10% after birth is to be expected but preterm infants may lose more especially infants of medical instability (Cormack, 2012). Birth weight should be regained within 2 weeks for term infant and within 3 weeks for preterm infants (Heird, 2008). The provision of nutrients immediately after birth allows for immediate nutrient intakes and also decreases the loss after birth. One of the key goals is to maintain birth weight and advance on birth weight during hospital admission.

Ehrenkranz *et al*, 1999, showed that infants greater than 800 grams tended to regain birth weight earlier with a mean of 11.5-15.5 days compared to infants less than 800 grams with a mean of 15.2- 17.2 days to regain birth weight. These findings are supported by a study showing infants less than 1200grams took longer to regain birth weight than infants with a birth weight of 1200g-1849g (Lucas, Gore, & Cole, 1984). In contrast to these studies, Pauls et al, 1998 found that infants of lower birth weight (450-599 grams) regained birth weight faster with a mean of 7.8 days compared to infants of greater birth weights (900-999 grams) with a mean of 11 days (Pauls, Bauer, & Versmold, 1998). These findings suggest that infants of lower birth weight take longer to regain weight; however, contrasting evidence shows otherwise.



#### **2.4.4 Postnatal Growth of Preterm Infants Prior to Discharge**

Postnatal growth faltering (PNGF) has been defined traditionally as a growth less than the 10<sup>th</sup> percentile (Shah *et al.*, 2006). This definition fails to acknowledge that preterm infants are often born <10<sup>th</sup> percentile and are likely to continue to track below the 10<sup>th</sup> percentile (Marks, Reichman, Lusky, & Zmora, 2006). A more appropriate definition for PNGF looks at the change in Z-scores between birth and discharge with decreases in Z-scores indicating PNGF (Cooke., Ainsworth., & Fenton., 2004). Recommendations have shown a decrease in z-score of 1 or more indicates growth faltering and is therefore clinically significant (Mehta *et al.*, 2013). Furthermore a decrease of Z-scores of 2 or more between birth and discharge indicates severe PNGF (Marks *et al.*, 2006; Shah *et al.*, 2006). Using Z-scores to identify PNGF, allows for identification of infants who may benefit from early nutrition interventions (Shah *et al.*, 2006) alongside the supervision of a dietitian.

Literature has shown that majority of infants will experience weight loss between birth and discharge due to adaptation to the outside environment. An inter-neonatal intensive care unit study found a mean change in z score of -0.67 scores between birth and discharge (Blackwell *et al.*, 2005). A further study showed a decrease from birth to 7 weeks post birth with a decrease of 1.04 Z-scores This study also showed that after 2 weeks, infants >31 weeks' gestation stabilised with no significant changes; however, at 2 weeks infants <30 weeks continued to decrease in scores until 5 weeks after birth (Embleton *et al.*, 2001). This was supported by a study comparing a neonatal unit to a special care baby unit showing a drop in Z-scores of 0.72 and 0.86 respectively (Cooke *et al.*, 2004). Anthropometric measures have also been shown to drop during admission. A study with 24,371 preterm infants found infants head circumference and length were appropriate at birth but 34% and 16% of infants dropped below the 10<sup>th</sup> percentile at discharge for length and head circumferences respectively (Clark, Thomas, & Peabody, 2003) These studies present on the overall change between birth and discharge; however, they fail to present on the amount of infants that dropped by 1 or more Z-scores which would identify infants at risk of PNGF.

A longitudinal study in preterm infants over a six year period found a decline in z score by 0 to -1 in 46.5%, by >-1 to -2 in 39.1% and by more than -2 in 10.6% (Marks *et al.*, 2006). These findings demonstrate the importance of monitoring, recording and interpreting infant's anthropometric data from birth to discharge which this will allow

appropriate referrals to be made and also begin nutrition interventions early in line with dietetic recommendations.

## **2.5 Monitoring and Dietitian Referral**

Due to the medical fragility and vulnerability of preterm infants, monitoring of nutrition status is important given the central role nutrition holds in providing optimal outcomes for premature infants. The involvement of an interdisciplinary team which may involve speech language therapists, dietitians, lactation consultants and social workers allows for specific interventions in collaboration with medical interventions (Sneve, Kattelmann, Ren, & Stevens, 2008).

Dietitians as part of the interdisciplinary team have been highlighted as important contributors in providing optimal outcomes for premature infants admitted to neonatal units. Dietitians are able to provide individualised, evidence based interventions and expertise to enable appropriate nutritional care. Research has demonstrated the importance of dietetic involvement with Olsen et al reporting NICU's with greater dietetic input have greater protein intakes, greater fortification of feeds and higher reporting of weights, length and head circumferences (Olsen *et al.*, 2005). The differences in nutritional outcomes and growth parameters before and after dietetic involvement were investigated. Results of the study found that although there was no difference in length of admission; weights, head circumference and length increased after dietetic input (Donovan, Puppala, Angst, & Coyle, 2006). Literature has also reported early nutrition interventions to also reduce hospital stay, reduce necrotising enterocolitis and reduce time to regain birth weight (Tuthill, 2007). These findings highlight the importance of dietetic involvement as well as a multi disciplinary team within neonatal intensive care units in providing consistent and individualised monitoring and nutrition interventions for preterm infants (Sneve *et al.*, 2008).

## **2.6 Summary**

Preterm infants are a unique population of neonates with specific nutrient requirements to support optimal growth and to reduce risk of complications. Underdeveloped gastrointestinal systems and poor motor skills, seen in both early and late preterm infants, make feeding these infants difficult (Harding *et al.*, 2013). This results in inadequate nutrient intakes with subsequent poor growth progression.

With increasing rates of preterm birth and rising rates of late preterm birth, provision of nutrients and growth are important to monitor to provide optimal outcomes for

these infants. Research is lacking in regards to feeding and growth outcomes in preterm infants globally and within New Zealand. Maternity monitoring groups are also calling for more research on preterm infants admitted to New Zealand DHBs (National Maternity Monitoring Group, 2013). Therefore this study will investigate feeding practices occurring within SCBU at Whangarei hospital, by observing the modes, types, and duration of feeding during admission and at discharge. Growth outcomes in preterm infants during admission and at discharge will be collected and analyzed through Z-scores to assess the risk and incidence of growth faltering in preterm infants admitted to SCBU. Achieving the overall aim aids in identifying areas for improvement within SCBU in relation to feeding practices and nutritional monitoring which have the potential to improve growth outcomes.

## **Chapter 3: Methods**

### **3.1 Study Design**

The aim of this retrospective study was to assess the feeding practices, growth outcomes and nutritional monitoring of preterm infants admitted to the Special Care Baby Unit at Whangarei Hospital in New Zealand.

### **3.2 Ethical Approval**

Ethical approval was gained from the Human Disabilities Ethics Committee (HDEC): Northern A Health and Disabilities Committee (14/NTA/29, application approved 28/03/2014 Appendix A). Peer review of the protocol was undertaken at the locality by Eruera Maxted (Senior Dietetics Advisor, NDHB). Permission was granted at the locality from Dr. Michael Roberts (Chief Medical Officer, Northern District Health Board (NDHB) (Appendix B).

Ethical approval through HDEC was mandatory as data collection required a student (Masters in Nutrition and Dietetics) to gain access to confidential medical information regarding preterm infant's admission and their clinical care whilst in SCBU. Consent was not gained from participants or parents/ guardians as data were collected retrospectively from medical and electronic notes without the direct involvement of participants. Therefore, HDEC approval included the provision that the Masters student could access the medical and electronic notes without patient consent, under supervision from a clinical supervisor (Mary McNab, Senior Dietitian Paediatric Services).

#### **3.2.1 Consultation**

Consultation with neonatal paediatricians, nursing and administration staff was conducted to form a relationship with the Whangarei hospital community. Through this engagement, the research was understood and well received by the staff working within SCBU. Māori consultation was undertaken with Eruera Maxted to identify any cultural aspects that needed to be considered in this study.

## **3.3 Study Population**

### **3.3.1 Setting**

Whangarei hospital is the largest hospital in Northland (246 beds) and treats acute and chronic conditions to all of Northland. The SCBU unit is located adjacent to the maternity ward at Whangarei hospital with a total of 8 cots. The unit offers close medical monitoring and treatment for preterm and full term infants who are critically ill and aid in establishment of feeds and maternal care (Northland District Health Board, 2012b). Although SCBU is classed as a tertiary care unit, it is defined as a low dependency unit with infants who are severely unwell or born at less than 32 weeks' gestation potentially transferred to the Neonatal Intensive Care Unit (NICU) at Auckland District Health Board or to the NICU at Counties Manukau District Health Board. Referral to NICU is under the paediatrician's direction and infants are transferred back to SCBU when stable.

### **3.3.2 Eligibility**

Infants were eligible for the study if they were preterm (born at less than 37 weeks' gestation) and admitted to the SCBU at Whangarei Hospital for at least 3 days.

### **3.3.3 Justification of Retrospective Study Period**

Previous research which has retrospectively collected data on feeding practices of preterm infants in a hospital setting has used periods of at least 1 year duration (Cormack & Bloomfield, 2006; Simmer, Metcalf, & Daniels, 1997). In order to capture a representative period of SCBU, it was decided that the data collection period should run over at least one calendar year of admissions. As the study commenced in March 2014, data were collected retrospectively until January 2013.

### **3.3.4 Recruitment of Participants**

The study did not require direct recruitment of participants as data were collected retrospectively from medical notes, discharge summaries, and electronic records. The admission book located on SCBU provides a record of the patient's details, date of birth and date of admission for all infants admitted to the unit. The admissions book did not specify the length of stay or gestational age of the infants. Therefore all medical notes for the infants admitted to SCBU during the specified time period, were recalled from the documents release office and screened by the researcher for eligibility by ensuring the infant was <37 weeks' gestation at birth and remained on the unit for 3 days or more. All eligible infants were then recorded on a log sheet.

A record of the number of infants screened during this process was kept which included term infants, infants for whom admission was less than 3 days and infants who were readmitted so that all infants admitted during this period were accounted for. Medical notes that were unattainable due to readmission or outpatient clinics were recalled for a further three attempts but were excluded if unattainable by the third recall. All participants were de-identified and only identified by a research identification number (ID) throughout the recruitment process to maintain confidentiality.

### **3.4 Data Collection Procedure**

Data collection included collecting data from medical records which contains drug charts, feeding charts, growth charts and discharge summaries. Nursing notes were contained within the medical notes which recorded a day by day account of the infants medical status including observations (temperature, skin colour, glucose levels) and also notes from other medical professionals (speech language therapist, dietitian, lactation consultants). Demographic information of the infant was sourced from the medical notes including gestational age, gender, reason for admission to SCBU and birth measurements. Maternal demographic data were also collected from medical notes. A day by day record of method and type of feed, amount of feds' and breastfeeding progress was collected from medical and nursing notes. Growth progress was collected from the growth charts and from the growth grid (Appendix C) which is a graph used to plot infants weight every second day on SCBU (the rationale for using the growth grid is that it provides a more visual representation of body weight than the WHO growth charts). An electronic data base known as Concerto was also utilised during data collection. The electronic database displays details of a patient's medical progress from admission to discharge including discharge summaries, inpatient/outpatient encounters and biochemical laboratory results. Concerto also recorded all hospital encounters which allowed identification of infants that were transferred to a different DHBs for ongoing medical interventions.

