AN ANALYSIS OF INTER-HEALTHCARE FACILITY TRANSFER OF NEONATES WITHIN THE ETHEKWINI HEALTH DISTRICT OF KWAZULU-NATAL

A dissertation submitted in fulfilment of the requirements for the degree of Master of Technology: Emergency Medical Care in the Faculty of Health Sciences at the Durban University of Technology

PRADEEP ASHOKCOOMAR

2012

Durban University of Technology

Supervisor: Mr R Naidoo

MSc: Cardiology

Co-Supervisor: Prof JK Adam

D Tech: Clin Tech

DECLARATION OF ORIGINALITY

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Durban University of Technology or to any other institution for assessment or for any other purpose.

Candidate's name: Mr Pradeep Ashokcoomar

Candidate's signature: _____ Date: ___/____/____

ETHICAL CLEARANCE

This is to certify that the studies contained in this dissertation have the approval of the Institutional Research Ethics Committee (IREC) of the Durban University of Technology (DUT) in KwaZulu-Natal.

The allocated Ethics Clearance number is: **IREC 001/11**

Candidate's name: Mr Pradeep Ashokcoomar

Candidate's signature: _____ Date: ___/____/_2012

ABSTRACT

Introduction

The safe transfer of neonates from one healthcare facility to another is an integral component in the process of neonatal care. Neonates, a term applying specifically to infants during the first 28 days of life, are transferred from medical healthcare facilities which do not have specialist care or intensive care management to more specialised facilities in order to improve their clinical outcome and chance of survival. The transfer system is thus an important aspect of the overall care provided to neonates. The transfer process, however, poses a threat of aggravating the clinical condition of the neonate. Inter-healthcare facility transfer of a neonate requires careful planning, skilled personnel and specialised equipment to maintain the continuum of care, as this directly impacts on the morbidity and mortality of the neonate.

Purpose of the study

The purpose of the study was to undertake a descriptive analysis of the current neonatal inter-healthcare facility transfer system in the eThekwini Health District of KwaZulu-Natal (KZN). This service is provided by the public sector ambulance service known as the Emergency Medical Rescue Service (EMRS). The study, based on 120 consecutive transfers, assessed the clinical demographics of the neonates, the time taken to complete the transfers, including time sub-intervals, the equipment that was necessary for the transfers and the qualifications and procedures performed by the transfer team. The study also identified any adverse events that were encountered during the transfers.

Methodology

The study was conducted from 19 December 2011 to 30 January 2012. It used quantitative methodology and a non-experimental prospective design to undertake a descriptive analysis of 120 inter-healthcare facility transfers of neonates within the eThekwini Health District of KwaZulu-Natal. Data collection relied upon two types of questionnaires. A descriptive survey method incorporated logistic and deductive reasoning to evaluate the objectives of this study. Frequency distributions were generated to describe data categories. Bivariate analysis was conducted using chi-square.

Results

During the study period there were a total of 120 neonatal inter-healthcare facility transfers. All referrals were undertaken by road ambulances. Eighty-three (62.2%), transfers were undertaken by the operational ambulance units, 35 (29.2%) by the obstetric unit and 2 (1.7%) by the planned patient transport units. Thirty one (28.5%) transfers were on Fridays, followed by 24 (20.8%) on Mondays and 20 (16.6%) on weekends. Ninety seven (80.8%) were during the hours of dayshift (07h00-19h00) and 23 (19.2%) were during nightshift (19h00-07h00). Of the 120 neonatal transfers, 29 (24.2%) were specialised transfers, of which 22 (75.9%) were ventilated.

With reference to the gestational ages of the neonates being transferred 90 (76.7%), were pre-term, 26 (21.7%) were term and 2 (1.7%) were post-term. There were 11 (9.2%) newborns (from birth to 4 hours), 56 (46.7%) early neonates (from 4 hours to 7 days) and 53 (44.2%) late neonates (from 7 days to 28 days). Of the 120 neonatal transfers, 90 (75.0%) were pre-term having associated co-morbidities and 49 (40.8%) had respiratory problems**.**

The mean time ± standard deviation (SD), taken by EMRS eThekwini to complete an inter-healthcare facility transfer was 3h 49min ± 1h 57min. The minimum time to complete a transfer was 55min and the maximum time was 10h 34min. The mean time ± SD from requests to dispatch was 1h 20min ± 1h 36min. The delays in dispatch were associated with no ambulances being available 70 (58.3%), no ALS

personnel available 48 (40.0%), no equipment available 23 (19.2%) and no ILS personnel available 7 (5.8%) to undertake the transfers. Junior or inexperienced personnel in the communication centre also contributed to the time delays by dispatching ALS personnel for non-specialised transfers and requesting neonatal equipment when it had not been requested by the referring personnel for the transfer. The mean time ± SD from the referring hospital to the time mobile to the receiving hospital was 43min ± 26min. Six (5.0%) neonates were clinically unstable at the referring facility for transfer. For 15 (12.5%) transfers, neonates had been inappropriately packaged for transport by the hospital staff, which added to the delays, p. value = 0.018.

The necessary equipment was unavailable for 37 (30.8%) of the transfers. The lack of equipment was due to problems such as poor resource allocation, and malfunctioning, inappropriate, insufficient and unsterile equipment. The pre-departure checklist had not been completed in 50 (41.67%) of the transfers.

The study identified 10 (8.3%) adverse events related to the physiological state of the neonate and included 1 (0.8%) mortality. Nine (7.5%) neonates suffered serious life threating complications during transportation, 8 (6.7%) of which were due to desaturation, 6 (5.0%) due to respiratory deterioration, 3 (2.5%) due to cardiac deterioration and 1 (0.8%) due to temperature related problems. Eighteen (15.0%) of 120 transfers experienced equipment related adverse events of which 9 (7.5%) were associated with ventilators, 9 (7.5%) with incubators, 3 (2.5%) with the ambulance, 2 (1.7%) with the oxygen supply and 1 (0.8%) with arterial cannulation. Five (33.3%) of the 15 equipment related adverse events contributed directly to life threatening physiologically related adverse events, p. value = 0.007.

Conclusion and recommendation

The Emergency Medical Rescue Service (EMRS) is involved in the transportation of a significant number of neonates between various healthcare facilities in the eThekwini Health District, some requiring intensive care and some not. This descriptive, prospective study has identified numerous shortfalls in the service provided by the EMRS in the eThekwini District.

Inter-healthcare facility transfer of neonates can be safely performed by the transport services if the operations are well co-ordinated and there are dedicated, specialised and trained transport teams armed with appropriate equipment and medication, together with the guidance of policies and quality assurance. Transport teams must be trained to provide this specialised care in various environments, including ground and air ambulances and understand the multiphase neonatal transfer processes. There must be good communication and co-ordination by all role players, which is underpinned by good team work to improve the standards of neonatal care and monitoring. Only then can clinical excellence be achieved when transporting neonates between healthcare facilities.

DEDICATION

This dissertation is dedicated to:

My family, (my parents, my wife, Maureen, my daughter, Shinese, my brother and sister-in-law, Ryan and Desree, and their daughter Teyra, and my sister and brother-in-law, Hema and Calvin), who have honored me by courageously sharing the sorrows and triumphs of our lives. You are truly the inspiration for this work and I thank you for your encouragement, support and patience throughout this study. It meant so much to me during the pursuit of my master's degree and I am grateful for all that you've done for me. To each of you, I offer my sincere thanks and deepest gratitude.

My darling daughter, Shinese, for being the most important part of my life, for filling my life with amazing love, sweet memories, new tasks and riotous joy. This research is especially dedicated to you.

ACKNOWLEDGEMENTS

There are many people who have provided me with guidance and support during the past two years which has helped me to complete this master's degree. To each of you, I offer my sincere and humble thanks and deepest gratitude.

- Firstly, thank you God for giving me the wisdom and courage to complete this study.

- To my family. My wholehearted thanks you to you all for giving me the strength, encouragement, unconditional love and patience to complete this study.

- To Mr Raveen Naidoo, my supervisor. I want to express my heartfelt gratefulness to you for your expert supervision, guidance, knowledge, encouragement, support, accessibility, motivation and most especially, for believing in me during this study.

- To Prof JK Adam, my co-supervisor. Thank you for your guidance and knowledge.

- To Mr Deepak Singh, my statistician and Mrs Margaret Addis, my editor. Thank you for your time and support.

- To all the managers of EMRS, Mrs S Mfeka, Mrs B Zungu, Mr M Naidoo and Mr N Padayachi, thank you for your support in undertaking this study in eThekwini.

- To the participants, thank you for participating in this study and sharing your medical knowledge. I would also like extend my sincere appreciation to my colleagues in EMRS who serve humanity unselfishly and continuously in order to help those in need for the greatest good of mankind. It is hoped that your participation in this study will contribute to providing a better service in emergency medical care in the future.

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ABBREVIATIONS AND GLOSSARYOF TERMS

Addington Hospital	ADD	Mainly a district level government hospital, but partly regional level government hospital.
Advanced Life Support	ALS	An Advance Life Support Practitioner is qualified to practice a large array of invasive techniques in pre-hospital emergency care profession, registered with the HPCSA.
Basic Life Support	BLS	A Basic Life Support Practitioner is the entry level qualification to the pre-hospital emergency care profession, registered with the HPCSA.
Code blue		A patient that died.
Code red		A life threatening emergency also known as Priority 1.
Code yellow		A non-life threatening emergency also known as Priority 2.
Dispatch time		The time between the receipt of the request by the communication centre and the relay of dispatch instruction to the responding crew.
Emergency Care Practitioner	ECP	A Bachelor Degree in Emergency Medical Care is an additional scope of practice which includes thrombolysis and rapid sequence induction to advanced life support, registered with the HPCSA.

Emergency care provider		A general term used for an individual who is registered with the HPCSA, professional board for pre-hospital emergency care. The registrations are either BLS, ILS, ALS, ECT or ECP.
Emergency Medical Rescue Service	EMRS	The public sector ambulance service that provides an essential pre-hospital healthcare service in KZN.
Emergency Medical Service	EMS	A health system component that functions to provide pre-hospital emergency healthcare and to transport patients to health care facilities.
Emergency Care Technician	ECT	A mid-level course of two years leading to registration as an ECT with HPCSA.
Estimated time of arrival	ETA	An estimated time of arrival.
Health Professions Council of South Africa	HPCSA	A regulatory body whose role to protect the public and to guide healthcare professionals.
Hyaline membrane disease	HMD	A respiratory condition present in pre-term neonates, secondary to surfactant deficiency resulting in impaired oxygenation at the level of the alveoli.
Inkosi Albert Luthuli Central Hospital	IALCH	A tertiary level government hospital.

Intermediate Life Support	ILS	An Intermediate Life Support Practitioner is qualified to practice limited invasive techniques in pre-hospital emergency care profession, registered with the HPCSA.
King Edward VIII Hospital	KEH	A regional level government hospital.
Low birth weight	LBW	Neonates that weigh less than 2 500g at birth.
Mahatma Gandhi Memorial Hospital	MGMH	A regional level government hospital.
Meconium Aspiration Syndrome	MAS	A respiratory condition affecting newborn when meconium is present in their lungs during or before delivery.
Mobilisation time		Mobilisation time is the time between receipt of the dispatch instruction by the responding crew and the crew's mode of transport becoming mobile on the case.
Neonatal Intensive Care Unit	NICU	An intensive care unit for infant patients within the neonatal age group.
Patient Return Form	PRF	A compulsory legal document completed by an emergency care provider when clinically managing a patient.
Planned Patient Transport	PPT	The non-emergency inter-healthcare facility primary or repatriation transport service.

Primary Health Clinic	PHC	A district level government facility.
Prince Mshiyeni Memorial Hospital	PMMH	A regional level government hospital.
Respiratory Distress Syndrome	RDS	An acute lung disease usually manifested by tachypnea, grunting, nasal flaring, retraction and poor feeding.
R K Khan Hospital	RKK	A regional level government hospital.

CHAPTER 1

OVERVIEW OF THE STUDY

1.1 Introduction

This introductory chapter will provide the background of the study, followed by the purpose, the objectives and the rationale of the study. In this chapter, the researcher will also describe his interest in such research and finally conclude with the assumptions and delimitations of the study.

1.2 Background of the study

Neonates are considered a relatively high risk population, having the potential to experience a variety of predicted and unpredicted problems (Smith, Draper, Manktelow & Field, 2009). If neonates require specialised attention, they are generally transferred to neonatal healthcare facilities where they can receive a higher level of care (Ratnavel, 2009). Inter-healthcare facility transportation places significant stress on these neonates as they can easily deteriorate during the transfer, which has a direct impact on their morbidity and mortality. However, with appropriate care, sophisticated monitoring equipment and a skilled transfer team, the risk of adverse events can be minimized (Boxwell, 2010).

To differentiate between the terms infant, newborn and neonate, the term infant refers to babies from birth to one year old, the term newborn refers specifically to an infant at the time of birth and the term neonate refers specifically to infants from birth to the first 28 days of life. Neonates are further subdivided into early neonates (the first seven days of life) and late neonates (older than 7 days, but not yet having completed 28 days of life) (American Heart Association, European Resusitation Council & International Liaison Committee on Resusitation, 2010).

An estimated 10.5 million child deaths occur worldwide each year and approximately four million (38%) of these deaths occur in the first four weeks of life, known as the

neonatal period. This means that a neonate has a 30 fold increased risk of dying during the first month of life than in the following 11 months. Neonatal deaths make up approximately two thirds of the infant mortality (birth to one year). In addition to this burden, four million neonates are stillborn. The ratio of neonatal to post-neonatal mortality varies by country or region according to the nature and stage of development of neonatal care provided (World Health Organization, 2005).

In South Africa, neonatal deaths account for a large proportion of infant deaths. Of the total of 12 699 neonatal deaths that were reported in 2005, 9 501 were early neonatal deaths and 3 198 were late neonatal deaths. Prematurity was the main cause of death, but other common causes included obstetric complications before or during birth, neonatal difficulty in adapting to extra-uterine life and harmful practices after birth that led to infections (World Health Organization, 2005).

The fourth Millennium Development Goal states that infant and child mortality have been dropping in most countries in the world. However, sub-Saharan Africa remains an exception to this trend, where statistics show that one child in every eight dies before their fifth birthday (129 per 1000 live births). Child mortality is on the increase, primarily due to the impact of HIV and AIDS. The target has been set for South Africa to decrease the infant and child mortality rate to 20 deaths per 1 000 live births, or lower, by the year 2015 (Department of Health 2010a).

The National Department of Health Strategic Plan remains firmly focused on the implementation of the 10 Point Plan for the heath sector during the period 2010/11 to 2012/13, which consists of the following priorities as shown in Table 1 (Department of Health 2010b) .

Table 1: The DOH 10 Point Plan

i.	Provision of strategic leadership and creation of a social compact for better health outcomes;
ii.	Implementation of National Health Insurance (NHI);
iii.	Improving quality of health services;
iv.	Overhauling the health care system and improving its management;
v.	Improving human resources management, planning and development;
vi.	Revitalisation of infrastructure;
vii.	Accelerated implementation of HIV & AIDS and Sexually Transmitted Infections National Strategic Plan 2007-11 and increase focus on TB and other communicable diseases;
viii.	Mass mobilisation for better health for the population;
ix.	Review of the drug policy; and
x.	Strengthening research and development.

Point (iii) of the 10 Point Plan for the heath sector is to improve the quality of health services in South Africa. In keeping with this new approach, the health sector will devote particular attention to decreasing maternal mortality, increasing life expectancy at birth and reducing child mortality.

According to midyear statistics (Statistics South Africa, 2011), the province of KwaZulu-Natal has the second largest population of approximately 10,5 million people, 3,5 million of whom live within the eThekwini Municipality. Of these, approximately 34,4% are unemployed, which is the highest rate of unemployment in any Metropolitan district in South Africa. A quality of life survey, which was commissioned by the eThekwini Municipality, states that poverty is a major problem within its district. Therefore, a large proportion of the population depends on the

public health sector (Dray, McGill, Muller, Muller & Skinner, 2006). In the preliminary stages of this research, the researcher arranged interviews with Dr Kelly, a specialist neonatologist and head of the Neonatal/Paediatric Intensive Care Unit at the Inkosi Albert Luthuli Central Hospital and Dr Niree Naidoo, the Principal Specialist Neonatologist at Prince Mshiyeni Memorial Hospital to get as much information about the subject matter as possible. During the interviews held on 14 March 2011, Dr Kelly stated that some 58 000 neonates had been born in the eThekwini Municipality in KwaZulu-Natal during the year of 2010, a figure that was confirmed by Dr Naidoo. The high birth rate in the province contributes to the frequent neonatal inter-healthcare facility transfers, as many of the hospitals do not have the necessary equipment or staff should the neonate require specialist or intensive care management.

The neonatal period is a critical time, particularly the early neonatal period. Although the vast majority of newborn neonates follow an uneventful course, those who do require medical intervention tend to need urgent, specialised attention by skilled healthcare providers in an appropriately equipped facility. This is essential to maximise the likelihood of a favourable outcome (Smith et al., 2009). The use of specialised centres for the treatment of sick neonates has resulted in an improved rate of survival. Therefore, the safe and efficient transfer of these neonates to specialised centres is an important part of their overall care. Continuum of care is necessary throughout the transfer process, which includes appropriate stabilisation initiated on recognition of a problem (Bethany, Farris & William, 2007).

1.3 Purpose of the study

The purpose of the study is to undertake a descriptive analysis of the inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal.

1.4 Objectives of the study

The objectives of the study were to:

- analyse the clinical demographics of inter-healthcare facility transfer of neonates;
- assess time frames from the request of the transfer to the handover of the neonate at the destination;
- determine the qualifications of the transfer team, the procedures performed during transfer and the availability of equipment required for the transfer; and
- investigate any adverse events encountered during the transfer of the neonate.

1.5 Rationale of the study

Safe, efficient, equipped and skilled inter-healthcare facility transfer of neonates by emergency medical services is an essential component of overall care, especially for those requiring intensive care. Specialised, dedicated neonatal transport teams have been proven to improved neonatal outcomes (Britto, Nadel, Maconochie, Levin & Habibi, 1995; Mullane, Byrne, Clarke, Gorman, Griffin, Ramesh & Rohinath, 2002; Miller, Novak, Weinger & Buerhaus, 2008). This study could be used as a quality improvement mechanism by identifying potential gaps or challenges experienced during the inter-healthcare facility transfer of neonates and making recommendations into key issues for the future improvement of this service. Studies of this nature are essential components of providing appropriate emergency medical care and contribute to a very limited body of knowledge of inter-healthcare facility transfer of neonates in South Africa.

1.6 The researcher's interest in the study

The researcher has been employed by the Emergency Medical Rescue Service (EMRS) in KwaZulu-Natal since 1989. During these years the researcher has been involved in many neonatal inter-healthcare facility transfers and, having developed

an interest in this area of service, realised that there is a paucity of research in inter-healthcare facility transfers of neonates in South Africa. According to his experiences in the field, a large number neonates being transferred from one healthcare facility to another are transported by non-specialised neonatal transport teams with inadequate or malfunctioning equipment. It is the researcher's belief that dedicated and specifically trained neonatal transport teams need to be established to improve the care that is provided during transfers and that standards should be established for neonatal management and monitoring during transfer. This motivated the researcher to undertake this particular study.

1.7 Assumptions and delimitations of the study

1.7.1 The following assumptions were made:

- The Emergency Medical Rescue Service in eThekwini has all the necessary resources (ambulances, equipment and appropriately trained personnel) to provide a neonatal inter-healthcare facility transfer service (Department of Health 2005).

- Ambulances with the required equipment will be dispatched within three minutes of the request (Department of Health 2005).

1.7.2 The delimitations of the study were as follows:

- The study was limited to the neonatal transfers provided by the public sector ambulance service known as the Emergency Medical Rescue Service (EMRS) within the eThekwini Health District of KwaZulu-Natal. The private sector ambulance services and other health districts were excluded from this study.

1.8 Structure of the dissertation

The structure of this dissertation is as follows:

- Chapter 1 provides the study background, the aims and objectives and the purpose of the study.
- Chapter 2 presents the literature review for inter-facility transfer of neonates, which specifically focuses around the objectives of the study.
- Chapter 3 discusses the methodology of the research, which includes the study design, data collection methods and analysis, sampling, population, inclusion and exclusion criteria, reliability and validity, problems, limitations and ethical considerations.
- Chapter 4 presents a comprehensive descriptive and inferential analysis of the results which is shown in Tables or Figures.
- Chapter 5 discusses the findings of the study.
- Chapter 6 provides the conclusions and recommendations of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Although there has been a growing interest in inter-healthcare facility transfers of neonates, much of the research has focused on the criteria necessitating neonatal transfer and very little research is associated with the transfer process itself, who is involved, how, when and by what means (Miller et al., 2008). A common feature in the neonatal period is the rapidly progressive course of diseases, and inter-healthcare facility transport of neonates is necessary when a neonate's condition requires investigation or a higher level of care than can be provided by the referring facility (Chen, Macnab & Sun, 2005).

The ideal transport of a baby is done naturally, in utero. Unfortunately, problems cannot always be identified in time to transfer the mother to a specialised facility before the neonate is born and many problems only emerge during birth. From the moment a perinatal problem is recognised to the point of its resolution, there is a need for a continuum of care. The use of specialised centres for the treatment of sick newborn neonates has been associated with better chances of survival. The safe transfer of neonates to these centres is, however, a crucial part of the overall care (Bethany et al., 2007).

Caring for a critically ill neonate during a transfer is very different from caring for a neonate in a Neonatal Intensive Care Unit (NICU), which has state of the art equipment and highly trained staff to deal with emergencies. In a moving vehicle, however, the emergency care practitioners have to deal with adverse weather conditions, noise, mechanical vibration, unstable equipment, restricted lighting, limited work space and limited support services. In spite of these difficulties, however, if the neonatal intensive care patient is prepared for the transfer with meticulous attention and the ambulance is furnished with the appropriate equipment

in good working order, the possibility of equipment problems and neonatal clinical instability should be minimized during transport (Boxwell, 2010).

Inter-healthcare facility transport of neonatal intensive care patients requires co-ordination among referring personnel, transport team personnel, emergency medical services and the receiving personnel. Specialised transport teams can facilitate these transfers as well as provide a unique service to the neonates and their families. As providing intensive care to neonates in a transport environment is very different from providing this care in the neonatal intensive care unit, transport personnel must be trained to provide this care in various environments, including ground ambulances, rotor wing aircraft (helicopters) and fixed wing aircraft ambulances (Horowitz & Rozenfeld, 2007).

The neonatal transfer process is made up of four phases, which are the activation phase, the preparation phase, the retrieval phase and the reception phase. To initiate the transport process, the appropriate medical control centre needs to be contacted. Upon receiving the transport request, the medical control operator decides whether the transfer is appropriate and discusses stabilisation issues with the referring doctors. Additional communication occurs between the referring and receiving doctors, transport teams, and pilot or drivers (Miller et al., 2008).

The risk of deterioration from the primary illness, complications of treatment, and the transfer process itself makes the inter-healthcare facility transfer environment potentially hazardous for the neonate. Therefore, appropriate stabilisation, initiated on recognition of a problem, is necessary throughout the transfer process (Britto et al., 1995).

Factors to be considered in inter-healthcare facility transfer of the neonate include clinical demographics, the level of skill of the transfer team, the equipment required for neonatal transfer and the transportation of the neonate in a safe, effective and efficient manner. These factors are the cornerstones of good neonatal transport.

2.2 Clinical demographics

The fourth Millennium Development Goal (2010) states that, globally, 86% of all neonatal deaths are caused by 3 problems: infection, asphyxia and prematurity. Infection alone accounts for 36% of the 4 million deaths annually. Infections can occur at any time in the neonatal period, but are the major cause of neonatal death after the first week. Asphyxia is the term used when the newborn does not cry or breathe immediately after delivery or has difficulty doing so (gasping), and accounts for 23% of newborn deaths. Without a trained person present at the delivery to identify and treat asphyxia, the newborn will die or possibly suffer grave morbidities, such as mental retardation or cerebral palsy. Prematurity is the direct cause of 27% of newborn deaths. Many pre-term newborns suffer from respiratory problems due to immature lungs and, as a result of being born early, have low birth weight (defined as being below 2 500 grams), a problem that underlies about 70% of all neonatal deaths. Pre-term neonates are less able to maintain a normal body temperature, have difficulty feeding and are at higher risk of infection (Department of Health 2010a).

The care of low-birth weight and pre-term neonates has long been an area of healthcare concern. Vulnerabilities of pre-term neonates include the transition to extra-uterine life, physiologic limitations, central nervous system immaturity and the need for intensive care. In addition to physiologic immaturities, neonates may experience pathophysiologic problems. Pre-term neonates, therefore, are dependent on intensive care for survival, to maintain vital functions, promote growth and development, and provide opportunities for development and organization (Blackburn & Faan, 1998). Efficient, reliable neonatal transport is a crucial requirement to transport these neonates to a neonatal intensive care unit (Boxwell, 2010).

A systematic review by the World Health Organisation analysed preterm birth rates worldwide to assess the incidence of this public health problem, map the regional distribution of preterm births and gain insight into existing assessment strategies. Data was collected from 2003 until 2007. The findings estimated that in 2005, 12.9 million births worldwide were pre-term. Approximately 11 million (85%) of these pre-

term births were concentrated in Africa and Asia, while about 0.5 million occurred in Europe and North America (excluding Mexico) and 0.9 million in Latin America and the Caribbean. The highest rates of pre-term birth were in Africa and North America (11.9% and 10.6% of all births, respectively), and the lowest were in Europe (6.2%). The study concluded that pre-term births is a global perinatal health problem in developing countries, especially Africa and Southern Asia, which incur the highest burden of pre-term births, not only in terms of associated mortality, but also with regard to short and long-term morbidity and financial implications for health-care systems. Therefore, a better understanding of the causes of pre-term birth and effective obstetric and neonatal care must be the priority of developing countries (Beck, Wojdyla, Say, Betran, Merialdi, Requejo, Rubens, Menon & Van Look, 2010).

In light of the paucity of literature in neonatal inter-healthcare facility transfers in South Africa, the researcher arranged interviews on 14th March, 2011 with two leading specialist neonatologists to obtain anecdotal evidence. During one of these interviews, Dr Niree Naidoo, the Principal Specialist Neonatologist at Prince Mshiyeni Memorial Hospital, stated that there had been a total of 12 969 deliveries in the year 2010 and, of these, 3 537 (25%) were admitted to hospital with complications, many requiring transfer to more specialised facilities. She explained that the main reasons for inter-healthcare facility transfer of neonates are a lack of specialised neonatal facilities, lack of suitably trained staff, lack of specialist care and a lack of intensive care management. The neonates are usually transferred within the first 24 to 48 hours from birth and the most common causes necessitating transfer include pre-term birth, low-birth-weight, infections, asphyxia and birth trauma. Common complications associated with pre-term neonates are hyaline membrane disease, congenital pneumonia, neonatal sepsis, abdominal pathology requiring supportive care, such as perforated bowel secondary to necrotising enterocolitis, and structural lung pathology, such as lung cysts or diaphragmatic hernia. The most common problems encountered by full-term neonates are congenital pneumonia, meconium aspiration syndrome, persistent pulmonary hypertension, structural lung abnormalities, complex congenital cardiac lesions, supportive ventilation, sepsis or abdominal pathology. This information was confirmed during another interview on 14th March 2011 with Dr John Christopher

Kelly, a specialist neonatologist, who is the head of the clinical unit at Inkosi Albert Luthuli Central Hospital.

Regardless of the clinical demographics of the neonate, stabilisation and meticulous attention to resuscitation procedures before transport, and intensive care monitoring and necessary clinical interventions during transport are the main keys to avoiding complications during the transfer. Therefore, a combination of pre-transfer stabilisation, a safe, effective and efficient manner of transport and skilled, experienced transport teams are crucial requirements in ensuring that the neonate reaches the destination safely.

The basis of a safe, effective and efficient transport is good communication and coordination between referring doctors, receiving doctors and the transportation team. It is necessary to plan carefully for these occasions, and for paramedics attending the transport to be able to continue with any necessary intensive care while the neonate is in transit (Barry & Ralston, 1994).

2.3 Pre-transport stabilisation (packaging)

All too often it is forgotten that in an emergency, speed is no substitute for the time invested in resuscitating and stabilising the neonate before the journey. There is a rare need for haste and panic transfers are easy to spot and often result in morbidity or mortality. According to Hadley (1988), there is not a hospital or a clinic that does not provide a better environment for stabilising a neonate than bouncing around in the back of an ambulance or in a restricted space of a noisy unstable aircraft.

The golden hour concept that treatment should be received within the first hour has led to the emphasis on speed delivery during neonatal inter-healthcare facility transfers. However, timely interventions and enhanced monitoring and care provided before the transfer are the key to improved outcomes in critically ill neonates as interventions in a less safe environment could potentially have a negative effect on the outcomes. Taking intensive care to the neonate and pre-transport stabilisation may be more beneficial than rapid delivery to a health care facility (Stroud, Prodhan, Moss, Fiser, Schexnayder & Anand, 2010).

The personnel from referring facilities often perceive the length of time taken by the transport team to prepare the neonate for transport as a problem. A study conducted by The British Columbia Children's Hospital in Vancouver, Canada, examined the effects on time at the referring hospital of the number and complexity of interventions performed by the transport team to stabilise the neonate prior to transfer. Data were collected from 55 inter-facility transports over a 10 week period. Thirty of the 55 (55%) neonatal transports required no interventions (Class 1) with a stabilisation mean time ± standard deviation (SD) of 52 min ± 25min. Sixteen (29%) required low level interventions only (Class 2), such as peripheral intravenous insertions, oxygen administration, arterial blood gas assessment, nasogastric tube insertion and foley insertion, with a stabilisation mean time ± SD of 60min ± 22min. Nine (16%) required high-level interventions (Class 3), which included intubation, arterial cannulation, central venous cannulation, and chest tube insertion, with a stabilisation mean time ± SD of 140min ± 52min. The stabilisation times for high level interventions (Class 3) were significantly greater than both no (Class 1) and low (Class 2) level interventions with a p. value = < 0.0001 (Chen et al., 2005).

2.4 Transporting the neonate in a safe, effective and efficient manner

When effecting the transfer of a neonate from one healthcare facility to another, the choice of the mode of transport depends on a multitude of factors which include geography (distance, topography), time of day, road and weather conditions, availability of vehicles and/or crews, urgency of the transfer, safety and cost. The Emergency Medical Rescue Services in KwaZulu-Natal operate both ground ambulances and two types of air ambulances, one rotor wing aircraft (helicopter) and one fixed wing aircraft and each of these is associated with their own challenges. Ground ambulances are the least costly and fixed wing aircraft are less expensive than helicopters. Ground ambulances have proved quicker for short distances than air ambulances, although there can be an increase in transport time over long distances and traffic delays. Ground ambulances are more spacious than air ambulances, can stop easily if a procedure must be performed and can be used in most weather conditions (Lupton & Pendray, 2004). When using air ambulances for the transfer of neonates, aeromedical considerations must be taken into account. An increased inspired oxygen concentration is mandatory for all aeromedical transfers

as a fall in barometric pressure results in reduced alveolar partial pressure of oxygen and may lead to hypoxaemia. A fall in barometric pressure also leads to an increase in the volume of gas filled cavities in the neonate. Pneumothoraces must be drained. Nasogastric tubes should be inserted and set on free drainage. Increased altitude is also associated with a fall in temperature which leads to hypothermia. Limited cabin space in air ambulances obscures neonatal assessment, monitoring and interventions. Noise and vibration may cause nausea, pain and motor dysfunction to the neonate and the attending paramedics might experience difficulty in monitoring the visual and auditory alarms of obscured equipment, which may result in disastrous consequences (Whiteley, Gray, McHugh & O'Riordan, 2002).

According to Lupton & Pendray (2004), the decision regarding which mode of transport to use is determined by many variables and should ultimately be the joint decision of the transport co-ordinator and the dispatcher. This is an area where knowledge and experience triumph over protocols. The transport co-ordinator should have the authority to make the decisions regarding the transfer and the administration thereof. The transport co-ordinator is responsible for:

- assessing the need for the inter-facility healthcare transport;
- assessing the neonate's condition;
- triaging the neonate in consultation with the referring physician;
- determining the priority of the transfer;
- deciding the equipment and the appropriately trained personnel required;
- advising on interim care;
- supervising neonatal care throughout the transfer process;
- choosing the mode of transport; and
- activating the transport team.

The confined space of the ambulances, especially aircrafts, make it mandatory that the neonate is as well secured as possible and protected from the environment, while still allowing easy access to intravenous lines and the airway. The neonate must be secured, even in an incubator. It is also important for the safety of the neonate and team members that all equipment is secured to prevent loose items acting as missiles during sudden acceleration or deceleration of the vehicle (Taljard, 2008).

Systematic issues including time delays and inadequate transport processes were associated with increased neonatal mortality. Neonatal transport teams spend some time stabilising a neonate's condition prior to transport. Without adequate stabilisation, a clinical deterioration en-route can be expected (Miller et al., 2008). Shortened inter-healthcare facility transport time may lead to improved outcomes for the smallest and most critically ill neonates. However, there is no point in stabilising a neonate, arranging the transfer and then allowing the neonate to deteriorate through neglect, while waiting for the transport team to arrive (Ohning, 2008).

A comparative study in India investigated the associations between the duration of inter-healthcare facility neonatal transport and their outcomes. This study showed that neonates who spent a longer time in transit while being transferred from one facility to another had a 79% higher odds ratio of death than those being transported for a short duration. There was strong evidence that those transported for more than 90 min had more than twice the rate of neonatal death (95% CI), and some evidence that those transported for between 60 and 89 min had an 80% higher rate of neonatal death (rate ratio 1.81, 95%), both compared with those transported for between 30 and 59 min, after adjusting for the confounding effects. The study concluded that there is an association between the duration of transport and an increase in neonatal mortality (Mori, Fujimura, Shiraishi, Evans, Corkett, Negishi & Doyle, 2007).

The Metro Emergency Medical Services in Cape Town introduced a dedicated maternal and neonatal Flying Squad service programme in 2006. This service was intended to provide better pre-hospital care for mothers and children. To assess the success of this initiative, a retrospective study reviewed the calls handled by a non-dedicated Flying Squad service from 1 January to 31 December 2005 and calls

handled by the new neonatal Flying Squad service from 1 January to 31 December 2008. All incidents evaluated in the study revealed a significant improvement in transit times between 2005 and 2008. The Flying Squad dispatch performance improved from 11.7% to 46.6% of all incidents dispatched within 4min (p. value = < 0.0001). The response time performance at the 15min threshold did not demonstrate a statistically significant improvement (p. value = 0.4). The improvement in the 30min performance category was statistically significant in both maternity and neonatal incidents. The maternity incidents displayed the greatest improvement with the 30min performance increasing from 30.3% to 72.9%. The neonatal transfers displayed a reduction in total pre-hospital mean times from 177min to 128min. The study concluded that the introduction of the Flying Squad programme has resulted in significant improvement in the transit times of both neonatal and obstetric patients. Although developing nations face severe resource constraints, the Flying Squad programme offers significant gains (De Vries, Wallis & Maritz, 2011).

A descriptive review of flight data by Werman and Neely (1996) was aimed to determine whether the institution of a formal neonatal transport policy would increase the effective utilisation of air medical resources and to determine whether such a policy would be useful to other air medical transport programmes. Data utilised were from time periods before and after the institution of the policy. The results showed that after implementation of the policy, the total number of neonatal transports decreased from 85 in 13 months to 60 in 17 months, as did the number of return transports per month from 4.6% to 1.3%. In addition, the average mission time for all neonatal transports decreased. The study concluded that the implementation and development of the neonatal team transport policy increased the effective utilisation of air medical resources and decreased the return transfers.

It is essential that a systematic approach is taken when transferring a neonate, starting with the decision to transfer, through the pre-transfer stabilisation, in-transfer monitoring and stabilisation until finally handing over the neonate to the receiving hospital. This will encompass all the stages including clinical demographics, skill of the transfer team, equipment required for neonatal transfer and transporting the neonate in a safe, effective and efficient manner (AAGBI Safety Guidelines, 2009).

2.5 Skill of the transfer team

The transfer of a critically ill neonate is inherently risky and up to 75% of neonates transferred by non-specialised teams can suffer serious clinical complications, such as airway and cardiovascular compromise or even death. These risks can be considerably reduced if a specialised retrieval team stabilises the neonate and establishes intensive care at the referring hospital before transfer (Britto et al., 1995). Meticulous preparation and stabilisation of the neonate before departure minimizes the clinical risks during transportation. This encompasses adequate resuscitation, initiation of all supportive therapies and monitoring, improvement in the clinical condition and pre-emptive management to avoid problems in transit. A systematic ABC approach is useful to ensure that all aspects have been attended to. The airway, breathing, circulation, neurological status, temperature and blood glucose level of the neonate are assessed as it is prepared for transportation, Once the neonate has been thoroughly assessed in the hospital, the neonate is transferred to the ambulance which has the necessary equipment to provide continuous therapy and monitoring throughout the transfer. Neonatal deterioration during transport can be rapid therefore the neonate must be regularly assessed by appropriate skilled transport personnel (Britto et al., 1995; Rowney & Simpson, 2006).

One of the major risks of neonatal transport is exposure to inadequately trained transport personnel. A retrospective study in Ireland showed that the transport of critically ill neonates by specialised transport teams has been associated with a significant improvement in their clinical condition on arrival at the receiving hospital. The study aimed to determine if the National Neonatal Transport Programme, introduced in 2001, improved clinical condition of neonates at the end of transfer. A total of 176 neonates were transported between March 2001 and March 2002. Before this programme was established each unit had been responsible for its own transport. There have been many advances in neonatal care, but the establishment of the National Neonatal Transport Programme by providing an experienced well-trained team for the transfer of critically ill neonates is a significant step in improving care available to critically ill neonates in Ireland (Mullane et al., 2002) .

A South African study emphasised that neonatal transport in third world countries remains hazardous because of the shortage of human and material resources. An audit of the transportation of 126 surgically ill neonates was undertaken to identify areas where improvement is possible. Failure to maintain simple interventions such as intravenous fluid replacement and nasogastric drainage were found. The authors of this study came to the conclusion that investment in education is likely to pay greater dividends than further technological advances (Hadley & Mars, 2001).