Length of SCBU admission was defined as days of admission to SCBU, whilst length of hospital admission was defined as total days hospitalised including days spent at other DHBs. As monitoring was an important component of this research, "NR" (not recorded) was used to symbolise data that was not recorded or recorded incorrectly within medical notes, nursing notes or electronic notes.

## **3.5 Data Collection**

### ***3.5.1 Demographic Data Collection***

Demographic data were collected to describe the characteristics of the infants recruited to the study. The demographic questionnaire (Appendix D) collected gestational age at birth, gender, single or twin births and length of admission to SCBU.

### ***3.5.2 Maternal Demographic and Health Status Information***

Neonatal health outcomes are closely related to maternal health and data were collected on the characteristics of the mothers. Maternal demographic data included ethnicity, maternal age, pregnancy complications and smoking status during pregnancy. Data were collected on the total number of previous pregnancies (Gravida) and the total previous pregnancies >20 weeks' gestation (Para).

## **3.6 Feeding Data**

Collection of feeding data were essential to analyse the feeding practices of each infant. Daily feeding charts (Appendix E) recorded during SCBU admission are collated after hospital discharge and inserted into one section of the medical files. The charts display all feeding details including prescribed fluid intake, mode of feeding and amounts of fluid intake per day. One day was defined from 12pm- 12pm the following day and all feeding charts recorded date, and intake throughout the day. All recorded feeding information was collected day by day for each included infant. The data displayed on the feeding charts was used to gain breastfeeding practices, enteral feeding practices and other modes of feeding.

### ***3.6.1 Breastfeeding***

Breastfeeding data were collected from the feeding charts located within the medical files of each infant. Days after birth were used to measure initiation of breastfeeding. Nurses record the day breastfeeding had begun, as well as all breastfeeds during the day by recording time of breast feeds along with any top up's (expressed breast milk or formula used to meet full feed requirements when breastfeeding was not sufficient), that were administered following breastfeeding. Staff within SCBU utilise breastfeeding codes to describe the progression of breastfeeding ranging from A through to F.



- A. Offered the breast, not interested/sleepy
- B. Interested in feeding, however does not latch
- C. Latches onto the breast, however comes on and off or falls as asleep.
- D. Latches, however sucking is uncoordinated or has frequent long pauses.
- E. Latches well, long slow rhythmical sucking and swallowing - Short feed.
- F. Latches well, long slow rhythmical sucking and swallowing - Long feed.

The breastfeeding code provides guidance for SCBU staff for breastfeeding progression. Every breastfeed for each infant should have a code denoted to it (A-F) and should be recorded in feeding charts. Nursing staff should then monitor progress to ensure the infant is developing breastfeeding skills or to recognise cues that breastfeeding is not progressing as recommended and therefore additional nutrition support is required. Nutritional support may be provided through mixed feeding (breast +bottle feeds) or the infant may require additional supplements or fortifiers to support growth.

### ***3.6.2 Enteral Feeding***

Guidelines for enteral feeding in SCBU were based on protocols from ADHB (Auckland District Health Board National Womens, 2012). Infants within SCBU were fed via enteral routes when breast feeding was contradicted or for infants who required nutritional support in addition to breastfeeding. The day enteral feeding was initiated and ceased was recorded. The number of days the infant was enterally fed and the time it took to reach full enteral feeding volumes, was also recorded. Full enteral feeds was defined at reaching 180 mls per kg per day as specified in the National Women's Neonatal (Auckland District Health Board National Womens, 2012).

### ***3.6.3 Method of Feeding on Discharge***

Method of feeding on discharge was also recorded to assess feeding progress during SCBU admission and to gain an overview of methods and types of feeding for preterm infants at hospital discharge. These were recorded in the feeding charts by nurses and checked against the mode of feeding recorded in the discharge summary or in clinical notes by paediatricians. The method of feeding (breast, bottle or tube) was recorded as well as the type of feed (breast, formula or mixed). Exclusive breastfeeding was defined as an infant feeding directly from the breast of the mother



with no other nutrition support provided. Mixed feeding was classed as a combination of EBM and formula.

### **3.7 Growth Data**

Birth measurements were recorded, including birth weight, birth length and birth head circumference which were all displayed (if the infants was measured) in the birthing records section of the medical notes. Birth weight was also displayed on the feeding charts with the amount of net weight gain or loss recorded since birth which was checked during data collection if weight was not recorded on growth charts. Weights are recommended to be done every second day according to the SCBU protocol which is adopted from Auckland DHB (ADHB) newborn services clinical guidelines for admissions into NICU (Auckland District Health Board National Womens, 2012). Ongoing weight, head circumference and length during admission were continually recorded on feeding charts but also displayed on the growth grid or on the WHO growth charts. If growth measurements were unattainable during data collection, or if growth data was not recorded within the infants medical files, then an “NR” was noted to indicate that the data was not recorded.

### **3.8 Medical History and Events during Admission**

In addition to feeding and growth data, a brief medical history of the infant was collected and the reason for admission to SCBU was collected. This data provided an insight into the reason behind the prescribed feed (EBM vs. formula) and the method of feeding (bottle, tube feeds or breast) as medical conditions can affect feeding tolerance.

### **3.9 Standard Operating Procedure for Data Collection from Medical Notes**

To ensure data collection was gathered in a uniform manner as well as to ensure the collection was robust, the following standard operating procedure (SOP) was adhered to. All medical information required for data collection was obtained from medical files tracked to the researcher via the medical release office. All admissions between the required dates were screened for eligibility and logging of infants who met or did not meet the criteria was recorded. Demographic information was documented on the demographic questionnaire (Appendix D). Numerical data were recorded on a spreadsheet under the research ID with daily records documented under the study day (days of admission to SCBU). Data collected from the medical files included

demographic information, prescribed fluids, prescribed supplements or fortifiers, feeding amounts, feeding method and growth progress during admission to SCBU. The medical notes were also utilised to gain an overview of the medical progress of the infant and also to record the feed type and method on discharge.

During data collection, if data were missing or if the required data were not recorded in the medical or electronic notes of the infant then other documentation were searched to identify the missing data. This was to ensure all attempts to collect complete datasets was achieved and to ensure consistency. This included searching other areas of the infant's medical notes including nursing notes, admission or discharge summaries and outpatient notes. In addition to medical notes, the electronic database was also searched to find missing data including searching general practitioner (GP) letters, community notes and other letters or summaries compiled from admissions to other DHBs. Further attempts were made to find missing data through consultation with the NDHB clinical supervisor, Mary McNab who attempted to seek out data that was not clearly recorded.

### **3.10 Statistical Analysis**

Collected data were statistically analysed using IBM SPSS statistics for Windows version 21 (IBM CORPORATION, New York, USA).

Descriptive statistics were used to describe the study population. Infants were further stratified into extremely premature ( $\leq 32$  weeks) or moderate to late premature ( $> 32$  weeks) groups.

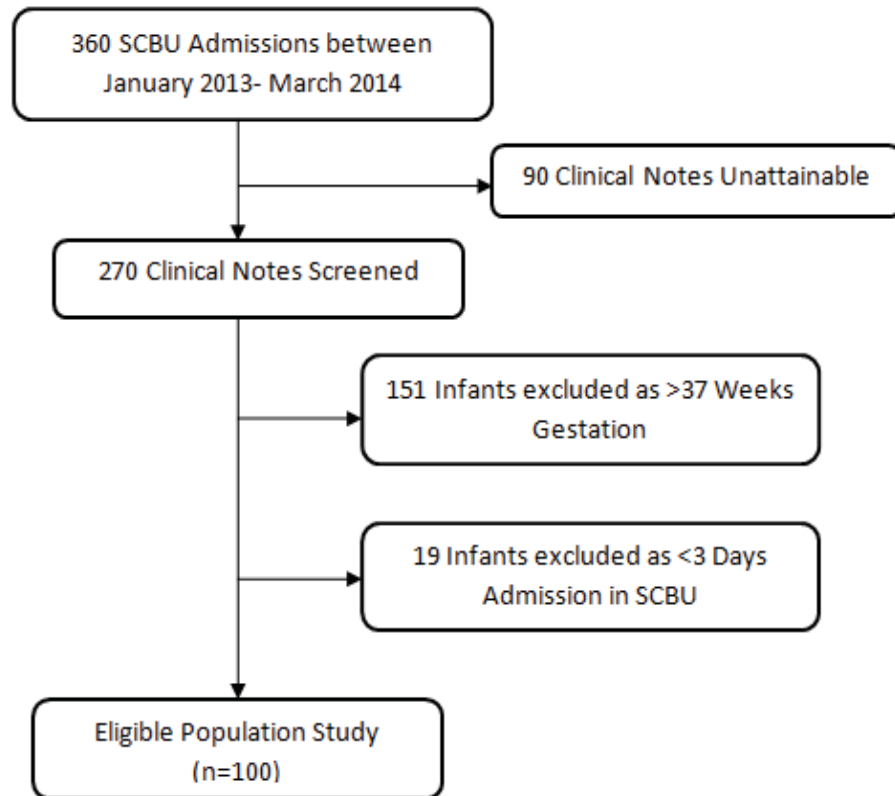
The variables were tested for normality using the Kolmogorov-Smirnov, Shapiro-Wilk tests, and normality plots. Data is appropriately expressed as mean (standard deviation (SD)) if normally distributed, geometric mean (95% confidence interval (CI)) if log-transformed, medians (25, 75 percentiles) if non-normally distributed data, or frequencies.

Z scores were calculated using UK-WHO data and used as standardised quantities to compare weight, length and head circumference at birth and discharge against the distribution of the reference population. Pearson's chi-square ( $\chi^2$ ) and Mann Whitney was used to examine differences between groups. Where the group sizes were too small, and the assumptions for  $\chi^2$  were not met, Fisher's exact test was used. A significance level of  $P < 0.05$  was taken as statistically significant.

## Chapter 4: Results

### 4.1 Description of Participants

**Figure 4.1** details the recruitment of preterm infants into the study through to the final number of infants used for data analysis.



**Figure 4.1:** Flow Diagram Displaying the Final Participant Numbers included in the Study

During the study period 360 infants were admitted to SCBU, 90 medical notes were unattainable due to infants being readmitted, booked out to outpatient clinics or the notes were transferred to a different District Health Board (DHB). Of the 270 medical notes which were available for screening, 151 infants were not preterm (born at less than 37 weeks' gestation) and 19 infants were admitted to the unit for less than 3 days (**Figure 4.1**). The final number of infants who met the eligibility criteria and were included in the final data analysis was 100.

## 4.2 Characteristics of Participants

The characteristics of the infants included in the study are shown in **Table 4.1**.

**Table 4.1:** Characteristics of Preterm Infants included in the Study

Characteristics	n=100	Range
Gestational Age at Birth Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	Days: 245 [231, 257] Weeks: 35 [33, 36]	Days:175 – 258 Weeks: 25 – 36.8
Degree of Prematurity n (%) ≤32 weeks gestation >32 weeks gestation	14 (14) 86 (86)	
Birth Weight (g) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	2227 [1867, 2625]	660 – 3700
Birth Weight n (%) >2500g LBW <2500g VLBW <1500g ELBW <1000g	31 (31) 59 (59) 7 (7) 3 (3)	
Birth Length (cm) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	45.8 [42.4, 47.8]	32.5 – 53.0
Birth Head Circumference (cm) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	31.5 [30, 33]	24 – 37
Gender n (%) Males Females	57 (57) 43 (43)	
Singleton n (%) Twin n (%)	74 (74) 26 (26)	
Length of Stay in SCBU (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]  ≤32 weeks gestation >32 weeks gestation	14 [6, 24]  30.5 [27, 39] 10.5 [6, 21]	3 – 56  8 – 56 3 – 51

Characteristics	n=100	Range
Length of Stay in Hospital (days) n=79*		
Median [25th, 75th percentiles]	15.0 [7, 24]	3 – 142
≤32 weeks gestation	52.5 [32, 94]	7 – 142
>32 weeks gestation	14 [6, 23]	3 – 61
Birth Location n (%)		
Whangarei Hospital	80 (80)	
Auckland City Hospital	10 (10)	
Home	5 (5)	
Kaitaia hospital	2 (2)	
North Shore Hospital	1 (1)	
Other	2 (2)	
Reason Admitted To SCBU n (%)		
Hypoglycemia	23 (23)	
LBW/ Premature	16 (16)	
Observation	14 (14)	
Respiratory Distress Syndrome	47 (47)	
Discharged Location n (%)		
Home	79 (79)	
Whangarei Hospital Ward	2 (2)	
NICU ADHB	9 (9)	
Other	10 (10)	

\* n=79 as 21 infants transferred to other clinical facilities at discharge.

#### 4.2.1 Infants Age and Weight at Birth

The study population had a median [25<sup>th</sup>, 75<sup>th</sup> percentiles] age of 245 days or 35 [33, 36.8] weeks' gestation at birth (**Table 4.1**). The youngest infant was 25 weeks' gestation and the eldest 36 weeks' gestation. The majority of the study population (86%) were classed as moderate to late preterm infants (born at >32 weeks' gestation) with 14 (14%) infants born ≤32 weeks' gestation. The number of infants within the moderately preterm category (32-33 weeks' gestation) was 34 and 52 infants were late preterm (34-36 weeks' gestation). The median [25<sup>th</sup>, 75<sup>th</sup> percentiles] birth weight for all infants was 2227g [1867, 2625], with a range of 660 – 3700g.

#### **4.2.2 Characteristics of Infants requiring Neonatal Intensive Level of Care**

Of the 14 infants classed as  $\leq 32$  weeks' gestation, 6 were born under Auckland District Health Board (ADHB) and 8 at Whangarei hospital. All 14 infants  $\leq 32$  weeks included in this study were transferred to the Neonatal Intensive Care unit (NICU) at ADHB immediately following birth and then transferred to back SCBU once medically stable. Median day's after birth that infants were transferred to SCBU from ADHB was 24 days with a maximum of 104 days (**Table 4.1**).

#### **4.2.3 Length of Stay in Hospital**

Nearly 50% of infants were referred to SCBU due to respiratory distress syndrome, followed by hypothermia (23%). The median length of stay within SCBU was 14 [6, 24] days, with a maximum stay of 56 days. Median length of total hospitalisation was 15 days with a range of 3 - 142 days. Infants  $\leq 32$  weeks had significantly longer hospitalisation compared with infants  $> 32$  weeks with a median difference of 20 days ( $P < 0.001$ ) (**Table 4.1**). The duration of hospital stay could not be determined in 21 infants as they were discharged to other clinical facilities for ongoing care.

#### **4.2.4 Discharge Location**

The majority (n=79) of infants admitted to SCBU were discharged home. The remaining infants (21) were transferred to other clinical facilities.

#### **4.2.5 Maternal Demographics**

Over half of the mothers identified as New Zealand Māori (56.3%) with 36.5% New Zealand European and 7.3% of other ethnicities. Mother's age ranged from 17 to 43 years, with a median age of 27 years. Of the 96 mothers, 38 (39.6%) smoked during their pregnancy (**Table 4.2**).

**Table 4.2: Maternal Characteristics for the Infants included in the Study**

<b>Maternal Characteristics</b>	<b>n= 96</b>	<b>Range</b>
Maternal Age (years) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	27 [23, 33]	17 – 43
Maternal Age (years) n (%)		
<20	3 (3.1)	
20 - 29	55 (57.3)	
30 - 40	35 (36.5)	
>40	3 (3.1)	
Maternal Ethnicity n (%)		
NZ Māori	54 (56.3)	
NZ European	35 (36.5)	
Asian	2 (2.1)	
Other European	2 (2.1)	
Other	3 (3.1)	
Maternal Smoking Status n (%)		
No	57 (59.4)	
Yes	38 (39.6)	
Not Recorded	1 (1.0)	

### **4.3 Types and Mode of Feeding during SCBU Admission**

#### **4.4 Breastfeeding**

##### **4.4.1 Breastfeeding Initiation during SCBU Admission**

Breastfeeding was initiated in 83% of the infants. Of the mothers of infants  $\leq 32$  weeks' gestation (n=14), 57.1% (n=8) initiated breastfeeding which was significantly lower compared to 87.2% (n=75) in mothers of infants  $>32$  weeks (n=88) ( $P<0.001$ ). There was no difference in breast feeding initiation between male and female infants (84.2% vs. 81.4% respectively,  $P=0.79$ ). A higher proportion of mothers of singleton births initiated breastfeeding (71.2%), compared with mothers of twin births (28.9%) but this was not significant ( $P=0.23$ ).

Comparing breast feeding initiation rates between mothers 20-29 years of age compared to mothers 30-39 years of age, there was a significant difference 59% vs.

32.8%, respectively ( $P < 0.001$ ). The other 2 age groups were not compared due to their low numbers,

#### 4.4.2 Days to Initiate Breastfeeding

Breast feeding initiation ranged from immediately after birth to 65 days (**Table 4.3**). Infants  $\leq 32$  weeks' gestation commenced breastfeeding significantly later than infants  $> 32$  weeks' gestation ( $P = 0.01$ ).

**Table 4.3:** Breastfeeding Initiation and Days to Initiate Breastfeeding during SCBU Admission

Breastfeeding Rates in SCBU	Rates of Breastfeeding n (%)	Days to Initiate Breastfeeding Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	Days to Initiate Breastfeeding Range	P-Value
Infants Breastfed During Admission	83 (83)	1.0 [0.0, 3.0]	0 – 65	
$\leq 32$ weeks (n=14) $> 32$ weeks (n=86)	8 (57.1) 75 (87.2)	14.5 [4.3, 34.8] 1.0 [0.0, 3.0]	0 – 65 0 – 21	$< 0.001^*$
32 - 33 weeks (n=34) 34 - 36 weeks (n=52)	20 (76.9) 55 (91.7)	1.4 [0.0, 7.5] 1.0 [0.0, 2.0]		0.01*

\* Significant difference between groups  $P < 0.05$  (Fisher's Exact Test)

## 4.5 Types and Modes of Feeding at Discharge

### 4.5.1 Breastfeeding and Mode of Feeding at Discharge

Of the 79 infants discharged home the majority received breast milk (73.4%), with 67.1% exclusively breastfeeding. Eleven infants born  $\leq 32$  weeks' gestation were discharged home. Of these infants 54.2% (n=6) were exclusive breastfeeding at discharge. Sixty eight Infants born  $> 32$  weeks were discharged home, 76.5% were exclusive breastfeeding (n=52).

Of the remaining infants discharged home, 13.9% were mixed fed and 12.7% were exclusively formula feeding.



#### 4.5.2 Breastfeeding Codes at Discharge

Of those infants that were breastfeeding on discharge, the breastfeeding code displayed for the final 24 hours of discharge was collected. The majority of infants 73.9% (51 infants were classed as having breastfeeds of “F” (latches well, long slow rhythmical sucking and swallowing - Long feed) in. The remaining 26.1% (19 infants) had breastfeeds classed as “E” (Latches well, long slow rhythmical sucking and swallowing - Short feed).

#### 4.6 Enteral Feeding

Seventy-six of the 100 infants received enteral nutrition during admission to SCBU. The median number of days on enteral feeding was 11 days, with a range of 1 to 35 days.

**Table 4.4:** Number of Days Preterm Infants Received Enteral Feeding

Age Category	Days Enterally Fed Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles] (days)	Range (days)
All Infants	11.0 [5.0, 20.0]	1 – 35
≤32 weeks (n=12)	25.0 [20.3, 30.3]	16 – 35
>32 weeks (n=64)	9.0 [4.0,18.0]	1 – 32

##### 4.6.1 Types of Enteral Feeds

The majority of infants who were enterally fed received expressed breast milk with mixed feeding also commonly used for enteral feeding (**Table 4.5**). Of the 12 infant’s ≤32 weeks’ gestation, 5 were receiving expressed breast milk for enteral feeds (**Table 4.5**). Of these infants, 4/5 infants received fortified breast milk for enteral feeding and 1 infant received unfortified expressed breast milk.

**Table 4.5: Type of Feeding used for Initiation of Enteral Feeding**

Type Feeding used for Enteral Feeds	All Infants (n=76)	≤32 weeks' gestation (n=12)	>32 weeks' gestation (n=64)
Expressed Breast Milk	45 (59.2)	5 (41.7)	40 (62.5)
Formula	3 (3.9)	2 (16.7)	1 (1.6)
Mixed Feeds (Breast Milk + Formula)	28 (36.8)	5 (41.7)	23 (35.9)

#### 4.6.2 Days to Reach Full Enteral Feeding Volumes

Infants reached full enteral volumes at a median day of 7, with a range of 2 to 11 days. Twenty two infants that were enterally fed did not achieve full enteral feeding during admission.