Inter-healthcare facility transportation of neonatal intensive care patients involves a highly confident and competent skilled team to ensure continuation of intensive care treatment so that the neonate arrives at its destination in a stable state. Anticipation, the ability to foresee contingencies and plan activities in advance, is fundamental to the leader's role. Generally, a transfer should not be undertaken until the neonate has been resuscitated and stabilised. All personnel should be well versed in the use of the equipment, common causes of its malfunction and the ability to trouble shoot and solve problems (Miller et al., 2008).

Inter-healthcare facility transport team personnel must be competent to perform all monitoring and care similar to that provided in a neonatal intensive care unit. Recommended certification includes basic life support, paediatric advanced life support, and the neonatal resuscitation programme. Transportation team personnel often face challenges because of the wide array of medical conditions, the uncertainty of the circumstances under which they function and the small, cramped space of the transport ambulance. Leadership, teamwork, and ability to think critically are essential in the pre-hospital setting (Horowitz & Rozenfeld, 2007).

A study by the British Columbia Children's Hospital in Vancouver, Canada, was undertaken to determine the optimal escort for inter-hospital transport of paediatrics. Hospital charts of 130 seriously ill or injured neonates transported to tertiary level intensive care units were examined to determine the incidence of secondary conditions incurred. Group 1, 72 % of n = 34, incurred secondary conditions with escorts who had not received specialised paediatric transport training, Group 2, 20% of n = 44, incurred secondary conditions with specialised paediatric transport escorts working alone and Group 3, 8% of n = 52, incurred secondary conditions with specialised paediatric transport escorts. The study recommended that all transport

coordinators review the qualifications and experience of their transport team personnel and assess their ability to provide optimal care for the neonates they transport, particularly during long transfers, transfers by air, and when serious illness or injury is involved (Macnab, 1991).

Ideally, a specific team should be allocated for neonatal transport only. This ensures a rapid, timely team dispatch and a neonatal focused emergency response to neonatal transfers. Having a standalone team also enhances familiarity with neonatal specific processes and equipment, thus the care of neonates is not compromised by a lack of staff availability and competency (Ratnavel, 2009). Relocating staff from other units for urgent transfers may pose concerns of the quality of neonatal care and safety as well as subsequent delays. Although the optimal team is best determined by the needs of the neonates, all team members should have extensive experience and training in neonatal resuscitation (Horowitz & Rozenfeld, 2007). According to Lupton and Pendray (2004), the following critical principles of the neonatal transportation teams should be considered:

- All team personnel must be properly trained and competent in the delivery of neonatal intensive care, the transport environment and stress management.
- Two team personnel, excluding the driver, are highly desirable for emergency neonatal transports as it can be an extremely difficult and very stressful environment.
- One member of the team needs to be delegated as the team leader.
- All team personnel must be aware of the contribution expected of each other. All personnel involved in execution of a transfer must work in a timely manner, and understand their respective accountabilities.

A retrospective descriptive comparative study in India compared prolonged, long distance transfers of neonates by road ambulances undertaken by a qualified transport team verses those done by the same team for shorter distances and time. The study period was over 48 months, from July 2004 to June 2008. A total of 1 015 neonates were transported, of which 220 were long distance transports and 795 were short distance transports. The most common reason for referral and transport

was prematurity, followed by sepsis. The most common complication associated with prematurity was hyaline membrane disease. Therefore, the neonates were comparable in their gestational age and ventilatory requirements (46% verses 39%). The biochemical and metabolic characteristics and 24 hour mortality rates for neonates who were transported for longer times and distances were comparable to those transported for shorter times. The study concluded that long distance transport is feasible with a specialised skilled neonatal transport team (Kumar, Kumar, Shaik, Ghanta & Venkatalakshmi, 2010).

According to studies by Britto et al., (1995), Mullane (2002), Lupton (2004), Macnab (1991), Horowitz (2007), Taljard (2008), Ratnavel (2009) and Kumar et al., (2010), specialised neonatal inter-facility transfer teams improve the overall outcomes of the neonate. The advantages of using specialised neonatal inter-facility teams are:

- Team members have had training and experience in the inter-healthcare facility transfer of neonates.
- Rapid and timely dispatch to the referring facility.
- Equipment is readily available and suited for the task.
- The transport team can operate without depleting the staff from operational sectors.

In addition to direct patient care, the responsibilities of the transport teams are to:

- practice within the standards of the latest policies and procedures;
- inspect equipment and keep records of use, scheduling maintenance and repairs;
- control and replenish medical sundries;
- undertake patient follow-up and clinical feedback;
- undertake quality improvement and continuing education;
- undertake training and development;

- undertake critical evaluation of team performance and system issues; and

- participate in lectures, group discussions and data collection.

Because of the difficulty of working in the confined space of an ambulance, one of the most important aspect that must take place in the hospital before transport is the packaging of the neonate. It is vital that the neonate's head is securely fixed, even in an incubator. Tracheal and ventilator tubes should also be securely fixed, but should be easily accessible to ensure airway management. Intravenous line extension tubing is useful for administering drugs or fluid without needing to move around, open incubator doors or unwrap the neonate. The ambulance environment is not always conducive to maintaining warmth, which can be a problem when transporting neonates, who are particularly vulnerable as they have a large surface area to weight ratio, a large head, thin skin and a neuromuscular blockade which prevents shivering The use of simple blankets, foil blankets, chemical warming packs, a hat and warm ambient temperature within the vehicle are sufficient to maintain body temperature in neonates over 1.5 kg body weight. Neonates less than 1.5 kg are usually transported by neonatal intensive care teams using a portable incubator to maintain body temperature. All equipment, syringe pumps and the monitor must be secured and readily visible to the team while seated. Emergency pharmacological agents, fluids, airway and ventilation equipment, including the self-inflating resuscitation bag valve mask system must be immediately available. A pre-departure checklist must be completed to prevent accidental omissions in stabilisation or inadvertently leaving equipment behind (Rowney & Simpson, 2006).

The skills of the transfer team and the outcome of the neonate during the inter-healthcare facility transfer depend largely on the equipment required for the transfer.

2.6 Equipment required for neonatal transfer

The quality of services provided by private and provincial ambulances transporting ill neonates in the Witwatersrand area was investigated by means of a case study. Of the 15 cases investigated, 11 neonates were transported by private ambulances and 4 by provincial ambulances. Data regarding the maternal and neonatal history, the

optimal maintenance of the neonate's condition, the communication system, as well as aspects relating to the transport personnel was collected by means of a structured instrument. Findings revealed that the quality of service provided in the transport of ill neonates was not up to the required standard, especially in the private ambulances. Deterioration of the neonate's body temperature, heart and respiration rates, as well as the serum glucose values after transport were some of the more important findings. The lack of equipment, especially in the private ambulances, increased the risk of transport (Roux, Nolte & Muller, 1989).

The equipment in the neonatal transfer vehicles should be suitable to monitor neonates of various gestational ages for a variety of problems. The equipment must be reliable and designed to work in difficult environments and be commensurate with the severity of the neonate’s illness and the anticipated duration of transport. Neonatal transport equipment commonly weighs over 100 kg and presents a challenge to vehicle operators in terms of weight, manual handling, crash-worthiness and power consumption (Boxwell, 2010).

According to Rowney & Simpson (2006), inter-facility neonatal transportation teams should be self-sufficient in that they should carry all the necessary equipment, medical sundries and pharmacological agents for neonatal stabilisation and transportation. As some of the smaller healthcare facilities may not be equipped with the full range of consumables for neonates, these should be pre-packed in special bags with multiple, labelled compartments to allow rapid access to the contents. Other important equipment that should be included in the ambulance are a mobile telephone, warm protective high-visibility clothing for staff and a container to dispose of sharp objects.

The equipment in ambulances needs to be in full working order and ready for any emergency that might arise during the transport. A pre-departure checklist should be carried out to ensure that all equipment is fully charged, and checked for their completeness and functioning before leaving to undertake the transfer. The equipment should be able to function for prolonged periods of time, as the transport environment may vary and be unpredictable. All electronic equipment should have an independent power supply (AC/DC capability), adequate visual and audio alarms, and a lack of electromagnetic interference. Power supply extensions must be carried

for use of external supplies when necessary. Oxygen and medical gas requirements should be determined and estimated before commencing the transfer. Equipment must be lightweight, compact, durable, well secured, and motion and g-force tolerant. (Lupton & Pendray, 2004; Boxwell, 2010).

According to Hackel, Simon, Wingert & Bergeson, (1986), neonatal inter-facility transfer equipment should meet the following criteria in both air and ground ambulances:

- they should have AC power capability;
- be easily maintained and cleaned;
- be self-contained, lightweight and portable;
- provide capabilities for neonatal intensive care in the transport setting;
- not interfere electromagnetically with navigation and communication systems;
- be durable enough to withstand severe mechanical, thermal and electrical stress and repeat use; and
- be packaged to enable continuous neonatal intensive care while entering and exiting a ground or air ambulance.

A study was undertaken to compare the physical stressors to which a critically ill neonate is exposed during emergency transfer by helicopter as compared to a ground ambulance to assess concurrent mechanical stresses from shock, vibration, and noise. The neonatal equipment included a transport incubator. The study was based on 10 hours of transport by ambulance and 2 hours by helicopter. Noise, whole body vibration, rate of turn, acceleration and pitch were extracted as the five most representative dynamic harshness indicators. Ground ambulance transfers had more dynamic effects in terms of braking shock, whereas helicopter transfers had more vibrations and higher noise. No difference was seen in the rate of turn and pitch amplitudes between the two transport modes. However, the study raises major concerns about the degree of exposure of the sick neonate to stationary and impulsive physical stressors during transportation, despite specialised teams and

modern means of transportation. An assessment of stress during transport is highly desirable, but requires a better understanding of the pathophysiologic effects of transport in newborn infants. Efforts should be made continuously to reduce physical stressors to enhance the safety of neonatal transport (Bouchut, Van Lancker, Chritin & Gueugniaud, 2011).

Hadley (1988) states that neonatal inter-health care facility transfers are an important part of the continuum of care provided to neonates as they are unable to fend for themselves or to compensate for any deficiencies in the service provided. Inter-health care facility transport of neonates from one level of care to another represents a dangerous break in the ideal of continuity. If the standard of care is not maintained during transportation, there is very little point in carrying out the transfer. The steps and principles involved in safe neonatal transfer are simple and the interventions required are within the means of every practitioner, institution and organisation. Hadley, (1988) suggests using an aid memoire in the form of the mnemonic, TWO SIDES, which will help prevent any important aspect of care going unattended. Table 2 presents the mnemonic, TWO SIDES, as a fingertip memory aid when transporting a neonate.

Table 2: The mnemonic, TWO SIDES

Tubes	Drainage tubes should be correctly inserted, placement confirmed, secured and free drainage into collection bags. Tracheal tubes should be correctly inserted, confirmed and strapped in the correct position.
Warmth	Maintain warmth. Set incubator temperature appropriately.
Oxygen	Adequate oxygenation.
Sugar	Correct the blood sugar level
Intravenous Infusions	Intravenous and arterial cannulations should be correctly inserted, placement confirmed, strapped and labelled. Infusions pumps or driver must be well secured.
Documentation	Collect and hand over all documentation.
Escorts	Nursing escort
Specimens	Collect and handover all specimens.

2.7 Adverse events encountered during inter-health care facility transfers

Barry and Ralston (1994) undertook an observational study in Leicester, recording adverse events occurring during inter-healthcare facility transfer of critically ill neonates over a six month period. Their findings showed 42 (75%) of the 56 cases reviewed had experienced adverse clinical events during transport. In 13 cases, the events were life threatening. The adverse events were most commonly attributed to inadequate circulatory and ventilatory support, inadequate monitoring, equipment failures and drug errors. Children who subsequently died were more likely to have had complicated transfers than those who survived.

Miller et al., (2008) observed that adverse events were associated with 34% of inter healthcare facility transfers. Of these, 50% were attributed to recommendations by admitting physicians not being followed and 30% were attributed to technical problems. These findings are consistent with earlier research (cited by Barry & Ralston, 1994) who identified inexperienced staff and inadequate and malfunctioning equipment as critical problems during neonatal transport and advocated specially trained paediatric transport teams to reduce adverse events.

A retrospective study in Newcastle, United Kingdom, reviewed critical incidents over a period of 8 years, from 1997 to 2004. Findings showed that of a total of 2 402 neonatal inter-healthcare facility transfers, 562 transfers were associated with at least one critical incident. These critical incidences were the result of poor preparation, logistical problems, poor communication, ambulance delays, damaged or malfunctioning equipment and various other clinical problems. Incidents deemed to be due to poor preparation included transport equipment being incompletely charged, forgetting to load the equipment before leaving for the transfer or insufficient gas supplies for the duration of the transfer. Logistical problems included being unable to assemble the transport team or being unable to access the hospital on arrival. There was poor communication to the transport team at different stages of the transfer process. Ambulance delays were defined as taking longer to arrive than agreed upon according to the urgency of the transfer. Transport equipment was damaged or malfunctioning during the transfer or staff had difficulty utilising the equipment adequately. The clinical problems included difficulties in stabilising the neonates before transportation. There were eight potential catastrophic incidents. Five cases required cardio pulmonary resuscitation. Deterioration of the patients were from extreme ambulance vibration, persistent metabolic acidosis which the team were unable to correct, difficult ventilation due to equipment failure and blocked endotracheal tubes (Moss, Embleton & Fenton, 2005).

A recent study in the Johannesburg metropolitan region aimed to ascertain the clinical physiological stability of sick neonates on arrival at the receiving hospital following transport from another health facility. A total of 104 retrievals transported by both private and public ambulances were assessed during the study period, from October to December 2007, of which 96 were reported in the audit. The study confirmed that many neonates arrived in a poor clinical condition following transfer to a referral hospital, resulting in a relatively high mortality in the 48 hours after transfer. The majority (92%) of the 96 neonate retrievals were made by paramedic-led teams. Common adverse clinical events noted on arrival at the receiving hospital included hypotonia (32%), hypoxia (22%), hypothermia (21%) and acidosis (40%). The mortality at 48 hours after transfer was 7% and the statistics revealed that significant predictors of mortality at 48 hours for transported neonates were bradycardia, hypoxia, hypotension and hypothermia (Mgcini, 2011).

A study in Ireland by Mullane et al., (2002), discussed earlier, showed that adverse events had reduced after the introduction of the National Neonatal Transport Programme. A review was conducted on neonate transfers in the late 80s noting their temperatures, blood glucose and blood pH at the end of transfers. This information was then compared with those of neonates transported by the National Neonatal Transport Programme. The number of hypothermic neonates had reduced from 12% to 7%, the number of hypoglycaemic neonates had reduced from 13% to 3% and the number of acidotic neonates had reduced from 20% to 5%. Of the 176 neonates transported during the study period from March 2001 to March 2002, no neonate had died during transport. Twenty-six (15%), however, died before being discharged from hospital. The causes of death were hypoplastic left heart (n=6), necrotising enterocolitis (n=5), prematurity (n=3), diaphragmatic hernia (n=2), encephalopathy (n=2) and other (n=8). It was concluded that the National Neonatal Transport Programme had improved the clinical condition of neonates at the end of transfer as compared to outcomes prior to the introduction of the programme.

Rowney and Simpson (2006) are of the opinion that critical incidents during inter-healthcare transportation of neonates are often associated with the switching of oxygen supplies and equipment when moving the neonate around the hospital, between trollies or neonatal beds, and in and out of ambulances. Despite pre-transport stabilisation and packaging and the best preparation, neonates may deteriorate in transit and the transport team should be skilled and equipped to clinically manage these situations. Critical incidents that occur during transportation of neonates can be classified as physiological related adverse events or equipment related adverse events. The findings of these authors revealed that the common physiological related adverse events that occur during inter-healthcare facility transportation include hypoxia, hypotension, hypothermia, hypoglycaemia, cardiac dysrhythmia, respiratory deterioration and deterioration in levels of consciousness.

The common equipment related adverse events that occur during inter-healthcare facility transportation are tracheal tube blockage, accidental tracheal extubation, loss of monitoring, loss of intravenous access, ventilator malfunction and exhaustion of oxygen supply.

These findings are consistent with studies by Barry and Ralston (1994), Miller et al., (2008) , Moss et al., (2005), Mgcini (2011) and Mullane et al., (2002) who identified similar adverse events.

The neonate should be reassessed regularly during inter-facility transportation using the systematic ABC approach recommended by Rowney and Simpson (2006) to avoid or minimise adverse events, especially in intensive care transfers. These are as follows:

- For intubated neonates, confirm the tube position, tube patency and tube fixation. Capnography is the most reliable method of monitoring airway security in intubated neonates, especially during periods of maximal risk such as loading and unloading from ambulances when clinical observation and monitoring is difficult. There is a high risk of tracheal tube blockage in internal tube diameter of < 5.0 mm by secretions, which is reduced by humidifying inspired gas using a heat and moisture exchanger and by regular tracheal suction.

- Adequacy of ventilation is assessed by observing chest movement, the airway pressure gauge on the ventilator and capnography monitoring. Regularly observe ventilator settings, connections and oxygen source.

- Assessment of circulation includes evaluation of heart rate, peripheral and central pulses, capillary refill, and blood pressure. Intravenous access sites are inspected regularly.

- Neurological status is assessed by evaluating pupil size and reactivity and fontanelle pressure. Seizure activity, which is masked by neuromuscular blockade, should be suspected if tachycardia, hypertension or pupil dilatation occurs suddenly. Body temperature and blood glucose in neonates can fall during transportation and should be measured regularly.

- Transport teams should have regular audit and risk management meetings to discuss these events.

2.8 Conclusion

According to the findings of the literature review, a large number of inter-health care facility transfers carried out by inexperienced staff and non-specialised transport teams, as well the use of inappropriate or malfunctioning equipment, have been associated with adverse events. Findings have also shown that the use of dedicated neonatal transfer units, which have the necessary equipment and are staffed by specialised personnel, have improved the quality of care provided to neonates requiring inter-healthcare transfer.

Inter-healthcare facility transfer of the neonate is a complex, tightly choreographed and multiple phase process. It is high risk because of the vulnerable nature of the neonates and the difficult environment and requires specialised equipment and skilled personnel. By identifying specific areas that are in need of improvement or restructuring, identifying priorities and making recommendations increases the potential of improving the quality of care provided to neonates who are being transferred from one facility to another and, thus, ultimately reducing the inter-healthcare facility transfer morbidity and mortality rates.

Even minor adverse physiological changes in a neonate during transportation may cascade into a life threatening complication. Therefore, it is essential that everyone involved in transferring a neonate understands the transport environment. The organization and safety of a neonate transfer system requires careful planning and meticulous stabilisation procedures, underpinned by good teamwork, clear communication between the referral hospitals and specialist retrieval team and a programme of continuous training of team members. Only then can a transport service achieve clinical excellence.

Chapter 3 discusses the research design and methodology, which includes the location of the study, the sample size, data collection methods and statistical methods used in data analysis, as well as the ethical issues.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodological studies address the development, the process of obtaining and organising data, and the validation and evaluation of research methods employed in addressing a research inquiry, investigation or problem (Polit & Beck, 2006).

A prospective study design was used to analyse neonatal inter-healthcare facility transfers within the eThekwini Health District of KwaZulu-Natal, due to insufficient, unreliable or a lack of existing data.