**Table 4.6: Median Days to Reach Full Enteral Feeding Volumes**

Days to Reach Full Volume Enteral Feeds <sup>a</sup>	Median [25 <sup>th</sup> , 75 <sup>th</sup> percentile] (days)	Range (days)
All Infants n=54 <sup>b</sup>	7.0 [7.0, 8.0]	3 – 11
>32 weeks n=42	7.0 [7.0, 8.0]	6 – 11

<sup>a</sup> Full enteral feeds classed as 180 mls/kg/day

<sup>b</sup> 54 infants reached full enteral feeding volumes

<sup>c</sup> Not reported for infants <32 weeks as full enteral feeding volumes achieved at NICU at ADHB

## 4.7 Growth

### 4.7.1 Days to Regain Birth Weight

Seventy nine infants were discharged home from SCBU whilst 21 infants were referred to other clinical facilities. Forty seven out of the 79 infants discharged home regained their birth weight prior to discharge. Median [25<sup>th</sup>, 75<sup>th</sup> percentile] day to regain birth weight was 8 [5, 12] with a range of 1 to 28 days.

Infants who were ≤32 weeks' gestation at birth regained their birth weight significantly earlier compared with infants born at >32 weeks' gestation (median 3 days versus 8 days respectively,  $P=0.03$ ).

#### 4.7.2 Postnatal Growth of Preterm Infants Prior to Discharge

The mean±SD weight z-score at birth was  $-0.02\pm 1.13$ , decreasing to  $-0.51\pm 1.29$  at discharge. The mean change in z-score between birth and discharge  $-0.49\pm 0.16$  was significant ( $P=0.01$ ) (Figure 4.2).

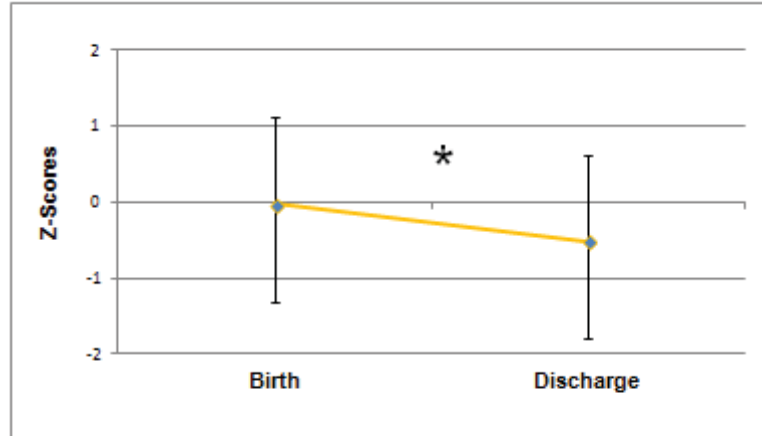


Figure 4.2: Z-scores for Weight at Birth and Discharge

There was an increase in weight z-score ( $>1$  z-score) between birth and discharge in 15 infants (18.5%). The z-score declined by 0 to -1 in 47 infants (58%), by  $>-1$  to -2 in 17 infants (21%), and by more than -2 Z-scores in 2 infants (2.5%).

Comparing infants who decreased  $\geq 1$  z-score with infants who increased Z-scores or decreased  $<1$  z-score, there was a significant difference between weight at discharge ( $P=0.04$ ) (Table 4.7). As a group, there was no significance of gestational age ( $P=0.22$ ) or birth weight with change in Z-scores ( $P=0.64$ ). Of the infants decreasing by  $>1$  z-score, the majority were enterally fed during admission (18 infants) with majority also initiating breastfeeding (18 infants) and breastfeeding upon discharge (18 infants) (Table 4.7).

**Table 4.7:** Comparison of Characteristics between Infants who Decreased  $\geq 1$  z-score with infants who increased in Z-scores between Birth and Discharge

Characteristics	Decreased by $\geq 1$ Z-Score (n=19)	Did not decrease $>1$ Z-Score (n=62)	P-Value
Gestational Age at Birth Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	Days: 238 [229, 244] Weeks: 34 [32.7, 34.8]	Days: 245 [229, 254] Weeks:35 [32.7, 36.3]	0.22
Degree of Prematurity n (%)			0.15
$\leq 32$ weeks	1 (5.3)	12 (19.4)	
$>32$ weeks	18 (94.7)	50 (80.6)	
Birth Weight (g) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	2060 [1950, 2360]	2077 [1695, 2486]	0.64
Discharge Weight (g) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	2355 [2205, 2800]	2607 [2243, 2822]	0.04*
Length of Admission to SCBU (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	21 [11, 25]	17 [9, 27]	0.32
Length of Hospitalisation (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	22 [16, 24.5]	19 [9, 31]	0.45
Breastfeeding Initiated (n %)			
Yes	18 (94.7)	51 (82.3)	
No	1 (5.2)	11 (17.7)	
Enteral Feeding (n %)			
Yes	18	54	
No	1	8	
Method of Feeding at Discharge (n %)			
Exclusive Breastfeeding	18 (94.7)	43 (69.4)	
Mixed Feeding	0 (0)	10 (16.1)	
Exclusive Formula	1 (5.2)	9 (14.5)	

\* Significant difference between groups  $P < 0.05$  (Mann-Whitney Test)

### **4.7.3 Head Circumference and Length Z-Scores**

All infants had head circumference and length measured at birth. Forty one out of the 100 infants had measurements recorded at discharge. Therefore, Z-scores for head circumference and length could not be calculated for all infants. Due to the missing data, characteristics of the infants were examined to identify whether differences existed between infants with recorded measures at discharge (n=41) and those without (n=59).

Infants with head circumference and length recorded at discharge were significantly younger with a median age of 238 days (34 weeks) at birth ( $P<0.001$ ). At birth these infants had significantly lower birth weights and were admitted to SCBU for a longer period of time ( $P<0.001$ ). **(Table 4.8).**

**Table 4.8:** Characteristics of infants with and without measures of Head Circumference and Length at Discharge

<b>Characteristics</b>	<b>Infants with Measures at Discharge (n=41)</b>	<b>Infants without Discharge Measurements (n=59)</b>	<b>P-Value</b>
Gestational Age at Birth Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	238 [224.5, 244.5]	253 [238, 257]	<0.001*
Birth Weight (g) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	1935 [1600, 2257.5]	2450 [2060, 2825]	<0.001*
Discharge Weight (g) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	2545 [2205, 2825]	2580 [2268.8, 2768.8]	0.78
Length of Admission to SCBU (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	21 [15, 27]	8 [5, 20]	<0.001*
Length of Hospitalisation (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	23 [16.5, 30.5]	9 [5, 21]	<0.001*
Day HC and Length were recorded (days) Median [25 <sup>th</sup> , 75 <sup>th</sup> percentiles]	11 [6.0, 19.5]		

\* Significant difference between groups  $P < 0.05$  (Mann-Whitney Test)

#### 4.7.4 Z- Scores for Head Circumference and Length

For infants who had head circumference and length reported at discharge (n=41), there was a mean change of  $0.27 \pm 0.48$  and  $0.18 \pm 0.13$  respectively (**Figure 4.3** and **Figure 4.4**).

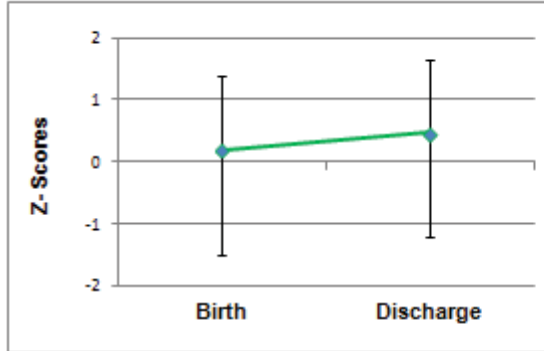


Figure 4.3: Z-scores for HC at Birth and Discharge

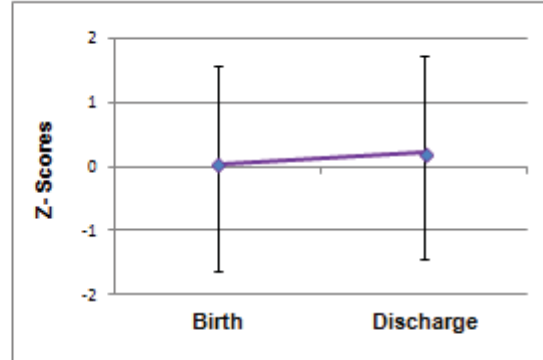


Figure 4.4: Z-scores for Lengths at Birth and Discharge

Of the infants that decreased by  $>1$  z-score between birth and discharge weights (n=19), 13 infants had head circumference measurements at discharge. In these 13 infants, head circumference decreased by  $-0.28 \pm 0.05$  between birth and discharge. In the infants decreasing by  $>1$  z-score, length was recorded in 11 infants at discharge with an overall decrease in z-score by  $-0.57 \pm 0.24$ .

## 4.8 Monitoring and Referral

### 4.8.1 Monitoring of Feeding

During data collection it was observed that the type of formula (term or preterm) was not recorded on feeding charts. The brand of formula was also not recorded.

### 4.8.2 Growth Monitoring

Weights were recorded every second day in 60 of the infants, with 79 infants having two or more weights recorded during admission to SCBU. Length and head circumference measurements were recorded at least once in 41 infants, with 59 infants having no record of length or head circumferences at discharge.

In addition, 21 infants discharge weights were not recorded in medical notes or on discharge summaries. Therefore, only 79 infants had recorded discharge weights for data analysis.

#### ***4.8.3 Referral to Dietetic Services during Admission***

Out of the 100 infants included for final analysis, only 6 premature infants were referred to dietetic services during SCBU admission. Ninety-four infants had no evidence of dietetic referral during SCBU admission. Of the 6 referrals, 3 were referred for feeding difficulties, 2 for growth issues and 1 for allergies.



## Chapter 5: Discussion

This is the first study to explore the feeding practices and growth of preterm infants admitted to the SCBU at Whangarei hospital in New Zealand. It was positive to identify that the preterm infants had high rates of breast feeding initiation and nearly 75% were receiving some milk on discharge. However, prior to discharge nearly 20% could be identified at risk of growth faltering which is of concern.

### 5.1 Study Population Characteristics

As expected the majority of the study population (86%) were moderate to late premature. The SCBU is classed as a low dependency tertiary unit and infants born at less than 32 weeks' gestation are routinely transferred to NICU for high dependency monitoring and transferred back to SCBU once medically stable. The number of infants who met this criteria for being transferred was small (n=14) and the results for these infants need to be interpreted in the context of their longer NICU admission prior to SCBU.

Late preterm infants (especially between 34-36 weeks' gestation) have been highlighted as a priority population due to their increasing prevalence within New Zealand and worldwide. The need for more research around the incidence of late preterm birth and postnatal care has been identified as an area of priority (National Maternity Monitoring Group, 2013). The median birth weight for the preterm infants was 2227g with a minimum of 660g and a maximum of 3700g birth weight. Over half (59%) were classed as low birth weight (LBW).

The majority of the mothers identified themselves as New Zealand Māori (56.3%) and over half of them were between 20-29 years of age. Characteristics of the mothers are reflective of the Northland population as Māori residents make up 30% (approximately 47,748 residents) of the Northland population. Thirty nine percent (39.6%) of mothers smoked during pregnancy. New Zealand maternity reports have shown a total of 16.2% of mothers smoked during pregnancy in 2010 with higher rates seen in Māori mothers (Ministry of Health, 2012). Previous reports for NDHB have highlighted smoking cessation during pregnancy as a target for health promotion (Bailey, 2013); however, no statistics have been reported previously on the prevalence of smoking during pregnancy in Northland mothers.

## **5.2 Types and Mode of Feeding during SCBU Admission**

### **5.2.1 Breastfeeding Initiation**

Of the 83 mothers that initiated breastfeeding within this study, 8 infants were  $\leq 32$  weeks' gestation and 75 infants were  $>32$  weeks' gestation. The lower breastfeeding initiation rates for preterm infants are well documented in the literature (Donath & Amir, 2008; Meyerink & Marquis, 2002; Pot *et al.*, 2012). Lower rates were also found within SCBU despite the fact that NDHB have high rates of breastfeeding at discharge at 94.3% (term and preterm combined) in 2011 (Bailey, 2013). Northland District Health Board have adopted the Baby Friendly Community Initiative (BFCl) since 2011 aiming to increase exclusive breastfeeding and duration of breastfeeding in Northland (Bailey, 2013). Breastfeeding rates have been shown to be steadily increasing in healthy term infants (Bailey, 2013); however, no statistics have been published in regards to breastfeeding initiation in preterm infants within Northland. The findings from this study contribute to the body of evidence which has identified that rates of breastfeeding initiation are lower in preterm infants.

All the infants born  $\leq 32$  weeks' gestation were transferred to NICU at ADHB after birth and transferred back to SCBU once medically stable. National Women's hospital in Auckland reported 60% of mothers initiated breastfeeding during NICU admission in 2012, with mothers of infants of greater prematurity unlikely to initiate or persist with breastfeeding (Pot *et al.*, 2012). Despite the travel required between Whangarei to Auckland, these infants managed to meet the breastfeeding rates reported by NICU with over half of the mothers managing to initiate breastfeeding. In fact all of the mothers within this study resided in Northland. All the mothers that managed to initiate breastfeeding travelled with their baby from Whangarei to Auckland. Despite lower breastfeeding rates in early preterm infants, it is encouraging that over half managed to initiate breastfeeding in these difficult circumstances.

#### *5.2.1.1 Maternal Factors Influencing Breastfeeding Initiation*

A large body of evidence has shown mothers age to be positively correlated with breastfeeding initiation (Chalmers *et al.*, 2009; Epsy & Senn, 2003). New Zealand data have shown similar trends with mothers  $<21$  years having lower breastfeeding initiation and mothers between 31-35 years with higher breastfeeding initiation across a 9 year period (Pot *et al.*, 2012). No NDHB data related to the age of the mother and breastfeeding initiation has been reported for term or preterm infants. This study

showed mothers between 20-29 years of age were significantly more likely to initiate breastfeeding (59.5%) followed by mothers 30-39 years (32.8%) ( $P=0.001$ ).

These findings could be due to mothers >30 years of age having more work commitments and other children to care for, thus breastfeeding continuation may not be feasible or a priority. Literature supported this notion that mothers with work commitments have lower rates of breastfeeding initiation and continuation (Fein & Roe, 1998; Noble, 2001). These results potentially highlight mothers >30 years of age as a group requiring further breastfeeding support during admission and upon discharge. Exploring the barriers associated with breastfeeding within this group is also important as decreased breastfeeding could be due to numerous factors which need to be identified; however, it was beyond the scope of this study.

Mothers with previous children have been shown to be more likely to breastfeed in literature (Trajanovska *et al.*, 2007). Within SCBU, 62.7% of mothers with previous births initiated breastfeeding compared with 37.3% breastfeeding in mothers with no previous pregnancies. This finding was not significant but an interesting finding. These results were to be expected as mothers with previous children are proposed to be more prepared, confident and aware of what to expect with breastfeeding due to prior experience. Greater research is needed in this area to identify mothers without previous children as a group at risk of poor breastfeeding initiation within SCBU.

Ethnicity and cultural beliefs is a further factor impacting upon a mother's decision to breastfeed. Low breastfeeding rates have been reported in Māori and Pacific cultures with shorter duration of breastfeeding (Glover *et al.*, 2009). There is limited statistics on breastfeeding in Māori particularly in Northland due to the disparity between maternity units. The SCBU results show 57% of mothers who recognised as Māori initiated breastfeeding. This was a positive finding but was expected as over half of the mothers within this study identified as Māori (56.3%,  $n=54$ ).

These results provide a snapshot into breastfeeding rates for Māori mothers with preterm infants in Northland. These results taken together with literature are positive findings but to enhance rates and to encourage prolonged breastfeeding following discharge, policies need to be put in place to provide optimal support for all mothers of different cultural backgrounds especially for Māori as they make up majority of the Northland population.

## **5.3 Types and Mode of Feeding at SCBU Discharge**

At the time of discharge, the type of feeding infants are discharged on is important to ensure the infants have developed feeding skills to support the growth and development of the preterm infant (Jefferies, 2014). Upon discharge from neonatal units the intensive monitoring of infants growth declines and there is minimal support and encouragement for continued breastfeeding at home. Research has shown the mothers often question if infants are meeting adequate volumes of breast milk, and are more likely to convert to formula feeding or supplementary feeding alongside breast milk (Kavanaugh, Mead, Meier, & Mangurten, 1995). Research has illustrated a decline in breastfeeding following discharge with one study showing a drop of 51% in breastfeeding between discharge and 6 months (Åkerström, Asplund, & Norman, 2007). This study did not assess breastfeeding following discharge but did report on breastfeeding and modes of feeding at discharge which can influence future methods of feeding.

### **5.3.1 Breastfeeding and Modes of Feeding at Discharge**

Of the 79 infants discharged home the majority received breast milk (73.4%) and 67.1% were being exclusively breastfed. Infants  $\leq 32$  weeks' gestation had lower rates of exclusive breastfeeding on discharge (54.5% n=6) compared to infants  $>32$  weeks' gestation (76.5% n=52). Rates of breastfeeding has been shown to drop by 10% between initiation and discharge in preterm infants admitted to neonatal intensive care facilities (Blackwell *et al.*, 2005; Smith *et al.*, 2003). Sixty two percent of infants were breastfeeding on discharge from SCBU which shows a decrease of 21% in breastfeeding between initiation and discharge. However, it is encouraging as majority of infants were being breastfed on discharge which is optimal as it has been identified that breastfeeding declines following discharge (Åkerström *et al.*, 2007).

Factors that have been shown to affect breastfeeding between initiation and discharge include low birth weight and multiple gestations. Literature showed that infants of lower birth weight are associated with lower discharge breastfeeding rates (Colaizy & Morriss, 2008; Furman *et al.*, 1998). These factors were not significant within SCBU with results revealing that of infants  $<1500$ g, only 3.2% were breastfeeding on discharge with majority of these infants adopting bottle feeds. Mothers of twin pregnancies are more susceptible to early breastfeeding cessation with one study showing a drop in breastfeeding of 40% in preterm infants across a 4 month period (Ostlund, Nordstrom, Dykes, & Flacking, 2010). In SCBU, singleton

infants were more likely to breastfeed (79%) compared with twin infants (21%) but this was not significant. Although these factors have been shown to affect breastfeeding in preterm infants, this study was not significantly powered to identify this with a larger study needed to show significance of these factors on breastfeeding at discharge.

The infants, who were not breastfeeding at discharge, were fed on the mixed feeding method (breast milk + formula). Mixed feeding is a good compromise when breastfeeding cannot meet optimal intake and the infant requires additional nutrients and energy to support growth (Aggett *et al.*, 2006). The fear is that upon discharge mothers will revert to exclusive formula feeding due to convenience and due to being in a less supportive breastfeeding environment. This concern has been investigated in the literature which demonstrates a decrease in breastfeeding following discharge. Infants discharged on mixed feeding are more likely to adopt formula feeding and discontinue breastfeeding (Evans, Lyons, & Killien, 1986; Hill, Ledbetter, & Kavanaugh, 1997). A further study showed mothers exposed to infant formulas were more likely to discontinue breastfeeding compared with mothers who were given their own breast pump (Dungy, Christensen-Szalanski, Losch, & Russell, 1992). Although the study within SCBU did not observe feeding following discharge, a significant proportion was discharged on mixed feeding regimes.

These results together with literature observations, highlights the need for continued breastfeeding support for these infants following discharge. Follow up at home or via phone with a lactation consultant has been shown to encourage continued breastfeeding (Bonuck, Trombley, Freeman, & McKee, 2005). Establishment of a peer support group where mothers are able to discuss barriers they are experiencing has also been shown to have beneficial effects on breastfeeding continuation (Long, Funk-Archuleta, Geiger, Mozar, & Heins, 1995; Schafer, Vogel, Viegas, & Hausafus, 1998). The implementation of these recommendations in mixed fed infants and in breastfeeding preterm infants following discharge could potentially increase breastfeeding rates and duration of breastfeeding significantly.

Although it is difficult to compare breastfeeding initiation and rates of breastfeeding for preterm infants at discharge with other New Zealand units due to maternity indicators not collecting data specifically on preterm infants, there may be potential to

improve breastfeeding practices through additional support of lactation during admission, at discharge and following discharge.

#### **5.4 Enteral Feeding**

Enteral feeding is a common strategy to ensure preterm infants are meeting their nutritional requirements to support growth. Evidence to guide enteral feeding practices is limited, making clinical decisions and the formulation of guidelines difficult. However research has highlighted early enteral feeding, attaining full enteral feeding volumes and using expressed breast milk has been associated with positive outcomes (Caple *et al.*, 2004; Leaf *et al.*, 2012).

Seventy six infants were enterally fed during admission to SCBU, of whom 12 were born at less than 32 weeks' gestation. The day that enteral feeding was commenced for these infants could not be determined as enteral feeding was initiated during their admission to NICU prior to being transferred to SCBU.

Enteral feeding was initiated in 64 infants born at >32 weeks on a median day of 9. This is relatively early when compared to infants of moderate to late prematurity in other studies (Klingenberg *et al.*, 2011). Although 9 days is considered early, there is a concern that taking more than a week to initiate enteral feeding may impact upon the preterm infant's ability to regain their birth weight within the first 2-3 weeks (Heird, 2008). Late preterm infants are more likely to attempt breastfeeding earlier due to more developed gastrointestinal systems (Tomashek *et al.*, 2006), but may have difficulty in breastfeeding due to inadequate milk supply with early tiring during breastfeeding (Wang *et al.*, 2004). Issues experienced with breastfeeding establishment may account for the delay in initiation of enteral feeding. Therefore, although enteral feeding was initiated relatively early within SCBU, monitoring of infants breastfeeding progress and weight gain is important in identifying infants who require early enteral feeding in an attempt to reduce growth faltering.