3.2 Study design

The proposed study was conducted using quantitative methodology and a non-experimental prospective design to undertake a descriptive analysis of the inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal. A descriptive survey method incorporating logistic and deductive reasoning was used to evaluate the objectives of this study (Polit & Beck, 2006).

3.3 Study setting

The study was set in the eThekwini Health District area serviced by the EMRS. This area is situated on the eastern seaboard of KwaZulu-Natal (KZN) in South Africa, as shown in Figure 1.

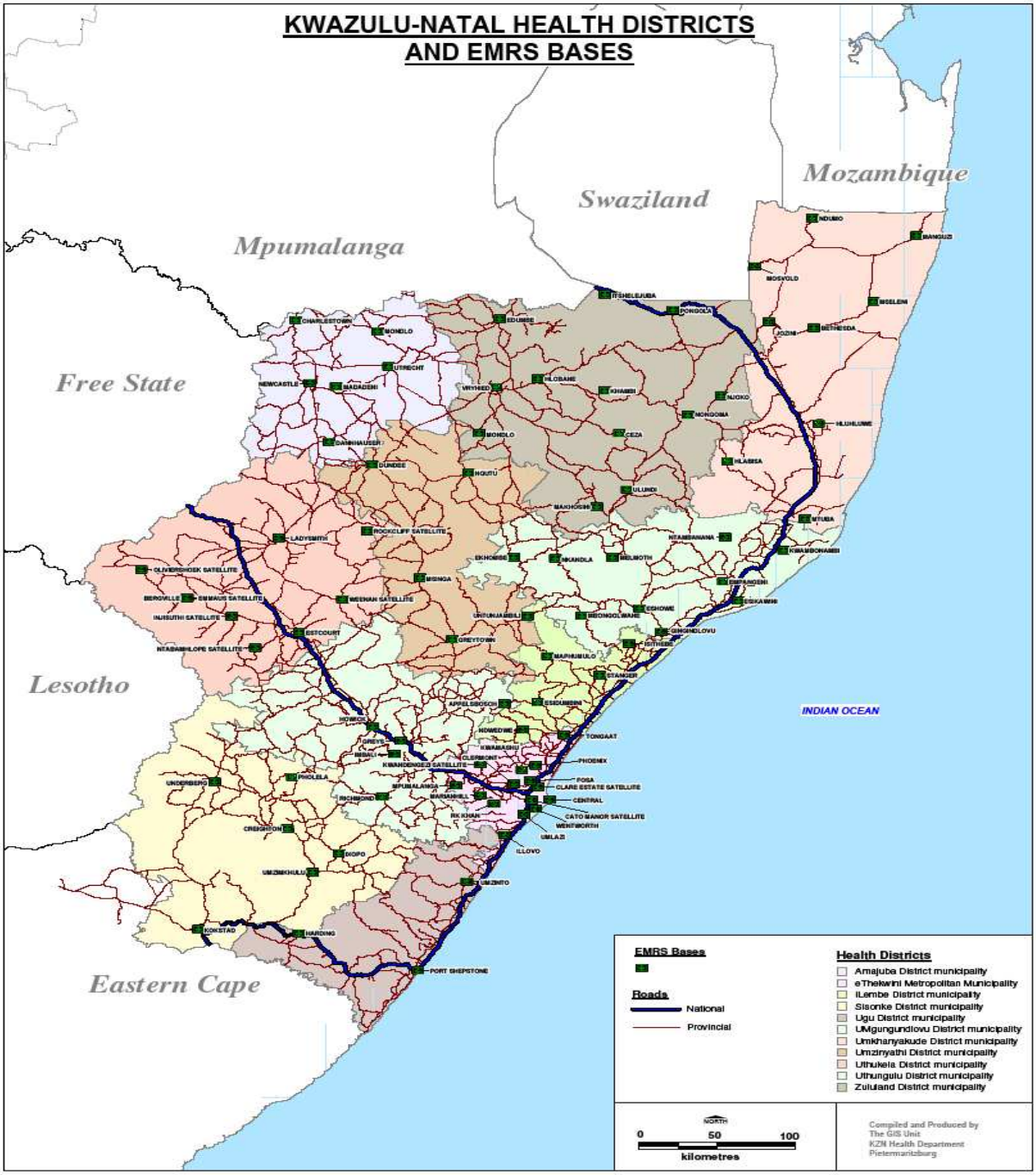

Figure 1: KwaZulu-Natal Health District and EMRS Bases

(Geographic Information Systems Unit, 2010b)

3.4 Location

3.4.1 Healthcare facilities in the eThekwini Health District

The eThekwini public healthcare facilities consist of various primary health care units (clinics and community health centres) throughout the province, 37 district hospitals (level 3), 14 regional hospitals (level 2) and one tertiary hospital (level 1) (Department of Health 2006).

District hospitals are the level 3 facilities with generalist staff, such as general practitioners. These hospitals provide basic diagnostic and therapeutic services with no intensive care units. Complicated health problems are referred to regional hospitals. Regional hospitals are the level 2 facilities that provide care requiring the intervention of specialists, general practitioners and intensive care. Regional hospitals are often the most overburdened of all the levels of hospitals, bearing the brunt of the many inadequacies in the district hospitals. Regional hospitals have limited intensive care units and specialist neonatal facilities and are able to ventilate and stabilise neonates before transfer. Tertiary hospitals are level 1 facility which provides specialist and sub-specialist care. These hospitals receive neonates from, and provide sub-specialist support to, a number of regional hospitals. The Inkosi Albert Luthuli Central Hospital serves as the tertiary hospital for the Province of KwaZulu-Natal and is based in the eThekwini Health District of KwaZulu-Natal. It has the largest neonatal intensive care facility in KZN (Department of Health 2006).

According to the Department of Health's Framework for Referral System for Health Service in KwaZulu-Natal, if the tertiary and regional hospitals have no available beds to accept a neonatal patient, then arrangements must be made by the referring doctor for a private hospital to receive the patient (Department of Health 2003).

It is the responsibility of the referring doctor to arrange for the neonate to be accepted by the receiving facility. The neonate must be prepared for transfer prior to the arrival of the ambulance in order to expedite the transfer. Handover of the specialised neonatal transfer to the paramedic (ALS) must be done by the referring doctor. Once the receiving hospital has completed its investigations or stabilisation of

the neonate, the neonate may be transferred back to the respective hospital or discharged home (Department of Health 2003).

The following diagram (Figure 2) represents the referral pattern framework of obstetrics and neonates for regional and tertiary care facilities in the eThekwini Health District, KwaZulu-Natal (Department of Health 2003).

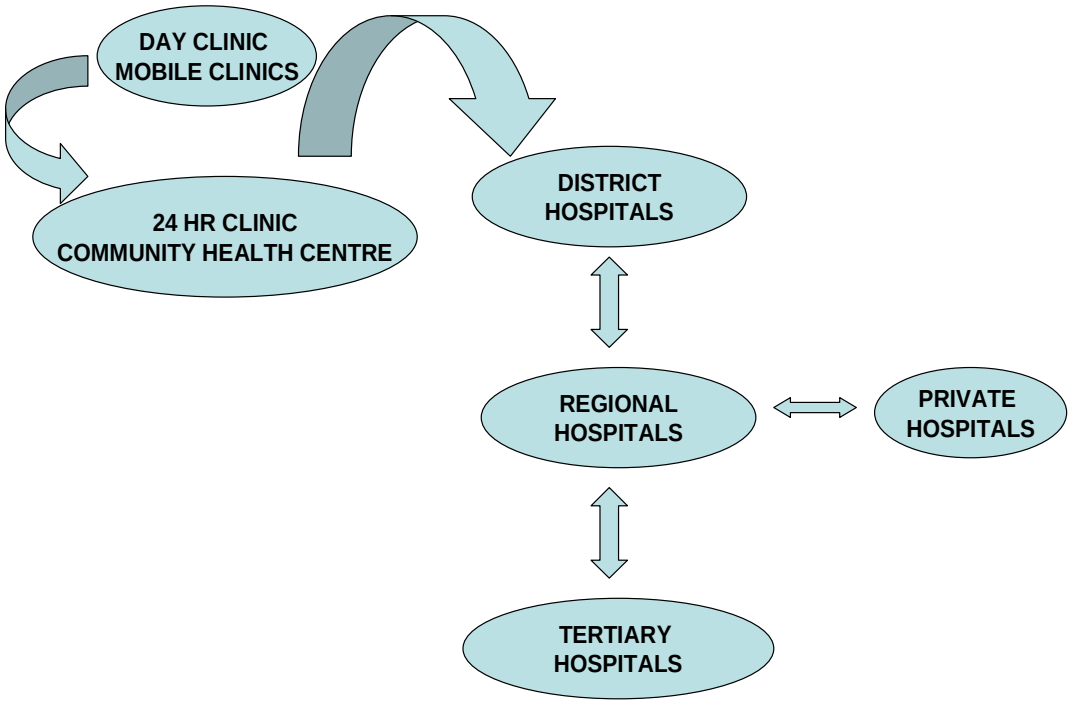

Figure 2: Referral pattern framework of obstetrics and neonates

3.4.1.1 Responsibility of the referring doctor

According to the Department of Health's Framework for a Referral System for Health Service in KwaZulu-Natal, it is the responsibility of the referring doctor to arrange for the neonate to be accepted by a specifically named doctor. The referring doctor should understand and adhere to the protocols of the receiving hospitals to prevent non-acceptance of the neonate (Department of Health 2003).

- The neonate will need to be prepared for transport prior to the ambulance arriving in order to expedite the transfer. In the event of a lack of appropriate skills, assistance may be sought by the doctor from the paramedic (ALS).

- The most senior medical care provider of the transport team may request the referring doctor to undertake certain additional measures prior to transfer. This may include intubation, catheterization, IV cannulation, fluid therapy etc. These are requirements for the journey by ambulance and not necessarily be requirements for hospital treatment.

- Referring hospitals should ensure that the neonate is ready for transfer when the ambulance arrives. If the neonate is not ready and there are other outstanding cases, the ambulance will leave. That request will go back into the queue. Exceptions must be discussed with the communication centre.

- Specialised transfers must be taken over from one doctor and handed over to another doctor.

3.4.2 The Emergency Medical Rescue Service

The EMRS is one of the three core functions within the Department of Health. It provides an emergency rescue service throughout the province of KwaZulu-Natal and aims at providing quality, efficient, professional and caring pre-hospital emergency medical care. The EMRS is a robust system that provides a road and aeromedical ambulance service. The people who provide this service are highly trained professional medical care providers. Their qualifications include Basic Life Support (BLS), Intermediate Life Support (ILS), Advanced life Support (ALS), Emergency Care Technicians (ECT), and Emergency Care Practitioner (ECP). All the emergency care providers have been trained by HPCSA accredited institutions and those employed by EMRS must ensure that they are registered for the current year with the Health Professions Council of South Africa (HPCSA), and carry a valid current registration card at all times.

The Emergency Medical Rescue Service in the eThekwini Health District is the provincial ambulance service that provides emergency medical pre-hospital care for approximately 3,5 million people located over a total area of 2,291 km^2 or 885 square miles (eThekwini Municipality 2010). This Health District is sub-divided into four zones, the southern zone, the western zone, the central zone and the northern zone, with ambulance bases allocated to each zone. This division enables ambulances to

be allocated throughout the province of eThekwini. All referrals are made via the communication centre which is situated in Wentworth (central zone), where the requests are accepted and dispatched.

When interviewed on 01 February 2012, Mr Padayachi (communications officer) at the communication centre in Wentworth stated that in January 2012, the total staff compliment of EMRS in the eThekwini Health District was 672 personnel. This is summarised in Table 3.

The EMRS is divided into two sections: Operations and Planned Patient Transport:

Operations provide a 24 hour pre-hospital emergency medical care and rescue service as well as safe and timeous transportation and en-route care for patients requiring emergency inter-healthcare facility transfers. To regulate working times in relation to providing an essential 24 hour health service, operations have four shifts, which are arranged to provide a 24/7 emergency medical care and rescue service. Each shift consists of two days, two nights and four rest days. Day shifts commence at 07h00 and end at 19h00 and night shifts commence at 19h00 and end at 07h00. The members of the teams allocated to neonatal inter-healthcare facility transfers are determined by the needs of each neonate. Although the most senior emergency care provider is appointed team leader, all emergency care providers involved in the execution of a neonatal inter-healthcare facility transfer need to perform their duties collaboratively.

- The operational ambulance fleet during the study period consisted of approximately 45 ambulances, approximately 4 ALS response units and an aeromedical service (one helicopter and one aeroplane).

- The staff composition for the ambulances consisted of two crew members including the driver, who were either both BLS trained personnel or 1 BLS and 1 ILS trained personnel.

- The staff composition for the response units consisted of two crew members, including the driver, one ALS trained and the other either BLS or ILS trained.

- The aeromedical service consists of a rotor wing aircraft and a fixed wing aircraft. The staff members of both types of aircraft are ALS and ILS trained personnel. These aircraft are based at the King Shaka International Airport and can be used as a resource allocation (when the services are needed elsewhere) if required.

Planned Patient Transport (PPT) provides an elective patient transport service where inter-healthcare facility transfers must be pre-booked through an institutional coordinator who puts together a manifest for transportation. This service operates on weekdays from 08h00 – 16h00 only.

- The Planned Patient Transport fleet during the study period consisted of 32 ambulances and 2 obstetrics units.

- The staff composition for the ambulances consisted of two crew members who were either both BLS trained personnel or BLS and ILS trained personnel.

- One of the obstetrics units has an ECT trained personnel who is crewed with either a BLS or ILS personnel and the other obstetrics unit has an ALS trained personnel who is crewed with either a BLS or ILS personnel.

- The obstetric units are not only used for obstetric patients, but for any type of inter-healthcare transfer if the need arises. This includes neonatal inter-healthcare transfers.

- The obstetric units have one transport incubator between them, but have no other specialised equipment for specialised neonatal transfers. If the ALS personnel require specialised equipment for NICU inter-healthcare transfers, the equipment must be obtained from one of the operation bases.

The EMRS in the eThekwini Health District does not have a specific neonatal transfer team allocated for neonatal inter-healthcare facility transport. The specialised transport equipment is placed on charge at the various bases and in the event of neonatal transfer, the crew dispatched proceeds to the base where the equipment is available, loads the equipment into the ambulance and then proceeds

to the referring facility for the transfer. For specialised neonatal transfers requiring more highly qualified personnel, the ALS medical care providers, who are on the response unit, meet the ambulance crew at a specific base or at the referring hospital to undertake the transfer.

The location of EMRS bases in the eThekwini Health District of KZN is represented in Figure 3 and the staff compliment of EMRS in the eThekwini Health District for January 2012 is summarised in Table 3.

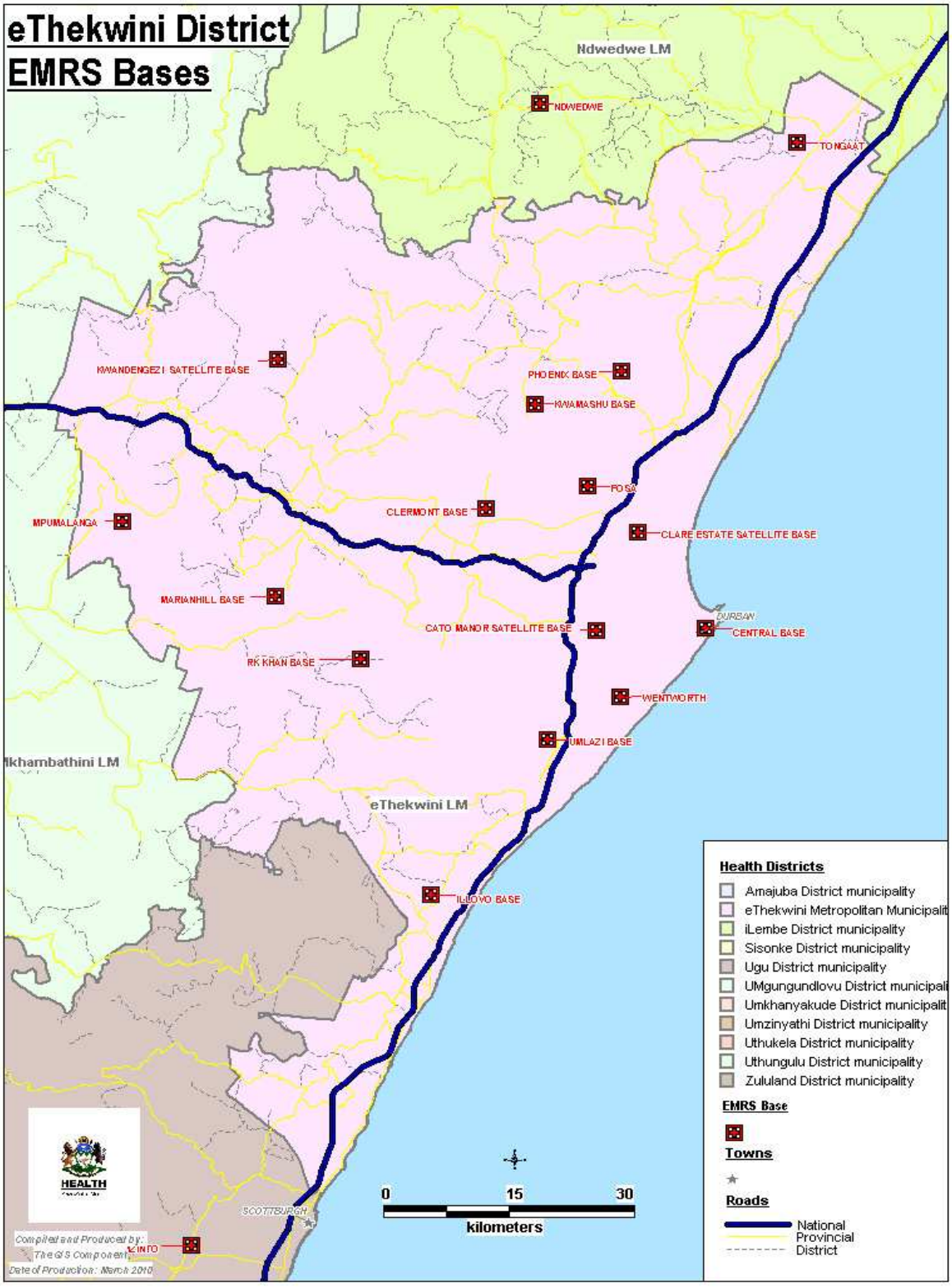

Figure 3: Map of eThekwini District EMRS bases

(Geographic Information Systems Unit, 2010a)

Table 3: Staff complement in EMRS eThekwini Health District for January 2012

Total staff compliment in EMRS eThekwini for January 2012	
ECP	573
Managers	044
Administration	036
General orderly	016
Security	003
TOTAL	**672**

Emergency Care Providers				
Qualification	**Operational**	**Elective**	**Communications**	**Total**
BLS	231	36	42	309
ILS	167	19	49	235
ALS	25	1	0	26
ECT	1	1	0	2
ECP	1	0	0	1
TOTAL	425	57	91	**573**

3.4.2.1 Dispatch code, dispatch time and mobilisation time

According to the Department of Health's Standing Operational Policies of the EMRS, a code red is an emergency and a code yellow is a non-emergency. Dispatch time is defined as the time between the receipt of the request by the communication centre and the relay of dispatch instruction to the responding crew. Mobilisation time is the time between receipt of the dispatch instruction by the responding crew and the crew's mode of transport becoming mobile on the case (Department of Health 2005).