In addition, due to late preterm infants difficulties with breastfeeding, reaching full enteral feeding volumes in late preterm infants may not be a priority as the goal is to supplement nutrient intakes whilst breastfeeding is being established (Meier, Furman, & Degenhardt, 2007). In infants of late prematurity, full enteral feeds were achieved in 17 infants with 15 infants not reaching full volumes. Meier *et al.*, 2007 has further suggested moderate preterm infants within neonatal facilities fail to achieve growth rates as feeding difficulties are considered minor due to their close proximity to term



infants This could explain why 15 infants did not meet full enteral feeding volumes within this study as the majority were comprised of late preterm infants. Our results are in line with current evidence and although reaching full enteral feeding volumes is a goal of enteral nutrition, in moderate to late preterm infants the purpose of enteral feeding is to supplement the nutrient needs whilst emphasis is placed on establishing breastfeeding in these infants (Meier *et al.*, 2007).

Enteral feeding with EBM is beneficial as it stimulates milk production, aids in establishment of lactation and preparing for breastfeeding following enteral feeding (Meier *et al.*, 2007). Within SCBU, 45 infants were initiated on EBM for enteral feeding. This is a positive finding as expressing breast milk maintains milk production and facilitates mothers to establish breastfeeding.

Whilst breastfeeding is established, nutrient requirements for the moderate to late preterm infant may not be met (Meier *et al.*, 2007). One option in this scenario is the use of donor breast milk. In New Zealand the only breast milk bank available is in Christchurch in the South Island but in the future this may be an option.

Mixed feeding provides the infant with whatever EBM is available and the addition of infant formula ensures that the nutrient requirements of the infant are met. It is imperative that mothers are supported to express otherwise infants may progress to only receiving formula milk. In a study conducted on the NICU at Auckland City hospital, all 34 infants within their study commenced on enteral EBM but by the end of the 3 month data collection, 25% were fed preterm formula (Cormack & Bloomfield, 2006). Within our study population 45 infants received EBM initial for enteral feeding but by discharge 17.8% were receiving only infant formula. These findings highlight the need for continued support for expression of breast milk during enteral feeding with the active involvement of lactation consultants (Sisk, Lovelady, Dillard, & Gruber, 2006).

## **5.5 Growth**

There is a wealth of evidence which has identified that preterm infants are at risk of post natal growth faltering (Cooke *et al.*, 2004; Engle *et al.*, 2007; Marks *et al.*, 2006) which justifies the study focusing on this population group within SCBU.

### **5.5.1 Day's to Regain Birth Weight**

Of the 79 infants discharged home, 32 infants did not regain birth weight and 29 of these infants were born at >32 weeks' gestation and 3 infants at ≤32 weeks' gestation. In preterm infants there is an expected 15% weight loss which occurs during the postnatal period due to the change to the extra uterine environment (Aggett *et al.*, 2006). Ideally this weight loss will be regained within 2-3 weeks after birth. However the length of admission for moderate to late preterm infants in the study was only 10.5 days which explains why so many of the infants did not regain their birth weight prior to discharge.

Although birth weight does not have to be regained prior to discharge the weight should be stable and showing an increasing trend (Auckland District Health Board National Womens, 2012). Infants who do not regain their birth weight need to be monitored after discharge and concerns have been raised that close monitoring in the community is not always undertaken (Steward, 2012).

Monitoring growth requires interpretation of growth parameters including ensuring that infants are tracking along appropriate percentiles and not decreasing in Z-scores. Infants that are identified as crossing percentiles or decreasing by greater than 1 z-score should be referred for appropriate follow up in the community. Follow up could include well child service home visits, the involvement of home care nurses or referral to dietetic outpatient services.

### **5.5.2 Postnatal Growth of Preterm Infants Prior to Discharge**

Postnatal growth faltering (PNGF) has been defined as tracking below the <10<sup>th</sup> percentile. This definition may not be suitable for preterm infants who are often born below the 10<sup>th</sup> percentile and therefore track below the 10<sup>th</sup> percentile until discharge (Cooke *et al.*, 2004). A more accurate approach in assessing growth in the preterm infants is to analyse changes between birth and discharge measurements via Z-scores. Z-score analysis was used to assess weight, length and head circumference. Z-score calculation is based on distribution of the reference population and as Z-scores are standardised quantities, we were able to compare across ages and sexes (World Health Organisation, 1997).

The majority of studies investigating growth in preterm infants have identified a decrease in Z-scores for weight between birth and discharge (Cooke *et al.*, 2004; Marks *et al.*, 2006). In our study population there was a mean decrease in Z-scores



for weight of  $-0.49 \pm 0.16$  between birth and discharge. This decrease was not clinically significant as the change in z-score did not cross growth percentiles. Although the change in z-score for weight was not deemed clinically significant, the mean change in z-score fails to identify individual infants at risk of postnatal growth faltering who require additional support.

A more recent method of assessing growth in NICU and SCBU uses individual changes in growth to assess individual decreases in Z-scores (Marks *et al.*, 2006). A decrease in  $>1$  standard deviation, indicates infants at high risk of growth faltering whilst a decrease in  $>2$  Z-scores identifies an infant at severe risk of postnatal growth faltering (Mehta *et al.*, 2013). Within SCBU, increases in Z-scores were observed in 15 infants (18.5%) with these infants increasing at least 1 z-score between birth and discharge. The z-score declined by 0 to -1 in 47 infants (58%), by  $>-1$  to -2 in 17 infants (21%), and by more than -2 in 2 infants (2.5%). Of the infants decreasing by 1-2 Z-scores, 2 were referred to dietetic services during admission but none of the infants that decreased by  $>2$  Z-scores were referred. The infants declining by  $>1$  z-score, had significantly lower discharge weights than infants who did not decrease by  $>1$  z-score. These results highlight 17 infants within SCBU at risk of growth faltering with 2 infants at risk of severe growth faltering which can have long term repercussions on neurodevelopment (Shah *et al.*, 2006). It is unknown whether these infants had follow up appointments to assess growth in the community as it was beyond the scope of the study.

Monitoring and recording of weight at birth, during admission, and at discharge is essential to identify infants at risk of growth faltering who require further nutritional support for optimal growth. Clinical policy should be outlined with clear directives for referrals appropriate for early nutrition interventions under the supervision of a dietitian. Infants decreasing by greater than 1 z-score should be followed up within the community to assess growth following discharge in an attempt in reducing long term complications of growth faltering.

### **5.5.3 Head Circumference and Length: Z-Score Analysis**

Although weight is commonly assessed in preterm infants, length provide an additional indication of growth progress during admission and can be used to further identify infants at risk of growth faltering. Head circumference is also an important indicator of brain growth due the close relationship between head circumference

measurements and brain development. Suboptimal head circumference during the postnatal period has been shown to be associated with poor neurological development with subsequent poor cognitive function in later infancy (Brandt, Sticker, & Lentze, 2003).

All infants admitted to SCBU had head circumference and lengths measured and recorded at birth. However, only 41 infants had a head circumference and a length recorded at discharge. The 41 infants with measurements after birth were significantly younger (34 weeks compared to 36 weeks), had lower birth weights and were admitted to SCBU for longer compared with infants with no measurements taken after birth.

The 48 infants, who did have measures of growth after birth, showed a positive increase in head circumference and length of  $0.27\pm 0.48$  and  $0.18\pm 0.13$  respectively between birth and discharge. Even though SCBU results show positive increases in comparison with other studies (Clark *et al.*, 2003), the results are not representative of the entire study population due to the missing values for 52 of the infants. There the change in Z-scores for head circumference and length were only representative of infants that were younger and hospitalised for longer.

A full picture of growth for infants admitted to SCBU cannot be reported due to missing data. These infants may be at risk of poor brain growth and faltering growth. Studies have highlighted late preterm infants to be at risk of developmental delays which is recognised once they start kindergarten or school (Davidoff *et al.*, 2006). It is concerning that there are limited results regarding head circumference and lengths of preterm infants within SCBU.

## **5.6 Dietetic Referrals**

Specifications for dietetic referral are outlined in the Neonatal Nutritional Risk Screening Criteria (Cormack, 2012). This criteria identifies that infants who are not meeting required fluid or energy intake, infants requiring fortifiers and infants with poor growth should be referred to dietetic services (Cormack, 2012).

Previous studies have shown positive results including improved growth measures and nutritional intake with consistent dietetic involvement in preterm infants admitted to neonatal intensive units (Olsen *et al.*, 2005). Early dietary interventions have been linked with reduced infection rates and decreased hospital admission for premature

infants (Tuthill, 2007). International studies have demonstrated active dietetic involvement in neonatal units and in the UK 33 units out of a total 48 neonatal units audited had regular access to dietetic involvement (Tuthill, 2007).

As hypothesised, there were a low number of referrals to dietetic services and only 6 infants out of 100 were referred during admission. The referrals were for inadequate growth, feeding issues and allergies. Findings from the study alongside evidence from the literature indicate that more of the infants could have been referred to dietetic services. Infants decreasing by more than 1 z-score for weight between admission and at discharge could be at risk of growth faltering and require early nutrition intervention to decrease their risk of growth faltering (Shah *et al.*, 2006).

These results from SCBU highlight the need not only for dietetic advocacy but also encouragement for referral to other specialists to improve outcomes for preterm infants admitted to SCBU. Clear directives for dietetic referral should be outlined to encourage active dietitian involvement where appropriate.

## Chapter 6: Conclusions

### 6.1 Summary of the Study

This study was designed to provide a situational analysis of feeding and growth outcomes for preterm infants admitted to SCBU. Data were collected retrospectively between January 2013 to March 2014 and included 100 preterm infants. Data collection focused on growth outcomes and feeding practices including mode, type and duration of feeding during admission and at discharge. Data was also collected on anthropometric monitoring and referrals to dietetic services. Descriptive statistics were used to describe the population group with Chi-square and Mann Whitney tests to make comparisons between groups. Anthropometric measures were converted to Z-scores using UK-WHO data to assess growth at birth and discharge. The findings from this study add to the small body of evidence on feeding and growth of preterm infants during admission to neonatal units. To our knowledge this is the first study to look at feeding practices of preterm infants within Northland and contributes significantly to the wider evidence of preterm research within New Zealand.

The first objective was to determine the proportion of infants for whom breastfeeding was initiated, and the number of days to establish full breastfeeding. Eighty three percent of mothers initiated breastfeeding which was higher in comparison with other studies in preterm infants (Epsy, 2003; Colaizy, 2008). Infants  $\leq 32$  weeks' gestation had lower initiation of breastfeeding when compared with infants  $> 32$  weeks. Infants  $\leq 32$  weeks were all transferred to NICU and transferred back to SCBU, with 57.1% still managing to initiate breastfeeding. Although breast feeding initiation was high in the preterm infants it was still below reported rates in term infants. The hypothesis that preterm infants will have lower rates of breastfeeding initiation when compared with term infants is accepted.

The second objective was to determine the proportion of preterm infants who received enteral nutrition (expressed breast milk and/or formula milk), and to determine the number of days to establish full enteral feeds. Results revealed that 76 infants received enteral feeding which illustrates the important role enteral feeding has in nutritional support of preterm infants during admission to SCBU. The majority of infants received expressed breast milk and achieved early attainment of full enteral

feeds in comparison with other studies. Preterm infants were being enterally fed in line with the SCBU protocol. The null hypothesis is accepted.

The third objective was to determine the proportion of preterm infants that were breastfed; formula fed, or received mixed feeding (breast and formula feeding) at discharge. The majority of infants were discharged on breast milk (73.4%) with 67.1% exclusively breastfeeding. Mixed feeding was observed in 13.9% of infants upon discharge and exclusive formula feeding in 12.7% of infants. These results are positive as the majority of infants were receiving breast milk at discharge which is optimal. Although these results are positive, Northland DHB has reported 94.3% (term and preterm infants) of infant's breastfeeding at discharge from maternity units in Northland (Bailey, 2013). The SCBU preterm infants do not meet the rates of term infants for breastfeeding at discharge. The hypothesis that breastfeeding at discharge in preterm infants will be lower in comparison with term infants is accepted.

The fourth objective was to determine the proportion of preterm infants who regained birth weight prior to discharge, and to observe the number of days to reach birth weight during admission. Within the study population, 47 infants regained birth weight prior to discharge home. It is concerning that 32 infants failed to regain birth weight due to the increased risk of growth faltering following hospital discharge and subsequent medical complications. The hypothesis is accepted as majority of infants failed to regain birth weight prior to discharge home.

The fifth objective was to compare growth Z-scores with UK-WHO data and to identify infants at risk of growth faltering. This was assessed by calculation of the mean difference between birth weight and discharge weight Z-scores. Change in z-score between birth and discharge showed a mean decline in z-score of  $-0.48 \pm 0.16$ , this was not clinically significant. However, 17 infants decreased by  $>1-2$  Z-scores indicating risk of postnatal growth faltering with a further 2 infants decreasing by  $>2$  Z-scores showing severe risk of postnatal growth faltering. The hypothesis that infants will not meet UK-WHO recommendations and growth faltering will be observed is accepted.

A further objective was to assess consistency of recording anthropometric measurements. All infants had weight, head circumference, and length recorded at birth. However, 21 infants did not have recorded discharge weights and only 41 infants had head circumference and length recorded at discharge. The hypothesis

that growth and anthropometric measurements will not be recorded as per protocol is accepted.

The final objective was to determine the number of preterm infants who were referred to dietetic services during admission. A total of 6 infants were referred out of the 100 infants in the study. This is concerning as 19 infants were shown to be at risk of growth faltering by decreasing by  $>1$  z-score during admission. The final hypothesis is accepted due to low referral rates to dietetic services.

## **6.2 Conclusion**

The results of this study provide data on feeding and growth outcomes in preterm infants admitted to SCBU in Northland.

Breastfeeding practices within the SCBU were positive with high initiation rates and many infants receiving EBM or being breastfed during admission. Although this study was not significantly powered to identify barriers or relationships associated with breastfeeding it would be an interesting area for further research.

Preterm infants admitted to SCBU are at risk of growth faltering as displayed by 19 infants decreasing by  $>1$  Z-scores. This finding places these infants at long term health complications secondary to growth faltering (Embleton, 2001). Monitoring and detailed recording of anthropometric data accurately at birth, during admission and at discharge will identify infants at risk of growth faltering. Identification of these infants early will enable early referral to dietetic services.

It is unclear as to the reason for low referrals to dietetic services within SCBU ;however, clear guidelines for feeding protocols and growth assessment could be used to identify infants appropriate for dietetic referral. In addition emphasis within the unit on detailed recording of feeding and accurate anthropometric measurements will enable dietitians to calculate nutritional deficits and provide appropriate supplements and fortifiers to support growth.

## **6.3 Strengths**

The study population is likely to be an accurate representation of preterm infants admitted to SCBU at Whangarei Hospital. The demographics of the wider Northland population in NDHB are described in the introduction. The higher proportion of Māori infants within this study is reflective of the geographical area and the fact that rates of preterm delivery are higher in Māori mothers (Bailey, 2013; Ministry of Health, 2012).

This study was comprised mainly of moderate to late preterm infants as expected due to SCBU being a low dependency tertiary unit. Although the findings from this study are specific to the SCBU at NDHB, they have the potential to be generalisable to other units in NZ if feeding protocols and clinical practices are similar. This study also reports on clinically relevant endpoints such as Z-scores for growth, rates of breastfeeding and enteral feeding. From these findings it is possible to make recommendations which could potentially improve clinical practice within SCBU.

Retrospective data collection from existing clinical documentation facilitated immediate access, was inexpensive and required less time than collecting prospective data. All data in this study was collected within 9 weeks whereas prospective data collection would have taken approximately 13 months which would have been unfeasible with the time constraints of an MSc research project. Furthermore, retrospective study designs allows for a large number of different variables and outcomes measures to be explored as many factors can be compared with data being readily available.

Bias of reporting clinical outcomes in medical and nursing documentation was reduced by using a retrospective design. In addition, prospective study designs require long periods of follow up with subjects. This increases the risk of the investigator losing contact with the subjects resulting in missing data. Missing data reduces the internal validity of a study. Follow up was required to meet the objectives of this study. Compliance and loss of subjects during data collection was therefore not an issue within this study.

## **6.4 Limitations**

The study population appeared reflective of the Northland population and of infants likely to be admitted to SCBU. Although a strength, it limits the ability to apply the results of this study to other neonatal care facilities in New Zealand that may offer different levels of care and whose inpatients may have differing characteristics. Although of interest, at a national level these results cannot be applied to all units which care for preterm units in NZ due to the small sample size, short duration of this study and unique population of Northland.

The study was limited by missing or unattainable data. Inadequate recording of data was seen in growth records with missing anthropometric measurements resulting in inability to calculate growth outcomes for many of the infants. It is unknown to what



extent the missing data biased the results as conclusions could only be drawn for those infants who had available data. Due to this study being conducted retrospectively, there is a potential for bias as the infants for whom charts could not be obtained (e.g. charts being used elsewhere in the hospital) could represent the infants who have greater health problems. To explore this further the characteristics of infants with missing data were identified and showed that these infants were significantly older and admitted to SCBU for a shorter period of time. Therefore results may only be representative of the infants who were admitted to the unit for a longer duration. Although this was a limitation, results have allowed recommendations to be made to improve monitoring for infants with short admissions to SCBU and of older age to identify infants at risk of growth faltering. Furthermore, a prospective study may have resulted in less missing data.

Collection of data from past documentation (retrospective) has many benefits but only allows assessment of clinical practice during the time period of the study and findings cannot be classed as current practices. This study looked retrospectively over one calendar year. Protocols and recommendations may have changed since March 2014 and findings in this study may have already been improved on. However, retrospectively collecting the data allowed for multiple variables to be compared allowing further areas of improvement within SCBU to be identified and appropriate recommendations can be made.

This study identified preterm infants admitted to SCBU are at risk of growth faltering. Although growth may be affected by nutrition, it cannot be confirmed that nutrition is the only contributing variable as growth is affected by many other factors particularly disease state. Regardless growth should be accurately and consistently monitored during admission and at discharge to allow for appropriate nutrition interventions and referral to dietetic services if required.



## **6.5 Recommendations for SCBU**

1. The admissions book located within SCBU should record all infant's gestational age and weights at birth and discharge to allow staff to track infants during admission. This is also a quick method of identifying infants requiring follow up in the community by comparison of birth and discharge weights.
2. Consistent monitoring of infant's growth which includes birth measurements, alternate weight measures during admission, and weights at discharge. Head circumference and length should also be recorded at birth, during admission and at discharge for every infant admitted to SCBU.
3. Emphasis on accurate and frequent recording of feeding and growth within medical and electronic patient notes to facilitate infants at risk of growth faltering or feeding issues to be identified early.
4. Policy formation with clear directives for dietetic referral especially in infants with growth faltering and feeding issues.
5. Six monthly audits completed within SCBU focusing on consistency of feeding practices, monitoring, and record keeping.

## **6.6 Recommendations for Future Research**

1. Assessment of the available support for breastfeeding during admission and beyond hospital discharge.
2. Investigation into feeding practices and growth outcomes of preterm infants in other neonatal units within New Zealand. This will allow comparisons to be made between DHBs.
3. Investigation into the barriers associated with breastfeeding in the SCBU environment.
4. Larger studies with a longer duration would be beneficial to gain a more accurate representation of clinical practices.

5. Research assessing feeding practices and growth outcomes of preterm infants at 4 months, 6 months, and 12 months corrected age.

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## **Appendices**

## Appendix A

### Human Disability Ethics Committee (HDEC) Letter of Approval



Health and Disability Ethics Committees

Ministry of Health  
C/- MEDSAFE, Level 6, Deloitte House  
10 Brandon Street  
PO Box 5013  
Wellington  
6011

0800 4 ETHICS hdec@moh.govt.nz 28 March 2014

Miss Ashleigh Share  
42 Joy Street, Albany Heights

Auckland 0632

Dear Miss Share

Re:	<b>Ethics ref:</b>	<b>14/NTA/29</b>
	Study title:	A retrospective observational cohort study investigating the nutritional and feeding practices of preterm infants (<37 weeks gestation) admitted to the Special Baby Care Unit (SCBU) at Whangarei hospital.

I am pleased to advise that this application has been approved by the Northern A Health and Disability Ethics Committee. This decision was made through the HDEC-Expedited Review pathway.

#### Conditions of HDEC approval

HDEC approval for this study is subject to the following conditions being met prior to the commencement of the study in New Zealand. It is your responsibility, and that of the study's sponsor, to ensure that these conditions are met. No further review by the Northern A Health and Disability Ethics Committee is required.

Standard conditions:

1. Before the study commences at *any* locality in New Zealand, all relevant regulatory approvals must be obtained.
2. Before the study commences at a *given* locality in New Zealand, it must be authorised by that locality in Online Forms. Locality authorisation confirms that the locality is suitable for the safe and effective conduct of the study, and that local research governance issues have been addressed.

#### After HDEC review

Please refer to the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on [www.ethics.health.govt.nz](http://www.ethics.health.govt.nz)) for HDEC requirements relating to amendments and other post-approval processes.

Your next progress report is due by 27 March 2015.

## Participant access to ACC

The Northern A Health and Disability Ethics Committee is satisfied that your study is not a clinical trial that is to be conducted principally for the benefit of the manufacturer or distributor of the medicine or item being trialled. Participants injured as a result of treatment received as part of your study may therefore be eligible for publicly-funded compensation through the Accident Compensation Corporation (ACC).

Please don't hesitate to contact the HDEC secretariat for further information. We wish you all the best for your study.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'B J Fergus', with a horizontal line underneath.