The dispatch time for a code red is within one minute and the mobilisation time is within 2 minutes of the request. The dispatch time for a code yellow is within 3 minutes and the mobilisation time is within 5 minutes of the request. However, if the mode of transport which has been dispatched is available, it must mobilise immediately. Inter-healthcare facility transfers are coded yellow until proven otherwise as the patient is still within a healthcare facility. Table 4 represents the dispatch codes, dispatch times and mobilisation times.

Table 4: Dispatch code, dispatch time and mobilisation time

Dispatch code	Dispatch time	Mobilisation time
Code Red	1 minute	2 minutes
Code Yellow	3 minutes	5 minutes

3.4.2.2 Time frames used in the study

The time frames used in the study were taken from the time the transfer was requested to the time it was completed, including all sub intervals. The sub intervals used are in accordance with the EMRS electronic spread sheet and the patient report form which are as follows,

- (T1) Time of request.
- (T2) Time of dispatch.
- (T3) Time mobile to the referring hospital.
- (T4) Time at the referring hospital.
- (T5) Time mobile to the receiving hospital.
- (T6) Time at the receiving hospital.
- (T7) Time completed at the receiving hospital.

The time differences are calculated as follows,

- T2-T1 = difference between the time of dispatch and time of request.
- T3-T2 = difference between the time mobile to the referring hospital and time of dispatch.
- T4-T3 = difference between the time at the referring hospital and time mobile to the referring hospital.

- T5-T4 = difference between the time mobile to the receiving hospital and time at referring hospital.
- T6-T5 = difference between the time at receiving hospital and time mobile to the receiving hospital.
- T7-T6 = difference between the time completed at the receiving hospital and time at receiving hospital.
- T7-T1 = difference between the time completed at the receiving hospital and time of request.

3.5 Study population

The study population consisted of all cases of state inter-healthcare facility transfers of neonates in the eThekwini Health District of KwaZulu-Natal by the Emergency Medical Rescue Service during the study period.

3.6 Study sample size

A total of 120 consecutive inter-healthcare facility neonatal transfers conducted by the EMRS of eThekwini Health District ambulance service were collected from 19 December 2011 to 30 January 2012. The sample size was determined to be adequate in consultation with a professional statistician prior to the study.

3.7 Inclusion and exclusion criteria

The neonatal period is from birth to the first 28 days of life, therefore, any infants which were more than 28 days old were excluded from the study. Only the provincial ambulance service of the eThekwini Health District of KwaZulu-Natal, the EMRS, was included in the study. Any transfers undertaken by private ambulance services were excluded from the study.

3.8 Data

Primary data for this study was obtained from two questionnaires. One questionnaire (Appendix 4) was completed by the communications officers at the communication centre and the second questionnaire (Appendix 5) was completed by the most senior emergency care provider of each transfer team.

3.8.1 Data collection process

After ethical clearance to conduct the study had been obtained from the DUT Ethics Committee (Appendix 1), permission was sought from the KwaZulu-Natal Department of Health (Appendix 2) to undertake research on the EMRS in the eThekwini Health District. The participants were aware of the study prior to the commencement as the researcher had made presentations about the study at some of the monthly Continued Professional Development (CPD) forums. These forums are accredited by the Health Professions Council of South Africa (HPCSA) and form the platform where all personnel receive regular updates. The researcher thereafter recruited the participants required, who were the communications officers and the emergency care providers. The recruitment was done at various ambulance bases, the communications centre and at some of the CPD forums. Detailed information about the nature of the research and its requirements were given to all participants (Appendix 3). An internal memorandum was forwarded to all staff members of EMRS eThekwini by the operational manager updating them about the study. The researcher also ensured that all participants were kept aware and updated on the progress of the research during the study period.

The four communications officers consented to partake in the study after the researcher had met with them at the communications centre (Appendix 3) and multiple copies of the questionnaires (Appendix 4) were given to them to complete during the course of the research. Regarding the emergency care providers who undertake the transfers, it was agreed that the most senior emergency care provider from each transfer team would sign the consent form (Appendix 3) at each individual transfer. Consent forms and multiple copies of the questionnaire (Appendix 5) were handed to the senior providers and were also available at the respective ambulance

bases where they were stationed. The processes used to undertake the research is detailed below.

Once a transfer had been accepted from the referring doctor by the EMRS communication centre, the communication officer on duty contacted the researcher immediately or at the end of the shift to inform him about the transfer so that it could be followed up. The communication centre has a four shifts cycle, with a different communication officer on each shift. This, therefore, involved four participants.

Each communication officer completed a consent form (Appendix 3) at the beginning of the research and subsequently filled in a questionnaire (Appendix 4) each time a request for a neonatal transfer was processed, which would provide the researcher with all the details concerning the transfer. The researcher also contacted the communication officer twice per shift, at the beginning of the shift and at the end of each shift, to ensure that no neonatal transfers had been missed. The most senior emergency care provider of the transfer team who undertook the transfer completed a consent form (Appendix 3) and questionnaire (Appendix 5) at the end of each transfer. If the emergency care provider had previously given consent (Appendix 3) to partake in the study, then there was no need for further consent.

The questionnaires and consent forms were collected by the researcher on the completion of each transfer or at the end of the emergency care provider's shift to assist the participants in ensuring that the questionnaires and consent forms were returned.

During the study period, 29 neonatal inter-healthcare facility transfers did not qualify due to the neonates exceeding the neonatal age group. A further 4 specialised neonatal inter-healthcare facility transfers were cancelled by the referring facilities before the transport team arrived, 1 because of the delay of the arrival of the transfer team and the other 3 because the neonates had been clinically unstable to transfer**.**

3.8.2 Data collection tool

As English is the common medium of language used in the EMRS and all documentation is in English, the consent forms and questionnaires were written in

English. The questionnaires were closed ended, clear, succinct and unambiguous so that they could be clearly understood by all the participants. The questions were short and simple vocabulary was used. There were no emotional, leading, double barrelled, negative or double negative questions in the questionnaires. In most cases, the participant was requested to tick one answer box only. However, if questions had various options or if more than one answer was necessary, then it was clearly specified.

The following diagrams represent the questions that were asked based on the four objectives of the study (Figures 4-7).

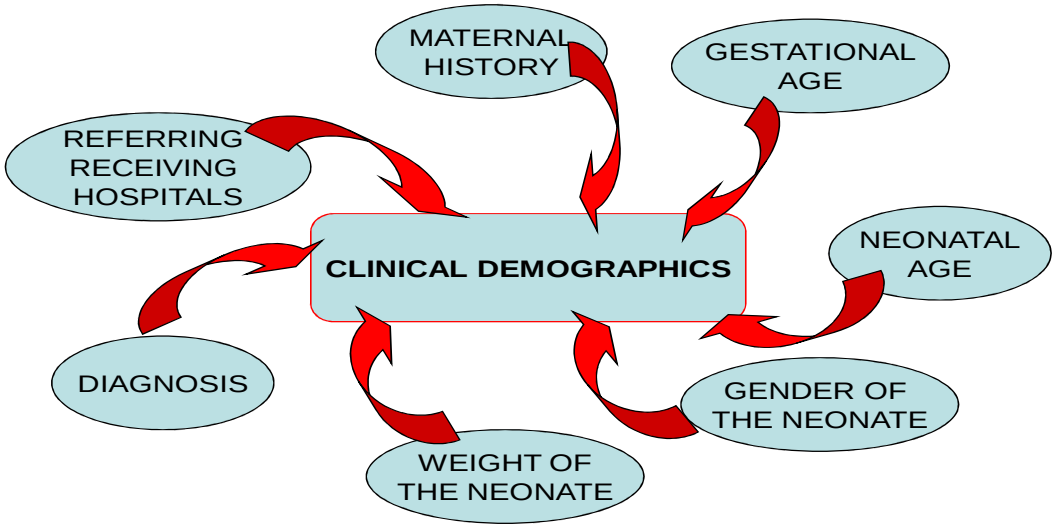

Figure 4: Clinical demographics of the patient

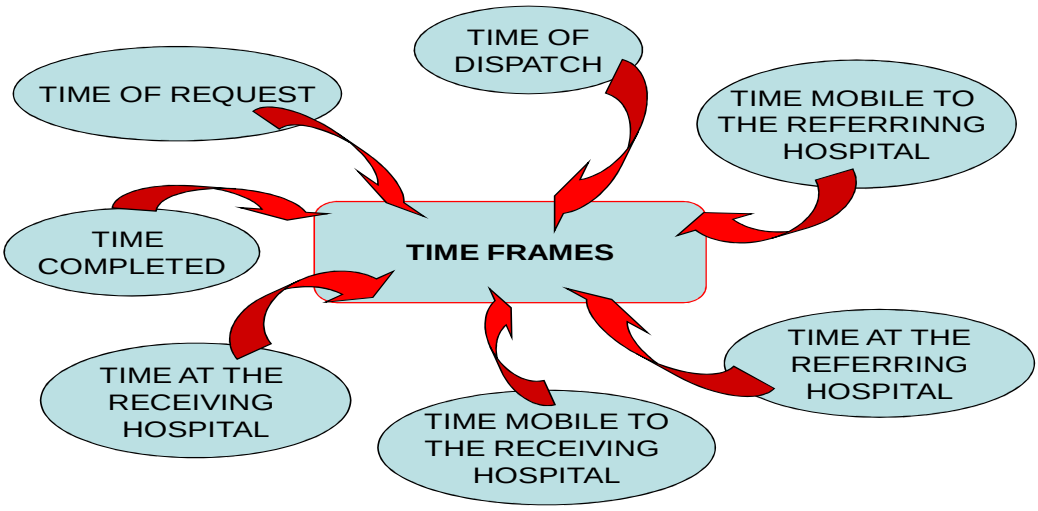

Figure 5: Time frames

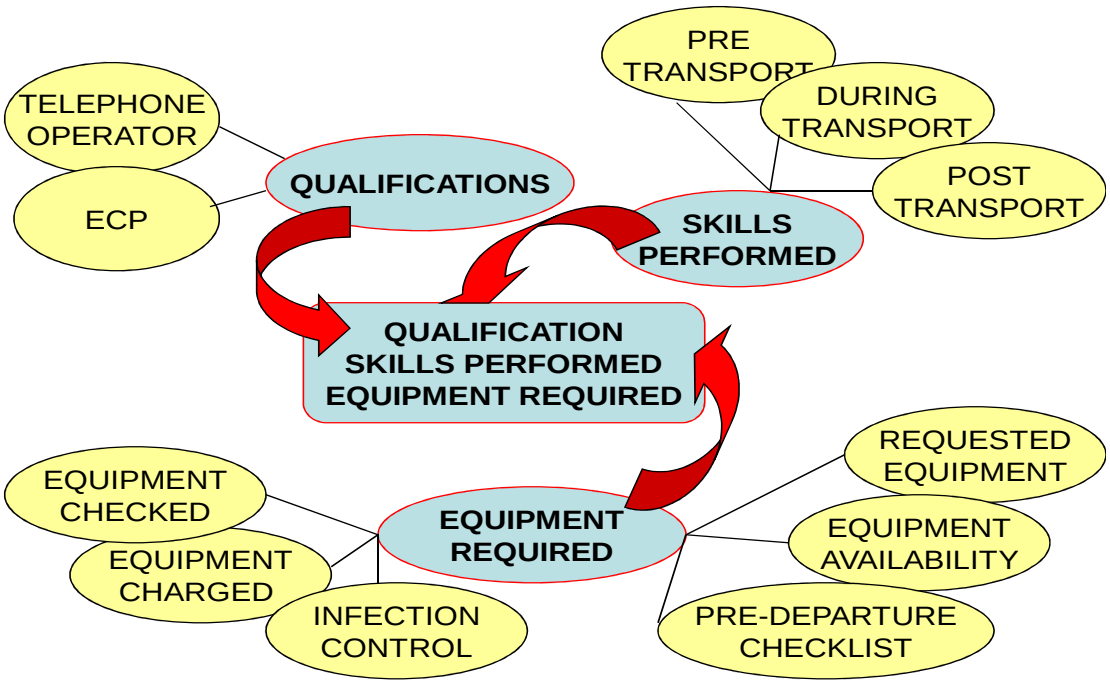

Figure 6: Qualifications, skills performed and equipment required

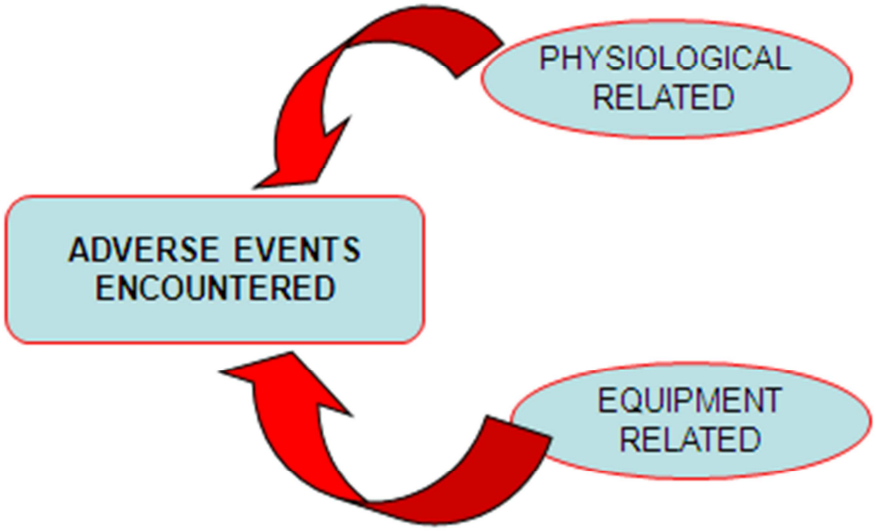

Figure 7: Adverse events encountered

3.8.3 Pilot study

According to Brink (2006), a pilot study, also known as a "preliminary study", is a small scale study that is conducted to investigate the feasibility of the proposed main study and to detect possible flaws in the data collection instrument. A pilot study was conducted to test all data collection tools for validity and reliability prior to the commencement of data collection. The 4 officers from the communication centre and 85 emergency care providers undertook the pilot study. The researcher asked the participants of the pilot study to comment on the length, structure and wording of the questionnaires. The data of the pilot study were not included in the main study. It took approximately 6 minutes to complete the questionnaires by the participants. No alterations to the questionnaires were made as the participants were satisfied with the content and layout of the questionnaires.

3.8.4 Validity

To test the validity of the questionnaires filled in by the communication officers, the researcher undertook random checks at the communication centre to ensure that the questionnaires (Appendix 4) had been completed correctly. In addition, to ensure that all data were correct and complete, the information reflected on questionnaires

was cross-checked with the official electronic spreadsheet, which was readily available through the communication officer.

To test the validity of questionnaires filled in by the senior emergency care provider, the researcher undertook random checks during the transferring process to ensure that the consent forms and questionnaires (Appendix 5) had been completed correctly. In addition, when the researcher collected the questionnaire from the senior emergency care provider of the transfer team, the researcher cross checked the information reflected on the questionnaire with the patient report form, which is a compulsory legal requirement by the EMRS when clinically managing or transporting a patient (Appendix 7). Necessary corrections were effected immediately, in consultation with the relevant emergency care provider.

3.8.5 Reliability

The design of the questionnaire was based on the literature review and the information that the researcher had obtained from his interviews with the specialist neonatologists from the regional and tertiary hospitals as well as input from the experienced specialist emergency care providers from the EMRS transportation team.

The completed questionnaires were appraised by:

1. the specialist neonatologists at the regional and tertiary hospitals during the interviews;

2. experienced specialist emergency care providers from the EMRS transportation team; and

3. the academic staff of the Department of Emergency Medical Care and Rescue; Durban University of Technology, at a Department Research Committee meeting.

3.8.6 Verification of the data input

The verification and accuracy of the data input was randomly checked and cross checked by the supervisor, the co-supervisor and the statistician to ensure that all data input was correct.

3.9 Statistical analysis

The service of a professional statistician was used to analyze raw quantitative data. The computer software programmes used were SPSS Statistics, version 20.0, released in 2011 and Statgraphics Centurion 15.1, which was released in 2006.

The statistical aspect of the research encompassed descriptive statistics, inferential statistics and the chi-square test.

Descriptive statistics make use of frequency and cross-tabulation tables and various types of graphs, including pie charts and bar graphs.

- Descriptive statistics describe the organising and summarising of quantitative data, investigate the distribution of scores on each variable, and determine whether the scores on different variables are related to each other (Lind, Marchal & Mason, 2004).

- Cross tabulation data resulted from observations made on two different related categorical variables (bivariate) summarised using tables, known as a two way frequency table or contingency table (Willemse, 2009).

- Graphs used have various levels of complexity with the horizontal or vertical bars having the same width but the length corresponding to the frequency. Pie charts used have various levels of complexity with divisions between variables (Willemse, 2009).

Inferential statistics, the use of correlations:

- Inferential statistical analysis is concerned with the testing of hypotheses. The independent t-test is the most appropriate parametric test for a comparison of the means. This tests any significant difference between the two variables. A p-value is generated from a test statistic. A significant result is indicated with "p. value = < 0.05". The choice of the value 0.05 as the level of significance is in fact totally arbitrary, but has become enshrined as a standard in statistics. Inferential statistical analysis allows the researcher to draw conclusions about populations from sample data (Lind et al., 2004).

- Correlation is a technique used to determine the connection between the actual dimensions of two or more variables. This study only looked at two variables at a time (Stephens, 2004).

Testing of hypotheses using **the chi-square test** for nominal data:

- A chi-square test for independence evaluates statistically significant differences between proportions for two or more groups in a data set. The Pearson's Product Moment Correlation Coefficient test was used in this study.

3.10 Ethical approval and consideration

3.10.1 Ethical approval

Full ethical approval was granted on 3 November 2011 by the Institutional Research Ethics Committee (IREC) of the DUT, Ethics Clearance number IREC 001/11 (Annexure 01).

3.10.2 Ethical consideration

The study was conducted following the guidelines of the Durban University of Technology's (DUT) ethical consideration for the conduct of research in the Faculty of Health Science's Policy document (Section C: Ethics). The three basic ethical

principles that provide guidance to researchers are beneficence, respect for human dignity, and justice (Polit & Beck, 2006). The three principles were adhered to by ensuring the information and consent forms were signed by the participants (Appendix 3).

The purpose and nature of the study, including risks and benefits, were fully disclosed to the participants so that informed decisions were made regarding their participation in this study. There was no coercion or pressure to participate and the participants could withdraw from the study at any time during the research with no adverse consequences (Appendix 3).

The study was entirely voluntary. No monetary or other type of remuneration was awarded for participation and no cost was incurred by the participants (Appendix 3).

Confidentiality was maintained by means of a code number, so that no names appeared on the data collection forms. All personally identifiable information was omitted during data collection thereby ensuring anonymity. Only the researcher and the supervisors had access to the raw data (Appendix 3).

3.11 Problems encountered in data collection

The challenges associated with the data collection were as follows:

- Twenty nine (29) transfers that were given to the researcher by the communication centre did not qualify because the age of the infants exceeded the neonatal age group. This was discovered by the researcher either telephonically or upon case follow ups. The neonatal age was clearly and repeatedly specified verbally and in writing before and during the study. These transfers were excluded from the study.

- There were two incidents of incorrect case numbers that were documented by the emergency care provider. This made matching the questionnaire from the communication officer and the emergency care provider challenging. The researcher together with the communications officer identified these cases by using other identifiable information. Once the correct case number had been identified it was immediately forwarded to the emergency care provider for

correction. Fortunately, the incorrect case numbers were identified on the same day and corrections were made by the emergency care provider before submission of the patient report form.

3.12 Conclusion

Despite the problems encountered and the limitations of the study, it was possible to obtain valuable information for inter-healthcare facility transfer of neonates in the eThekwini Health District of KwaZulu-Natal. This research was able to provide the answers to the objectives of the study and should be able to benefit the EMRS and the DOH to improve inter-healthcare facility transfer of neonates.

Chapter 4 presents a comprehensive descriptive and inferential analysis of the results which is shown in Tables or Figures.

CHAPTER 4

RESULTS

4.1 Introduction

This chapter provides detailed information on the research findings.

4.2 Clinical demographics results

4.2.1 Healthcare facilities transfer profile

There were a total of 120 neonates who were referred to other facilities and required the services of the EMRS during the study period, as shown in Table 5.

Table 5 is divided into four sections: the referring facility, the receiving facility, primary and return transfers, and day shift and night shift transfers.

Table 5: Referring and receiving facilities, primary and return transfers and dayshift and nightshift transfers

REFERRING FACILITIES			RECEIVING FACILITY		
	n	%		n	%
Prince Mshiyeni Memorial Hospital	09	(7.5)	Prince Mshiyeni Memorial Hospital	11	(9.2)
R K Khan Hospital	14	(11.7)	R K Khan Hospital	15	(12.5)
St Mary's hospital	02	(1.7)	St Mary's hospital	07	(5.8)
King Edward VIII Hospital	13	(10.8)	King Edward VIII Hospital	22	(18.3)
Mahatma Gandhi Memorial Hospital	07	(5.8)	Mahatma Gandhi Memorial Hospital	23	(19.2)
Addington hospital	02	(1.7)	Addington hospital	04	(3.3)
Inkosi Albert Luthuli Central Hospital	29	(24.2)	Inkosi Albert Luthuli Central Hospital	29	(24.2)
Clairwood Hospital	02	(1.7)	Clairwood Hospital	03	(2.5)
St Augustines Hospital	01	(0.8)	St Augustines Hospital	01	(0.8)
Isipingo Medical Towers Hospital	04	(3.3)	Isipingo Medical Towers Hospital	01	(0.8)
Wentworth Hospital	01	(0.8)	Osindisweni Hospital	03	(2.5)
City Health Hospital	09	(7.5)	Not Applicable	01	(0.8)
Primary Health Clinic	27	(22.5)			
TOTAL	**120**	**100**	**TOTAL**	**120**	**100**
PRIMARY AND RETURN TRANSFERS			**DAYSHIFT AND NIGHTSHIFT TRANSFER**		
Primary transfers	69	(57.5)	Dayshift	97	(80.8)
Return transfers	51	(42.5)	Nightshift	23	(19.2)
TOTAL	**120**	**100**	**TOTAL**	**120**	**100**

Ninety three (77.5%) neonates were referred from hospitals and 27 (22.5%) were referred from primary healthcare clinics. Of the 93 (77.5%) hospital referrals, 80 (66.7%) were referral from government hospitals and 13 (10.8%) from private hospitals.

One hundred and nineteen neonates (99.2%) were received by the receiving hospitals. One (0.8%) neonate who had been referred from a primary health clinic (PHC) died during transportation and was not taken to the receiving hospital. Twins were transported on two occasions.

Of the 120 referrals, 69 (57.5%) were primary transfers and 51 (42.5%) were return transfers. There were 97 (80.8%) neonatal transfers during the dayshift hours and 23 (19.2%) during the nightshift.

In terms of the transfer zones, as shown in Figure 8 below, 55 (45.8%) were from the central zone while 31 (25.8%) were from the southern zone, and 29 (24.2%) and 6 (4.2%) were from the northern and western zones respectively.

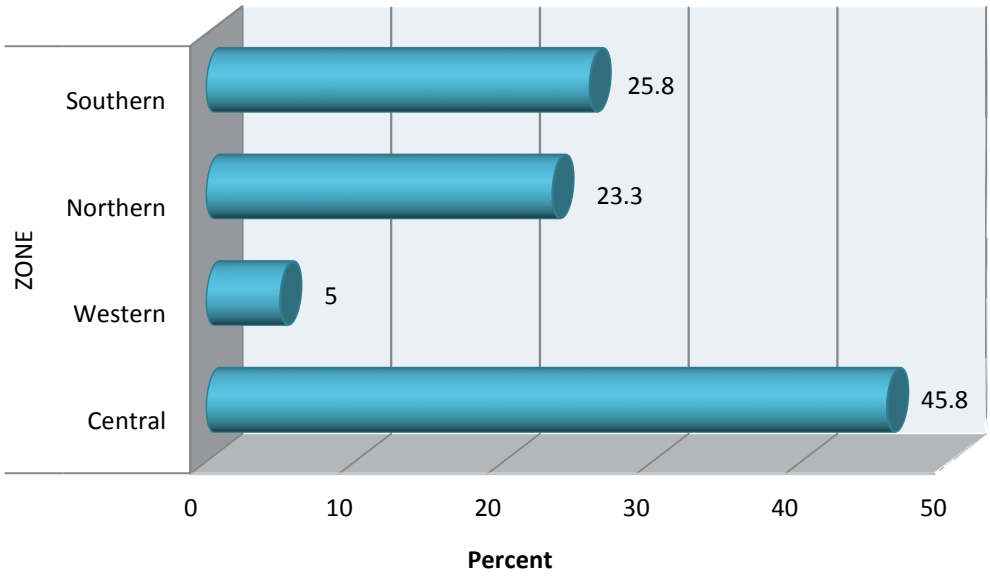

Figure 8: Transfers zones

Correlation between ALS transfers versus transfer zones shows central zone had 11 (37.9%) of 29 (24.2%) ALS transfers, which was the highest of all the zones. This was followed by 9 (31.0%) ALS transfers in the northern zone, 8 (27.6%) in the southern zone and 1 (3.4%) in the western zone.

In 22 (75.9%) of the 29 (24.2%) of the specialised transfers the neonates were ventilated**.** Eighteen (62.1%) specialised transfers were during the day shift (07h00 - 19h00).

Figure 9, below, shows that 31 (28.5%) of the transfers were on Fridays, followed by 24 (20.8%) on Mondays. During the weekends, there were 13 (10.8%) transfers on Saturdays and 7 (5.8%) on Sundays. The balance of the transfers were, 12 (10.8%) on Tuesdays, 14 (11.7%) on Wednesdays and 17 (14.2%) on Thursdays.

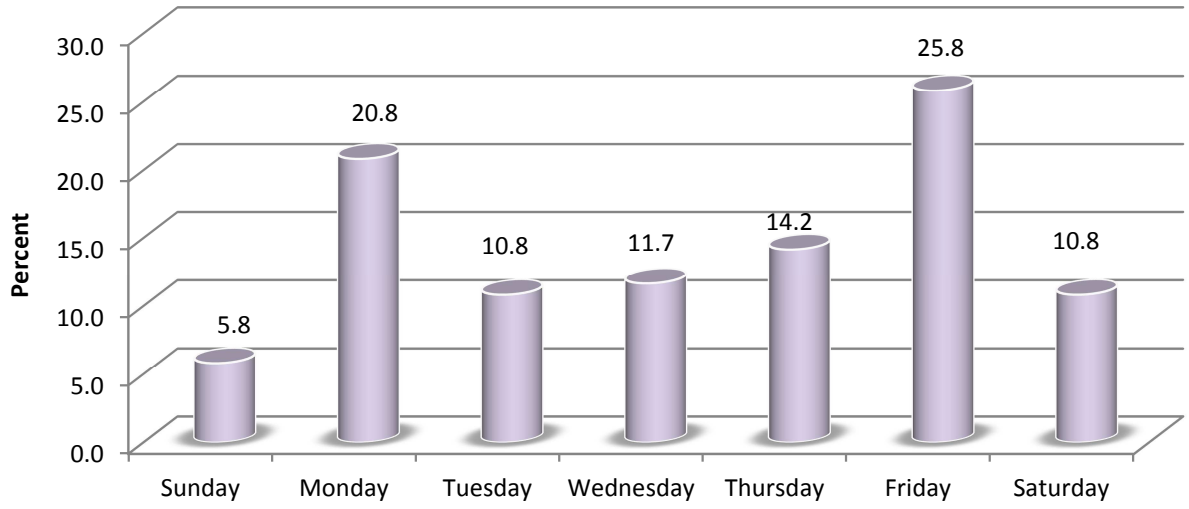

Figure 9: Day of the week

Correlation between the primary and return transfers versus the specialised transfers were 27 (22.5%) of the 69 (57.5%) primary transfers and 2 (1.7%) of the 51 (42.4%) return transfers.

4.2.2 The mode of transport

All of the 120 neonatal transfers requiring inter-healthcare facility transportation during the study period were undertaken by ground ambulances. The operational ambulance unit undertook 83 (69%) of the transfers, the obstetric unit undertook 35 (29%) and the planned patient transport units undertook 2 (2%).

4.2.3 The maternal history and the gestational age

Table 6 is divided into two sections which shows the history of the mother and the gestational ages of the neonates who formed part of the study. However, documenting the maternal history proved difficult for various reasons and had only been documented in 34 (28.3%) cases, with some reflecting more than one maternal history. In 7 (5.8%) of the cases where the neonate needed the ambulance service, no maternal history was available as the mothers had not booked into the relevant facilities and in 81 (67.5%) of the transfers, the maternal history had not been documented by the emergency care provider. The gestational ages of neonates transferred were from, 90 (76.7%) pre-term, 26 (21.7%) term and 2 (1.7%) post-term.

Table 6: Maternal history and gestational age

MATERNAL HISTORY			**GESTATIONAL AGE**		
	n	%		n	%
Hypertensive	05	(4.2)			
Eclampsia	03	(2.5)	Pre-term	92	(76.7)
Pre-eclampsia	07	(5.8)	Term	26	(21.7)
HIV/AIDS	04	(3.3)	Post-term	02	(1.7)
Obstructed labour	01	(0.8)			
Ante partum haemorrhage	06	(5.0)	**TOTAL**	**120**	**(100)**
Unknown (unbooked)	07	(5.8)			
Pulmonary Tuberculosis	02	(1.7)			
Multigravida	05	(4.2)			
Oligohydramious	01	(0.8)			
Not documented	81	(67.5)			

4.2.4 The neonatal characteristics

Table 7, outlines the characteristics of the neonates that formed part of the study and is divided into four parts which reflect their age, weight, gender and the diagnoses.

Table 7: Neonatal characteristics

NEONATAL AGE			DIAGNOSIS		
	n	%		n	%
From birth to 4 hours	11	(9.2)	Pre-term	90	(75.0)
Between 4 hours to 1 day	21	(17.5)	Respiratory distress syndrome	49	(40.8)
Between 1 day to 7 days	35	(29.2)	Meconium aspiration syndrome	13	(10.8)
Between 7 days to 28 days	53	(44.2)	Hyaline membrane disease	24	(20.0)
			Low birth weight	25	(20.8)
TOTAL	**120**	**(100)**	Congenital Pneumonia	12	(10.0)
			Congenital heart disease	02	(1.7)
NEONATAL WEIGHT			Neonatal sepsis	06	(5.0)
			Diaphragmatic hernia	03	(2.5)
			Perforated bowel	01	(0.8)
Less than 1000g	06	(5.0)	Supportive care	02	(1.7)
1000G – 1499g	42	(35.0)	Apnea	02	(1.7)
1500G – 1999g	29	(24.2)	Infection or suspected infections	14	(11.7)
2000G – 3999g	38	(31.7)	Patent ductus arteriosus	04	(3.3)
More than 4000g	05	(4.2)	Retinopathy of prematurity	01	(0.8)
			Tricuspid atresia	01	(0.8)
TOTAL	**120**	**(100)**	Abdominal obstruction	05	(5.2)
			Exposed intestines	02	(1.7)
NEONATAL GENDER			Tumour to eye	05	(4.2)
			Pyloric stenosis	01	(0.8)
			Hydrocephalysis	02	(1.7)
Male	83	(69.2)	Perforated trachea	01	(0.8)
Female	37	(30.8)	Birth abnormalities	03	(2.5)
TOTAL	**120**	**(100)**			

The data revealed that most (n=83, 69%) of the neonates requiring inter-healthcare facility transfer during the time of the study were male and 37 (30.8%) were female.

Eleven (9.2%) of the neonates were newborn (from birth to 4 hours old), 56 (46.7%) were early neonates (from 4 hours to 7 days) and 53 (44.2%) were late neonates (from 7 days to 28 days).

Six (5.0%) of neonates weighed less than 1 000g, 42 (35.0%) weighed between 1 000g and 1 499g, 29 (24.4%) weighed between 1 500g and 1 999g, 38 (31.7%) weighed between 2 000g and 3 999g, with only 5 (4.2%) weighing over 4 000g. Of the 120 neonatal transfers, 90 (75.0%) of the neonates were pre-term and presented associated co-morbidities. Forty nine (40.8%) were diagnosed with respiratory problems.

4.3 Time frames

Table 8 shows the time frames from the request to the completion of the transfer, including sub intervals.

Table 8: Time frames

TIME DIFFERENCES		MIN h:min	MAX h:min	MEAN h:min	(SD). STD DEVIATION h:min
From the request to the dispatch	T2 – T1	00:04	07:50	01:20	01.36
From the dispatch to the time mobile to the referring hospital	T3 – T2	00:00	04:00	00:27	00.44
From the time mobile to the referring hospital to the time at the referring hospital	T4 –T3	00:00	03:42	00:21	00.24
From the time at the referring hospital to the time mobile to the receiving hospital	T5 – T4	00:00	02:17	00:43	00.26
From the time mobile to receiving hospital to the time at the receiving hospital.	T6 – T5	00:00	01:30	00:27	00.16
From the time at the receiving hospital to the time completed the receiving hospital	T7 – T6	00:01	01:50	00:28	00.14
From the time of request to time completed at the receiving hospital	T7 – T1	00:55	10:34	03:49	01.57

4.3.1 Dispatched within 3 minutes of the request

Of the 120 neonatal transfers over the study period no transfers were dispatched within three minutes of the request.

4.3.2 The reasons for the delays in dispatch

No ambulances were available for 70 (47.3%) of the transfers, 48 (32.4%) of the transfers had no ALS medical care providers available, 23 (15.5%) of the transfers had no equipment available and 7 (4.7%) of the transfers had no ILS medical care providers available to undertake the transfers. There were also instances of more than 1 reason for the delays (Figure 10).

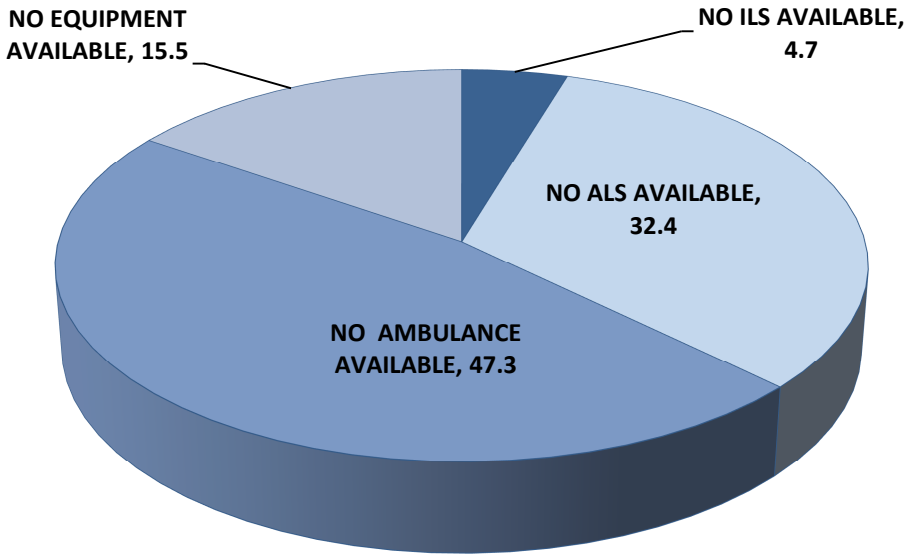

Figure 10: Delay in dispatch

The obstetric unit's mean time from requests to dispatch was 49min as opposed to 1h 34min by the operational ambulance units and 1h 20min by the elective units. Chi-square tests show a statistical significant in the mean times difference of the different units used, p. value = .0008.

Correlation between delays due to no ALS providers being available as per the communication centre versus the actual specialised transfers shows 48 (40.0%) of the transfers were delayed due to no ALS personnel being available to undertake the transfer, only 29 (24.2%) of these were specialised transfers requiring the more qualified skills of the ALS personnel. Therefore, of the 48 (40.0%), transfers, 22 (45.8%) were unnecessarily delayed as they were routine transfers that did not need ALS personnel.

Correlation between the qualifications of the medical care providers that had been dispatched versus no equipment requested by the referring personnel shows 17 (14.2) requests for the inter-healthcare facility transfer of neonates did not require any equipment, but only the transportation. ALS personnel were dispatched to 6 (35.3%) of these transfers, ECT personnel were dispatched to 2 (11.8%) of these transfers, ILS personnel were dispatched to 3 (17.6%) of these transfers and BLS to 6 (35.3%) of these transfers.

4.4 Qualification and the experience of the transfer team

4.4.1 Qualification and experience of the telephone operators

Table 9 shows the qualification of the telephone operators and their communication and operational experience. With respect to the qualification and experience of the telephone operators, the data revealed that of the 120 cases in the study, 71 (59.2%) of the transfers were accepted by BLS qualified personnel and 49 (40.8%) of the transfers were accepted by ILS qualified personnel. The communication centre has no ALS, ECT or ECP trained personnel. With respect to the communication experience of the telephone operators that accepted the 120 requests for the transfers, 36 (30.0%) of the request were taken by an operator who had less than 1 year communication experience, 3 (2.5%) by an operator who had between 1 to 3 years, 3 (2.5%) by an operator who had between 3 to 5 years and 78 (65.0%) by an operator who had more than 5 years of communication experience. Thirty three (27.5%) of the requests were accepted by telephone operators who had no operational experience, 2 (1.7%) by operators who had less than 1 year, 5 (4.2%) by operators who had between 1 to 3 years, 2 (1.7%) by operators who had between 3 to 5 years and 78 (65.0%) by operators who had more than 5 years of operational experience.