Dr Brian Fergus  
Chairperson

Northern A Health and Disability Ethics Committee

Encl: appendix A: documents submitted  
appendix B: statement of compliance and list of members

## Appendix A

### Documents submitted

<i>Document</i>	<i>Version</i>	<i>Date</i>
CV for CI: CV for CI: Ashleigh Share: Massey University Masters Student	1	24 November 2013
Protocol: Research Protocol	3	25 February 2014
CVs for other Investigators: Dr. Cathryn Conlon- University Supervisor CV	1	04 February 2014
Evidence of scientific review: Mary McNab peer review	1	20 February 2014
Covering Letter: Cover letter	1	20 February 2014
Survey/questionnaire: Data collection sheets	1	24 February 2014
Survey/questionnaire: Word data collection sheets	1	24 February 2014
Survey/questionnaire: Growth Data collection sheets	1	24 February 2014
Evidence of scientific review: Peer Review by Eruera Maxted (Senior Dietitian at NDHB)	1	25 February 2014
Evidence of scientific review: Chief Medical Officer NDHB peer Review	1	25 February 2014

### Appendix statement of compliance and list of members

#### Statement of compliance

The Northern A Health and Disability Ethics Committee:

- is constituted in accordance with its Terms of Reference
- methodsoperates in accordance with the *Standard Operating Procedures for Health and Disability Ethics Committees*, and with the principles of international good clinical practice (GCP)
- is approved by the Health Research Council of New Zealand's Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990
- is registered (number 00008714) with the US Department of Health and Human Services' Office for Human Research Protection (OHRP).

#### List of members

<i>Name</i>	<i>Category</i>	<i>Appointed</i>	<i>Term Expires</i>
Dr Brian Fergus	Lay (consumer/community perspectives)	01/07/2012	01/07/2015
Dr Karen Bartholomew	Non-lay (intervention studies)	01/07/2013	01/07/2016
Ms Susan Buckland	Lay (consumer/community perspectives)	01/07/2012	01/07/2015
Ms Shamim Chagani	Non-lay (health/disability service provision)	01/07/2012	01/07/2014
Dr Christine Crooks	Non-lay (intervention studies)	01/07/2013	01/07/2015
Mr Kerry Hiini	Lay (consumer/community perspectives)	01/07/2012	01/07/2014
Dr Etuate Saafi	Non-lay (intervention studies)	01/07/2012	01/07/2014
Ms Michele Stanton	Lay (the law)	01/07/2012	01/07/2014

<http://www.ethics.health.govt.nz>



## Appendix B

### Letter of Approval by NDHB Chief Medical Officer: Dr. Michael Roberts

**NORTHLAND DISTRICT HEALTH BOARD**  
*Te Poari Hauora Ā Rohe O Te Tai Tokerau*



25 February 2014

Ms Ashleigh Share  
**WHANGAREI**

Email : [Ashleigh.share@gmail.com](mailto:Ashleigh.share@gmail.com)

Dear Ashleigh,

**Re : Retrospective audit of feeding practices in preterm infants admitted to the Special Care Baby Unit at Whangarei hospital.**

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I write to confirm my discussion last week with Mary McNab, Dietitian at Northland District Health Board, in which I reviewed and approved the audit (as above) that you will be undertaking at Whangarei Hospital.

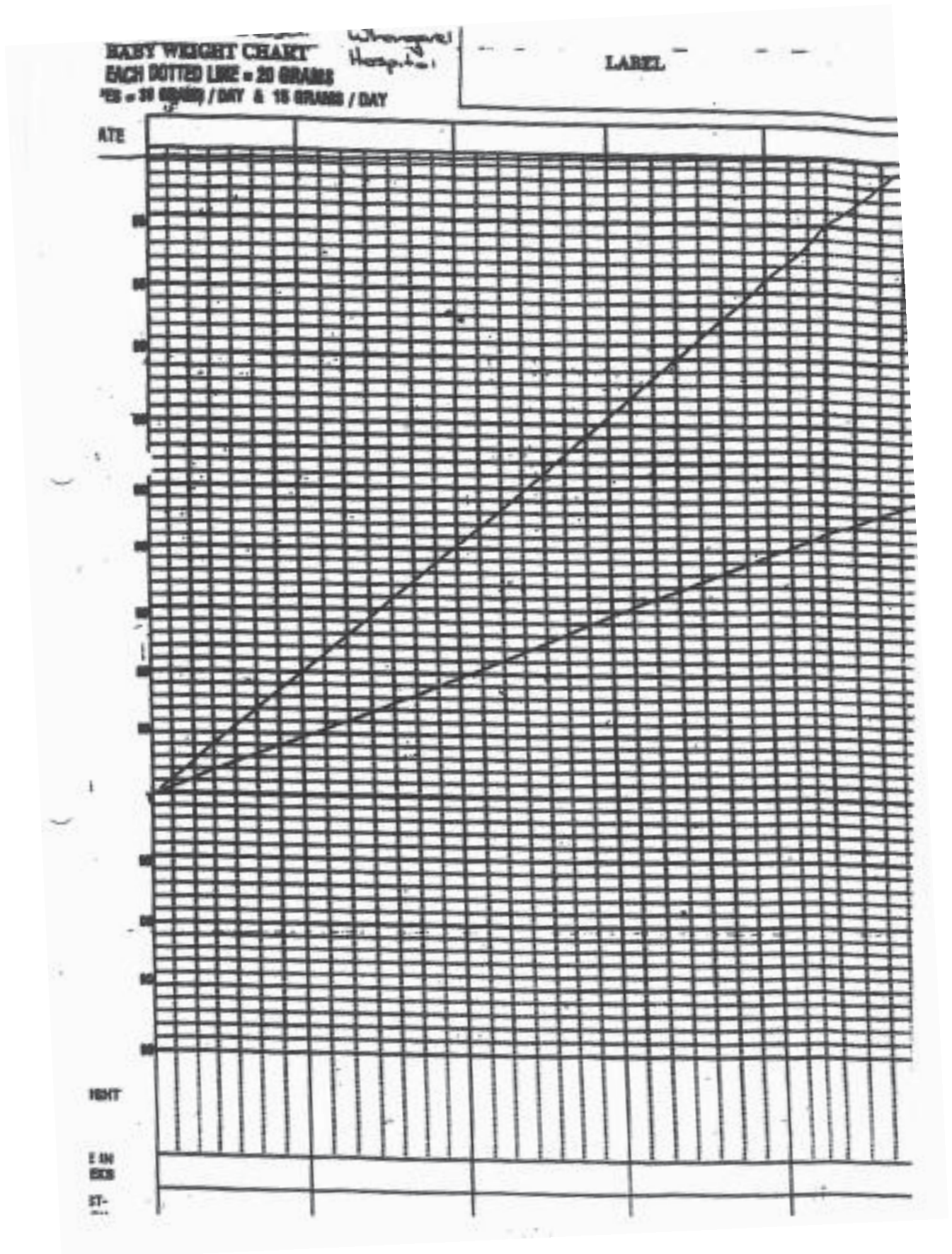
Kind regards,

Yours sincerely,

A handwritten signature in black ink, appearing to read "M. Roberts".

Dr Michael Roberts  
Chief Medical Officer  
**NORTHLAND DISTRICT HEALTH BOARD**

Appendix C  
SCBU Growth Grid



**Appendix D**

*Demographic Questionnaire*

# Feeding Practices Audit NDHB

Demographic Questionnaire

Ashleigh Share MSC Nutrition and Dietetics

## Confidential

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Instructions for filling out the data collection sheets.

Answer all questions

- In cases of answers with \_\_ numerical or other data as appropriate should be completed
- In cases of answers with  or  tick the applicable box
- When the question is not applicable you use NA
- When something is not recorded you use NR
- When something is unknown you type UNK
- Infant not on SCBU use NS

Dates should be filled out as dd/mm/yyyy for example 28/01/2014

Study Day 1 = First study day admitted to SCBU

Data will be collected until discharge

### Infant Demographic Data

---

Participant Study Number: \_\_\_\_\_

Date of Birth: \_\_\_/\_\_\_/\_\_\_ (day/month/year)

Gestational Age: \_\_\_ - \_\_\_ (weeks – days)

Gender:

- Male
- Female

Birthweight (g): \_\_\_\_\_

Birth Head Circumference (cm): \_\_\_\_\_

Birth Length (cm): \_\_\_\_\_

Birth Location:  
\_\_\_\_\_

Antenatal Steroids:

- Yes
- No

*If Yes:*

Were the antenatal steroids administered:

Days after birth referred to SCBU:  <24hours before delivery  
 ≥24 hours before delivery  
\_\_\_\_\_

Gestational age on admission to SCBU: \_\_\_ - \_\_\_ (weeks – days)

Admitted from:

- Labour ward at Whangarei
- Postnatal ward at Whangarei
- Home (Northland District)
- Transferred from (details)  
\_\_\_\_\_
- 
- Other (details)  
\_\_\_\_\_
- 

Admission to SCBU details:  
(Record data if available such as reason for admission)  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Singleton, twins, triplet

- Singleton
- twin
- triplet
- other (state)

Caesarean section

- Yes
- No

APGAR score at 5min

Length of stay at SCBU: \_\_\_\_\_ Days

Total days hospitalized: \_\_\_\_\_ Days

**Mother's Demographic Data**

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Brief medical history:

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---

Medical history from previous DHB if referred after birth:

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Medical issues:

Chronic lung disease:	Yes	No
NEC:	Yes	No
Pulmonary atresia:	Yes	No
Cystic fibrosis:	Yes	No
Hyperbilirubinemia:	Yes	No
Oesophageal reflux:	Yes	No
Biliary atresia:	Yes	No
Renal insufficiency:	Yes	No
Ventilation:	Yes	No
No. of days:		_____
Oxygen:	Yes	No
No. of days on oxygen:		_____
CPAP:	Yes	No
No. of days on CPAP:		_____
With holding feed:	Yes	No
Reason for withholding feeds:		_____

Reporting of micronutrient deficiencies in medical notes (eg Iron, vitamin D deficiency etc and any action taken):

---

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---

Breastfeeding Details:

---



Days after birth BF initiated: \_\_\_\_\_

---

### Dietitian referral

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Referred to dietitian:

- Yes
- No

Days after birth referred to dietitian: \_\_\_\_\_ Days

Reason for referral: \_\_\_\_\_

---

### Discharge Information

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Date of discharge: \_\_\_\_\_  
(day/month/year)

Age at discharge: \_\_\_\_\_

Discharged to: \_\_\_\_\_

Type of milk fed at discharge?

- Mothers own milk 100%
- Mothers own milk 50-90%
- Mothers own milk <50%
- Human donor milk
- Preterm infant formula
- Full term infant formula

Method of feeding at discharge:

- Breast-feeding
- Bottle feeding
- Cup feeding
- Tube feeding
- Don't know

Supplements used on discharge: \_\_\_\_\_

Fortifier used on discharge: \_\_\_\_\_