Table 9: Qualification and experience of the telephone operator

QUALIFICATION OF THE TELEPHONE OPERATOR				EXPERIENCE	COMMUNICATION EXPERIENCE		OPERATIONAL EXPERIENCE	
	n	%			n	%	n	%
BLS	71	(59.2)		NONE	-	-	33	(27.5)
ILS	49	(40.8)		LESS THAN 1 YEAR	36	(30.0)	02	(1.7)
ALS	-	-		BETWEEN 1 TO 3 YEARS	03	(2.5)	05	(4.2)
ECT	-	-		BETWEEN 3 TO 5 YEARS	03	(2.5)	02	(1.7)
ECP	-	-		MORE THAN 5 YEARS	78	(65.0)	78	(65.0)
TOTAL	**120**	**(100)**		**TOTAL**	**120**	**(100)**	**120**	**(100)**

4.4.2 Qualification and experience of the emergency care providers

Of the emergency care providers who were dispatched to transport the neonates from one healthcare facility to another, 56 (46.7%) were qualified in ALS, 39 (32.5%) in ILS, 13 (10.8%) in BLS, 11 (9.2%) were ECT and 1 (0.8%) was an ECP. Eleven (9.2%) of the emergency care providers who undertook the neonatal inter-health transfers had held their present qualification for less than 1 year, 33 (27.5%) for between 1 to 3 years, 1 (0.8%) for between 3 to 5 years and 75 (62.5%) for more than 5 years. Three (2.5%) of the emergency care providers that undertook the neonatal inter-healthcare transfers had operational experience of less than a year, 9 (7.5%) of between 1 to 3 years, 3 (2.5%) of between 3 to 5 years and 105 (87.5%) of more than 5 years (Table 10).

Table 10: Qualifications and experience of the emergency care providers

QUALIFICATION OF THE EMERGENCY CARE PROVIDER				EXPERIENCE	EXPERIENCE IN THE PRESENT QUALIFICATION		OPERATIONAL EXPERIENCE	
	n	%			n	%	n	%
BLS	13	(10.8)		NONE	-	-	-	-
ILS	39	(32.5)		LESS THAN 1 YEAR	11	(9.2)	03	(2.5)
ALS	56	(46.7)		BETWEEN 1 TO 3 YEARS	33	(27.5)	09	(7.5)
ECT	11	(9.2)		BETWEEN 3 TO 5 YEARS	01	(0.8)	03	(2.5)
ECP	01	(0.8)		MORE THAN 5 YEARS	75	(62.5)	105	(87.5)
TOTAL	**120**	**(100)**		**TOTAL**	**120**	**(100)**	**120**	**(100)**

Correlation between the operational experience and the qualifications of the telephone operators who accepted the specialised transfers shows 29 (24.2%) specialised transfers that were accepted by the telephone operators, 9 (31.0%) were accepted by BLS personnel with no operational experience and 1 (3.4%) was accepted by a BLS personnel who had had between 1 to 3 years of operational experience. There were 10 (34.5%) BLS and 9 (31.0%) ILS personnel who had accepted specialised transfers who had more than 5 years of experience.

4.5 Procedures performed

4.5.1 Clinical condition of the neonates at the referring facility

Of 120 neonatal inter-healthcare facility transfers, 6 (5.0%) of neonates were too unstable to transfer. Four (3.3%) neonates were unstable due to desaturation, 1 (0.8%) was cardiac related and 2 (1.7%) were due to respiratory related conditions.

Correlation between the qualifications of the emergency care providers who had been dispatched versus the stability status of neonates awaiting transfer shows 6 (5.0%) transfers in which the neonates had been unstable for transportation. ALS personnel had been dispatched to 5 (83.3%) of these transfers and 1 (16.7%) ILS personnel had been dispatched to the other.

4.5.2 Skilled intervention during different stages of transportation

The skilled interventions those were required during the different stages of transport. On 15 (12.5%) of the transfers, the neonates were inappropriately packaged for transport by the referral hospital and required the skilled intervention of the EMRS team, 13 (10.8%) of the neonates required skilled intervention during transportation and 8 (6.7%) of them required skilled interventions post transportation.

4.5.3 The skilled interventions that were performed

As some of the neonates had not been appropriately prepared when the ambulance arrived to transfer them to another facility, the EMRS team assisted with the preparation and packaging of the neonates which necessitated the following skilled interventions: 13 (10.8%) oxygenation via BVM, 02 (1.7%) intubation, 3 (2.5%) re-strapping the tracheal tube, 2 (1.7%) suctioning, 6 (5.0%) administration of pharmacological agents, 1 (0.8%) naso gastric tube insertion and 1 (0.8%) administration of fluids.

During the transport of the neonates, the skilled interventions of the attending teams included 9 (7.5%) oxygenation via BVM, 4 (3.3%) suctioning, 3 (2.5%) administration of pharmacological agents, 1 (0.8%) cardio pulmonary resuscitation, 3 (2.4%) administration of fluids and 01 (0.8) intravenous cannulation.

Post-transport interventions that were provided by the teams included 6 (5.0%) oxygenation via BVM, 1 (0.8%) suctioning and 2 (1.7%) administrations of pharmacologic agents. All clinical skills performed during the transport process were successful (Table 11).

Table 11: The skill intervention performed

SKILLS INTERVENTION PRE-TRANSPORT			SKILLS INTERVENTION DURING TRANSPORT			SKILLS INTERVENTION POST-TRANSPORT		
	n	%		n	%		n	%
Oxygenation via BVM	13	(10.8)	Oxygenation via BVM	09	(7.5)	Oxygenation via BVM	06	(5.0)
Suctioning	02	(1.7)	Suctioning	04	(3.3)	Suctioning	01	(0.8)
Admin. of pharm. agents	06	(5.0)	Admin. of pharm. agents	03	(2.5)	Admin. of pharm. agents	02	(1.7)
Intubation	02	(1.7)	Administration of fluids	03	(2.5)			
Adjusting depth of tracheal tube	02	(1.7)	Intravenous cannulation	01	(0.8)			
Re-strapping tracheal tube	03	(2.5)	Cardio pulmonary resuscitation	01	(0.8)			
NGT insertion	01	(0.8)						
Administration of fluids	01	(0.8)						

The data showed that all (n=15, 12.5%) the skilled interventions pre-transport, 13 (10.8%) during transport and 8 (6.7%) post-transport were during specialised transfers. The chi-square shows a significant relationship between the pre-transport skills performed and mean time delays at the referring hospital, p. value = 0.018.

4.6 The equipment required

4.6.1 The requesting personnel and the equipment requested

Of the 120 transfers carried out, 79 (65.8%) were requested by doctors and 41 (34.2%) by nurses. No equipment was specified in 17 (14.2%) of the requests. The other transfer requested specific equipment, however, with 89 (74.2%) requesting oxygen, 25 (20.8%) a transport ventilator, 86 (71.7%) an incubator, 3 (2.5%) a hot box, 5 (4.2%) syringe drivers, 14 (11.7%) infusion pumps, 23 (19.2%) a cardiac monitor, 22 (18.3%) a saturation monitor, 1 (0.8%) an end tidal CO_2 monitor, 1 (0.8%) a non-invasive blood pressure monitor (NIBP) and 2 (1.7%) a temperature monitor. Table 12 shows the requesting personnel and the equipment they requested.

Table 12: Requesting personnel and the equipment requested

REQUESTED BY			EQUIPMENT REQUESTED		
	n	%		n	%
			OXYGEN	89	(74.2)
			VENTILATOR	25	(20.8)
DOCTOR	79	(65.8)	INCUBATOR	86	(71.7)
NURSE	41	(34.2)	HOT BOX	3	(2.5)
			SYRINGE DRIVERS	5	(4.2)
TOTAL	**120**	(100)	INFUSION PUMPS	14	(11.7)
			CARDIAC MONITOR	23	(19.2)
			SATURATION MONITOR	22	(18.3)
			END TIDAL CO2 MONITOR	1	(0.8)
			NIBP MONITOR	1	(0.8)
			TEMPERATURE MONITOR	2	(1.7)
			NONE	17	(14.2)

4.6.2 Equipment required before proceeding on the transfer

Table 13 provides a summary of the availability of the equipment, what equipment was unavailable and the reasons for unavailability, whether the battery operated

equipment was charged, and whether the equipment was clean and sterile and could be used for the transfer.

Of the 120 inter-healthcare facility transfers, the equipment that had been requested for 37 (30.8%) transfers was unavailable. The following items of equipment that were requested were not available:, incubators for 21 (17.5%) of the transfers, ventilators for 10 (8.3%) transfers, ventilator circuits for 3 (2.5%) transfers, infusion pumps for 3 (2.5%) transfers, syringe drivers for 4 (3.3%) transfers, oxygen for 2 (1.7%) transfers, an administration set for 1 (0.8%) transfer and monitoring equipment for 13 (10.8%) transfers.

The data revealed that the equipment was not immediately available because in 23 (20.0%) of the transfers the equipment required was at another base, for 3 (2.5%) of the transfers the equipment had been sent for repairs and for 2 (1.7%) of the transfers the district did not have the equipment requested. There were other reasons for 9 (7.5%) of the transfers which included the following: the equipment not being complete for 2 (1.7%) of the transfers, equipment not on charge on 4 (3.3%) of the transfers, no access to equipment on 2 (1.7%) of the transfers and the oxygen in the ambulance had been depleted on 1 (0.8%) transfer.

Eighty six (71.6%) transfers required battery operated equipment of which 70 (58.3%) were fully charged and 16 (13.3%) were not. Of these 6 (5.0%) had not been recharged and were completely powerless, 6 (5.0%) had not maintained the charge due to battery problems and 4 (3.3%) had not been charged long enough for the equipment to be utilised.

A study of the data revealed that incubators had been requested by the referring hospital for 6 (5.0%) of the transfers, but could not be utilised immediately because they had not been cleaned after previous transfers. Four (3.3%) incubators had blood stained linings and contained sundry surgical items, some of them blood stained. Two (1.7%) of the incubators had only been wiped down at the hospital due to back-to-back transfers. Of the 22 (18.5%) ventilated transfers, 2 (1.7%) of the ventilator circuits were open packs. One (0.8%) circuit had not been disinfected, but had been autoclaved and the other 1 (0.8%) had not been autoclaved but had been disinfected.

Table 13: The equipment required before proceeding on the transfer

AVAILABILITY OF EQUIPMENT			UNAVAILABLE EQUIPMENT			REASONS FOR UNAVAILABITY		
	n	%		n	%		n	%
YES	66	(55.0)	Oxygen	02	(1.7)	Equipment was at another base	23	(20.0)
NO	37	(30.8)	Ventilator	10	(8.3)	Equipment sent for repairs	03	(2.5)
N/A	17	(14.2)	Incubator	21	(17.5)	None in the district	02	(1.7)
			Syringe driver	04	(3.3)	Other	09	(7.5)
			Infusion pump	03	(2.5)			
			Cardiac monitor	01	(0.8)			
			SpO_2 monitor	02	(1.7)			
			$EtCO_2$ monitor	06	(5.0)			
			NIBP monitor	03	(2.5)			
			Temperature monitor	01	(0.8)			
			Ventilator circuits	03	(2.5)			
TOTAL	**120**	**(100)**	Administration sets	01	(0.8)			

BATTERY OPERATED EQUIPMENT					
FULLY CHARGED			**REASONS FOR NOT FULLY CHARGED**		
YES	70	(58.3)			
NO	16	(13.3)	The equipment was not placed on charge	6	(5.0)
N/A	34	(28.3)	The equipment was not maintaining charge	6	(5.0)
			The equipment was not charged long enough	4	(3.3)
TOTAL	**120**	**(100)**			

VENTILATOR CIRCUIT					
SEALED PACK			**REASONS FOR NOT BEING IN A SEALED PACK**		
YES	20	**(16.8)**			
NO	02	**(1.7)**	The circuit was not autoclaved	01	(0.8)
N/A	98	**(81.7)**	The circuit was not disinfected	01	(0.8)
TOTAL	**120**	**(100)**			

EQUIPMENT CLEAN FOR TRANSFER			REASON FOR THE EQUIPMENT NOT BEING CLEAN		
YES	95	(79.2)			
NO	06	(5.0)	Incubator was used and not cleaned	04	(3.3)
N/A	19	(15.8)	Undertaken back to back transfers. Incubator wiped down only	02	(1.7)
TOTAL	**120**	**(100)**			

Correlation shows 17 (58.6%) of the 29 (24.2%) specialised transfers had not had the required equipment to undertake the transfer.

4.6.3 Pre transfer preparation before departure

Data revealed that pre-departure checklists had not been completed in 50 (41.67%) of the transfers. Of these, 48 (40.0%) of the transfers had no pre-departure checklists at all. Equipment had not been tested before departure in 8 (6.7%) of the transfers, but 3 (2.5%) of these had already been done at crew change. Reasons for not completing the pre-departure check lists included the following: no time to complete a pre-departure checklist, 1 (0.8%) transfer; no test lungs, 2 (1.7%) transfers; the crew called for assistance and the ALS had to proceed without testing the equipment, 1 (0.8%) transfer; the clinic incubator was used, 1 (0.8) transfer; and the equipment requested was not given to the transport team, 1 (0.8%) transfer (Refer to Table 14).

Table 14: Pre transfer preparation

PRE DEPATURE CHECKLIST					
COMPLETED			**REASONS FOR NOT COMPLETING A PRE CHECKLIST**		
	n	%		n	%
YES	59	(49.17)			
NO	50	(41.67)	No pre-departure checklist	48	(40.0)
N/A	11	(9.17)	No pre-departure checklist available	01	(0.8)
			No time to complete a pre-departure checklist	01	(0.8)
TOAL	**120**	**(100)**	Pre-departure checklist was done at crew change	01	(0.8)
EQUIPMENT TEST BEFORE UNDERTAKING THE TRANSFER					
TESTED			**REASONS FOR NOT TESTING EQUIPMENT**		
	n	%		n	%
YES	93	(77.5)			
NO	08	(6.7)	No time to test the equipment	01	(0.8)
N/A	19	(15.8)	The equipment was already tested	03	(2.5)
			Other	05	(4.2)
TOTAL	**120**	**(100)**			

4.7 Adverse events encountered during the transfer of the neonates

4.7.1 The referring facility handover

Doctors handed over 33 (27.5%) of the 120 neonates to the EMRS team for transfer and the other 87 (72.5%) neonates were handed over by nurses. Twenty two (18.3%) of the transfers were inappropriately handed over to the emergency care providers, with some transfers having more than one issue. Neonates in 7 (5.8%) of the transfers had no post-delivery events history, 10 (8.3%) had no clinical management history, 7 (5.8%) had no pharmacological history, 1 (0.8%) had no documentation at all, 6 (5.0%) had incomplete documentation and 1 (0.8%) neonate did not have an identity tag.

4.7.2 Physiological adverse events

The study identified 10 (8.3%) physiological related adverse events that occurred during the transfers, including 1 (0.8) mortality, which had been referred from a primary health care clinic. Nine (7.5%) neonates suffered serious life threating complications during transportation. Eight (6.7%) suffered desaturation, 6 (5.0%) had respiratory deterioration, 3 (2.5%) had cardiac deterioration and 1 (0.8%) had temperature related problems. The statistics show that some of neonates had more than 1 life threatening complication during their transfers.

Correlation between specialised transfers undertaken and physiological related adverse events showed 10 (8.3%) transfers during which neonates experienced physiological related adverse events, 9 (90.0%) were specialised transfers and 1 (10.0%) was an ILS transfer.

4.7.3 Equipment related adverse events

Eighteen (15.0%) of 120 transfers experienced equipment related adverse events and some transfers experienced more than one, as shown in Table 15.

Table 15: Equipment related adverse events

EQUIPMENT RELATED ADVERSE EVENTS			EQUIPMENT CAUSING ADVERSE EVENTS		
	n	%		n	%
			OXYGEN SUPPLY	02	(1.7)
YES	18	(15.0)	VENTILATOR	09	(7.5)
NO	102	(85.0)	INCUBATORS	09	(7.5)
			ARTERIAL CANULATION	01	(0.8)
TOTAL	**120**	**(100)**	AMBULANCE	03	(2.5)

Correlation between specialised transfers undertaken and equipment related adverse events shows 18 (15.0%) transfers that experienced adverse events, 11 (61.1%) occurred during specialised transfers.

Correlation between physiological related adverse events and equipment related adverse events is shows 5 (50.0%) of the 10 (8.3%) physiological related adverse events that occurred during transfers were a direct result of equipment related adverse events. Although a small number was involved 5 (50.0%), the chi square test showed a significant p. value = 0.007.

4.8 Conclusion

Analysis of 120 neonatal inter-healthcare facility transfers during the study period has generated enough data to describe the inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal. Data was analysed for all of the four objectives of this study. The results highlighted significant problems within the service, especially in the specialised transfers, which included time delays, equipment being unavailable, malfunctioning and not thoroughly clean, and poor co-ordination between the communication centre and the transfer teams.

Chapter 5 discusses the finding of the study in line with the study objectives.

CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter presents a detailed discussion of the results.

5.2 Clinical demographics

The 120 neonatal transfers in this study took place in just 43 days, an average of 2.79 per day. This is a high incidence of transfers than described in studies by Mullane et al., (2002) in Ireland, where it took one year, between March 2001 to March 2002, to transfer 176 neonates, an average of 0.482 per day and the study by Grosek (2007) in Slovenia, where it took one year, between May 2006 to May 2007, to transfer 178 neonates, an average of 0.487 per day. When compared to the study settings in Ireland and Slovenia, the reasons for higher incidence of transfers in eThekwini are a lack of specialised neonatal facilities, lack of suitably trained staff, lack of specialist care and a lack of intensive care management.

The EMRS in eThekwini has no specialised or dedicated transport team for neonatal inter-health care facility transfers. Findings from studies carried out by Britto et al., (1995), Mullane et al., (2002) and Miller et al., (2008) highlighted certain dangers in the transportation of neonates if they were carried out by non-specialised neonatal transportation teams in the form of equipment and physiological adverse events. Therefore, the EMRS needs to consider having specialised and dedicated transport teams with a thorough understanding of the transfer process (Appendix 8), utilise sophisticated transportation equipment, undertake training, development and quality assurance and introduce Standard Operating Policies (SOP) for inter-healthcare transfer of neonates.

Ninety seven (80.8%) transfers were carried out during the day. Seventy six (53.4%) of the transfers were from Friday to Monday. By not having a standalone neonatal transfer team and the unavailability of the obstetric units after hours, neonatal inter-

healthcare facility transfers were dispatched to the operational ambulances. When an obstetric unit was called out for a specialised neonatal transfer, neonatal equipment had to be sourced from other bases and added into the obstetric unit for the transfer. This led to time delays in proceeding with the transfers, mean ± SD 01h 20min ± 01h 36min. Further delays, thereafter, were inevitable because the equipment that had been borrowed for the neonatal transfers had to be returned to the respective bases on completion of the transfer. When the operational ambulances were used, the use of the operational ambulance affects the availability of the ambulance for other emergency calls. Specialised transfers impacted largely on the operational status by taking a duty ALS emergency care provider out of the system of emergency medical care. The absence of a standalone neonatal transfer team was also associated with delays in completing a transfer i.e., mean time ± SD 3h 49min ± 01h 57min, 50 (41.67%) cases of poor preparation, 37 (30.8%) cases of equipment unavailability, 16 (13.3%) cases having problems with the batteries, 23 (20%) cases of poor resource allocation and 10 (8.3%) cases of clinical problems.

In this study, one transfer had been dispatched to the aeromedical service due to the limited availability of resources. However, although this transfer was undertaken by the aeromedical crew, a ground ambulance was used instead of a rotor wing aircraft (helicopter). This was due to financial implications and the close proximity of the referring and receiving hospitals. The aeromedical service responded from the King Shaka International Airport, where it is based, which is outside the eThekwini health district.

There were 69 (57.5%) primary transfers. The Inkosi Albert Luthuli Central Hospital (IALCH), which is located in the central zone, is the only tertiary hospital in KwaZulu-Natal and therefore has the highest rate of referrals. This hospital received 29 (24.7%) transfers over the study period. The neonatal referrals that were dispatched to the IALCH were for a higher level of care and those that were dispatched from the IALCH were repatriation to the respective facilities of origin. Twenty-seven (22, 5%) of the 120 transfers were referrals from primary health care clinics which are distributed throughout eThekwini. These clinics depend largely on the EMRS for neonatal transportation and clinical assistance as they have limited resources. One (0.8%) neonate who was referred from a primary health care clinic died during

transport, known as a blue code. This will be discussed further in the discussion on adverse events.

The findings revealed poor documentation on the part of the emergency care providers, as no maternal history had been documented on 81 (67.5%) of the transfers.

A study of the gestational age of the neonates that were referred to other facilities revealed that 92 (76.7%) were pre-term. It is vital, therefore, that the transport teams must be fully knowledgeable regarding the complications arising from pre-term delivery and the management thereof. Keeping up to date with the universal techniques of resuscitation may save hundreds of thousands of neonate lives, which are currently lost each year in KZN. This will contribute towards the Millennium Development Goal 4. (Wall, Lee, Niermeyer, English, Keenan, Carlo, Bhutta, Bang, Narayanan, Ariawan & Lawn, 2009).

5.3 Time frames

The study identified large differences in the time it took to complete the transfers, ranging from the minimum time of 55min to the maximum time of 10h 34min, the mean time ± SD being 3h 49min ± 01h 57min. The factors contributing to times delays were associated with delays in dispatching the ambulance from the time of request and the packaging of the neonate for transport. The longest mean time ± SD from the requests to dispatches was 1h 20min ± 1h 36min.

According to the Department of Health's, SOP of EMRS KZN, the dispatch time for an inter-healthcare facility transfer should be within three minutes of the request (Department of Health 2005). During the study period, however, no transfer was dispatched within three minutes. The reasons for delays in dispatch were due to the limited availability of equipment and resources required by the transport team for the specialised neonatal intensive care transfers and also poor co-ordination and communication by the communication centre, which was staffed by junior (30.0%) and inexperienced (27.5%) personnel (Table 9). Findings of a study conducted by Kempley, Baki, Hayter, Ratnavel, Cavazzoni & Reyes (2007) showed that a

dedicated centralised neonatal transport team significantly improved the response times. This is also consistent with other studies by Britto et al., (1995), Mullane et al., (2002) and Miller et al., (2008).

According to the DOH Neonatal Intensive Care Review in London (2003) recommended that the specialist transfer services should be separated from the operational work force in each network. Findings of the current study showed that the obstetric unit had been used for 29% of the transfers and had achieved the quickest times from request to dispatch. The obstetric units in the eThekwini Health District are reserved for specific cases which include neonatal transfers. This operational availability of the obstetric units reduces the request to dispatch time and thereby produces quicker overall transfer times implying the need for dedicated specialised neonatal transfer units.

The mean time ± SD it took to carry out pre-transport stabilisation and packaging of the neonates were 43min ± 26min. Reasons for the delay, as highlighted by the participating emergency care providers were, neonates were not adequately prepared pre-transport resulting in emergency care providers undertaking packaging and stabilisation prior to transportation. According to DOH's Framework for a Referral System for Health Service in KZN, the onus is on the medical personnel of the referring healthcare facilities to stabilise and package the neonates to ensure that they are ready for transfer when the ambulance arrives in order to expedite the transfer (Department of Health 2003; Department of Health 2005). While the referring facility is responsible for not having the neonates properly prepared by the time the ambulances arrived, it must be noted that EMRS does not have a transport co-ordinator in the communication centre to give the necessary advice on pre-transport stabilisation and packaging requirements for transportation to the referring personnel.

Inexperienced and junior staff in the communication centre also contributed towards delays as evidenced by dispatch of inappropriate neonatal transfer equipment and inadequate dispatch of emergency care personnel. Seventeen (14.2%) of the transfer requests required transportation only, without any specialised equipment. These cases are for elective care (non-emergency) and should ideally be allocated to the planned patient transport unit (PTT) as they require no equipment and the

mother usually accompanies the neonate. Of the 17 transfers where no equipment had been required, 14 were during dayshifts, but only 1 (0.8%) of the transfers was dispatched to the PPT. Although these were not specialised transfers, ALS personnel working in the obstetric unit were dispatched to 5 of them and a further 11 ALS personnel were dispatched to the operational ambulance units although no equipment had been requested. The results showed that there was no consistency in the requests of the transfer to the nature of the transfer. In 4 of the 15 cases in which equipment was requested, the information was not relayed to the emergency care provider. In 10 transfers, equipment was requested by the referring personnel but no equipment was required for the transfer and on 1 transfer the dispatcher did not seem to understand what equipment was required for the transfer stating, “ALS equipment needed, proceed and investigate”. McCloskey & Orr (1991) state that the basis of a safe and timely transport is good co-ordination and communication between the referring facility, the transportation teams and the receiving facility. This may be accomplished by having adequately trained personnel in the communication centre, who are familiar with the latest guidelines in neonatal transport and neonatal care, and having an ALS co-ordinator overseeing the entire transfer process.

5.4 Qualification and experience of the telephone operator and the emergency care provider

Sharing experiences, information and advice on transportation with other services will continue to improve the standard of care of inter-facility neonatal transport. The telephone operators are the liaison between the inter-healthcare facilities and therefore, must understand the transfer’s process and its requirements (Moss et al., 2005). The current study noted that although there had been so many inconsistencies in the dispatching of units, personnel and equipment, the telephone operators on 78 (65%) of the transfers had more than five years’ experience in the communication centre as well as experience in operations. It would be beneficial, however, if these operators were trained in neonatal care and well versed in neonatal transport, as well as having the clinical supervision of a ALS transport co-ordinator who is qualified and experienced in this field.

The study data also demonstrated that the telephone operators who had co-ordinated 33 (27.5%) of the transfers were inexperienced and that some of the specialised transfers had been accepted by junior staff, working without clinical supervision. This has highlighted an area of great concern as, according to Miller et al., (2008), specialised transfers of neonates are a high risk and a multiple phase process which need to be tightly choreographed.

5.5 Procedures performed

As performing procedures on a neonate during transportation is a difficult process associated with very high levels of risk due the hazardous environment, it is vital to stabilise the neonate in the referring hospital before transferring them to the ambulance (Ratnavel, 2009). Six neonates (5.0%) were clinically unstable for transport when the transport team arrived at the receiving hospital. Of these, 5 (8.3%) were ALS transfers where the neonate had been stabilised before transport with the assistance of the transport team, and 1 (16.7%) was an ILS transfer where the neonate was transported without stabilisation and deteriorated further during the transfer.

However, while the transportation crew is en route to the referring facility, the communication centre must co-ordinate the packaging of the neonate with the referring facility in order to expedite the transfer so that the neonate is ready for transportation when the transfer team arrives. Having no appropriately qualified personnel in the communication centre to undertake this task resulted in some of the time delays when the emergency care provider needed to stabilise the neonate before leaving the referring hospital. Statistics revealed a significant relationship between neonatal pre-transport packaging and time delays, with a p. value = 0.018.

5.6 The equipment required

Clinically monitoring of a neonate during inter-healthcare facility transfers is a difficult task due to limited space, vibration and motion of the ambulance, poor lighting and high ambient noise. Barry & Ralston (1994) recommend that specially designed and dedicated monitoring equipment that is light weight and robust should be used and

that it should have a long battery life with backup. This study, however, revealed that although most of the equipment failures were related to battery failure, there were incidences when the equipment that was required was unavailable because it was malfunctioning, inappropriate, insufficient or unsterile. Technical problems with the equipment attributed to life threatening physiological adverse events, p. value = 0.007. Equipment issues, therefore, need urgent attention.

Delays due to unavailable equipment were associated with 30.8% of the transfers, the main reasons being limited equipment, poor co-ordination and poor resource allocation of available equipment. The findings revealed that equipment for 23 (20.8%) transfers had to be fetched from other bases. The northern zone had 2 ventilators while the other 3 zones shared 1. Not all bases had incubators, whereas some bases had 2. Ventilators were unavailable for 10 of the specialised transfers because they had been sent in for repairs and had not been returned or replaced, and so had to be borrowed from other bases to undertake the transfers. For 2 of the transfers the EMRS had to borrow incubators from the clinics and on 1 transfer a syringe driver had to be borrowed from one of the hospitals.

Transportation teams can be dispatched to transfers at any moment, therefore, the necessary equipment and medical supplies must be readily available to them. A standard pre-departure checklist of equipment and supplies should be mandatory to ensure that all equipment is in good working order and the medical supplies that will be required during the transportation phases are present (Horowitz & Rozenfeld, 2007). A pre-departure checklist is an aide memoire and therefore should be always be used. The findings of this study showed that not all bases of the EMRS carried out a pre-departure check of equipment. For 48 (40%) of the 120 transfers, no pre-departure checks had been carried out.

It is of grave concern that the study identified that in 2 (1.7%) the transfers that required ventilation, unsterile ventilator circuits were used. In one (0.8%) case, the ventilator circuit was not disinfected due to the unavailability of a disinfectant. This circuit was soaked and rinsed with tap water only, then autoclaved. The other circuit had been disinfected, but not autoclaved before use due to no additional circuits being available at that time. It was also documented that disposable circuits were autoclaved and re-used on 3 ventilated transfers due to a lack of circuits. On 6

(5.0%) of the transfers the incubators were not thoroughly clean. In 4 (3.3%) of the 6 (5.0%) transfers, the incubator had not been cleaned and disinfected after the previous cases and it was documented that blood stained linen, blood stained cotton wool, used medical tape, drip bags and a dead cockroach had been left in the incubators. This added to the time delays as the incubators had to be cleaned and disinfected before proceeding to the transfer. Due to back-to-back transfers, the incubators used in 2 (1.7%) of the 6 transfers were wiped down at the hospital with tap water only and not disinfected. Two sets of twins were transferred (both return transfers) during the study period and on both occasions, due to limited resources, they were transported together in one incubator. Despite the concerns expressed by the emergency care providers at the time, the decision to transport the two neonates in one incubator was made by the officer in the communication centre who is ILS qualified. In one of the cases, it was discovered at a later stage, after the emergency care provider had handed over the twins to the receiving facility, that one of the neonates had been treated for klebsiella pneumonia infection. It is imperative that clean and sterilised equipment is used during neonatal inter-healthcare facility transfers to prevent infection (Department of Health 2010b). The use of unsterile equipment is of serious concern when one considers the fragile nature of critically ill neonates. These findings imply the need for procurement of additional sterilised equipment and sterilised ventilator circuits as well as a disinfection protocol for incubators and auxiliary equipment.

5.7 Adverse events encountered during the transfer of the neonate

Adverse events encountered during the transfer of the neonates over the study period were categorised as physiologically related adverse events and equipment related adverse events. According to Barry & Ralston (1994), ideally, neonates in an intensive care environment should be supported during transportation with continuous and reliable monitoring and care. Neonatal deterioration, therefore, should rarely occur, and should be related to the neonatal illness rather that the physical transfer. Equipment failures and iatrogenic mortality or morbidity should not occur.

This study identified 10 (8.3%) physiologically related adverse events, including 1 (0.8%) mortality, and 15 (15.0%) equipment related adverse events. Five (4.2%) of the 15 equipment related adverse events contributed directly to 5 (4.2%) of the 10 life threatening physiologically related adverse events, p. value = 0.007. The other 13 (10.8%) equipment related adverse events did not result in any identifiable documented physiologically related adverse events.

All physiologically related adverse events were life threatening with conditions such as respiratory deterioration, cardiac deterioration, desaturation, temperature deterioration and cardiorespiratory arrest. Nine (7.5%) of the 10 physiologically related adverse events were encountered during specialised transfers and 1 (0.8) during an ILS transfer. The mortality occurred during a specialised transfer referred from one of the primary health care facilities. The initial responder to the primary health care facility was an operational ambulance with two BLS personnel, who subsequently called for ALS assistance as the neonate was unstable. The operational ambulance and the ALS personnel were not adequately equipped to carry out a specialised neonatal transfer. The neonate deteriorated into cardiorespiratory arrest during transportation approximately 6min from departure and the resuscitation efforts of the transport team were unsuccessful. The implications of this were possibly due a number of factors including the transfer being dispatched to the operational ambulances, which was not equipped to handle specialised transfers (having no ventilator, no incubator, no SpO_2 monitoring); delays due to the responding team not having the necessary qualifications and inappropriate packaging and pre-transport stabilisation (the neonate was not intubated, an intravenous line was not inserted and no medication was administered) by ALS personnel. Furthermore, although there are standard operating policies in relation to inter-facility transfers (Republic of South Africa, 2005), there are no formalised policies regarding inter-healthcare facility transfer of neonates, so the procedure for a code blue during inter-healthcare transfer was unclear. As the mother was accompanying the neonate, the transfer team took her and the deceased back to their residence.

The physiologically related adverse event that occurred during the ILS transfer was also associated with inappropriate pre-transport packaging and stabilisation as well

as haste. Although the ILS emergency care provider called for ALS assistance to help stabilise the neonate, no ALS assistance was available at the time. The decision to transport the unstable neonate was made by the communication officer (ILS) and the emergency care provider (ILS), who decided to go ahead with the transfer as the distance between the two hospitals was not far. However, this decision was outside the scope of practice of an ILS qualification. The neonate's condition deteriorated during transportation and it was handed over at the receiving facility in a more unstable condition than when taken over from the referring facility. Britto et al., (1995) states that the concept of swoop and scoop is no longer considered appropriate. The objective of the transport team is to achieve physiologically acceptable haemodynamic and metabolic parameters before transportation.

Adverse events on 9 of the 22 ventilated transfers were associated with problems with the ventilators, mostly due to battery failure. Together with battery failure there were also incorrect pressure readings on the ventilator, 3 of which were due to the re-use of disposable low pressure hoses which melt during autoclaving, thus giving incorrect pressure readings. Nine (7.5%) transfers experienced problems with the incubators losing heat as a result of battery failure. A power supply inverter was used in some transfers. The inverter only charges when plugged into the ambulance wall socket. When the incubators were unplugged from the inverter, they were unable to maintain their charge. It was also documented that the 12 volt wall mounted sockets in the ambulance were not compatible with some of the equipment. Another 3 equipment related adverse events were experienced, 2 of which involved the wall mounted oxygen sockets and 1 involved the stretcher. In 1 instance, a neonate was transferred from one ambulance to another whilst en route to hospital. The reason for this was that the oxygen wall socket in the ambulance was not working.

The adverse events encountered in this study are not unique to the EMRS in the eThekwini Health District of KwaZulu-Natal, however, but seem to be problems that are encountered by ambulance services worldwide, as similar finding have been reported by Moss et al., (2005), in the United Kingdom, by Mgcini (2011) in Johannesburg, South Africa, by Barry and Ralston (1994) in Leicester, England and by Mullane et al., (2002) in Ireland.

5.8 Limitations of the study

The limitations of the study were:

1. The sample size consisted of 120 consecutive neonatal inter-healthcare facility transfers only. It would have been statistically beneficial to have had a larger sample size.

2. The study involved the EMRS in only one health district, instead of the entire province of KwaZulu-Natal. To undertake a prospective study of the EMRS operating throughout the entire province seemed farfetched for only one researcher to handle. Therefore, the researcher limited the study to the services provided by the EMRS in the eThekwini District only.

3. Another limitation was the exclusion of the private sector ambulance services operating in the same area. The study was restricted to the public sector to identify challenges experienced in the public sector only.

5.9 Conclusion

This chapter presented the discussion of the results for each objective of the study. The Emergency Medical Rescue Service in eThekwini Health District is a robust mature EMS system that continually strives to provide quality emergency medical care. This study was undertaken by the researcher to provide a descriptive analysis, specifically within the field of neonatal inter-healthcare facility transfers that could be improved to provide a better service. It is the belief of the researcher that a proactive approach involving simple reorganization of existing facilities will contribute positively to safer and more efficient neonatal inter-healthcare facility transfers.

The following chapter concludes the study and contains the researcher's recommendations for inter-healthcare facility transfer of neonates.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The Emergency Medical Rescue Service operating in the eThekwini Health District is involved in the transportation of a significant number of intensive care and non-intensive care neonates between healthcare facilities. Transport teams must be trained to provide this specialised care for inter-healthcare facility transfers of neonates and need to fully understand all phases of the neonatal transfer process (Appendix 8). To achieve a high standard of neonatal care and monitoring it is essential that there is effective communication and co-ordination between all role players, which is underpinned by good team work. This descriptive, prospective study, however, identified numerous shortfalls in the service provided by the EMRS.

This study has shown that most of the transfers took place during the day and were undertaken by the operational ambulance units. Most of the time delays were caused during the dispatch of the ambulances and the pre-transport stabilisation and packaging of the neonates. The major factors contributing to the time delays during dispatch were associated with limited resources and inappropriately trained communication centre personnel accepting and co-ordinating the neonatal transfers. Pre-transport stabilisation and packaging delays occurred when the referring facilities had not had the neonates properly stabilised and packaged for transportation by the time the ambulance arrived to transport.

The study also identified that the service provided by EMRS was sometimes compromised by problems with their equipment. In many cases, the required equipment was not available, either due to insufficiency or poor resource allocation. Various equipment-related adverse events occurred en route, jeopardizing the quality of care that should have been administered to the neonates in transit. In some instances, the equipment malfunctioned and in others it failed altogether, often the result of batteries not having been properly charged. Unsterile equipment had

been used in some of the transfers as well as the multiple uses of disposable ventilator circuits.

The study identified physiological-related adverse events that occurred during the transfers and in some instances these were the direct result of equipment related adverse events. Some of these adverse events were life threatening. It must be noted that 1 death occurred as a resulted of inappropriate level of care, inadequate neonatal pre-transfer packaging and stabilisation and inadequate neonatal transport equipment.

6.2 Recommendations

Inter-healthcare facility transfer of neonates can be safely performed by the transport services if there are specialised and trained transport teams armed with appropriate equipment and medical supplies, together with the guidance of policies and quality assurance. Transport teams must be trained to provide this specialised care in all emergency transport mediums, both on the ground and in the air, including ground ambulances, rotor wing aircraft (helicopters) and fixed wing aircraft.

The following recommendations apply to inter-healthcare facility transfer of neonates:

- A thorough understanding of the transfer process by all those involved in inter-healthcare facility transfers of neonates in the eThekwini Health district.
- Specialised and dedicated neonatal transport teams in EMRS eThekwini.
- Sophisticated transportation equipment.
- Training and development.
- Standard Operating Policies.
- Quality assurance.

These are further discussed individually.

6.2.1 A thorough understanding of the transfer process

The transfer process is a joint responsibility of the referring hospital, the transportation team and the receiving hospital. The responsibility is shared by all those who are involved throughout the process, from beginning to end, including the doctors, nurses, emergency care providers and support services. It is, therefore, important that they have a thorough understanding of the transfer process. It is essential that a systematic approach is undertaken in order to provide the best service (Appendix 8)

6.2.2 Specialised and dedicated transport teams

Specialised and dedicated neonatal teams in EMRS eThekwini should be allocated specifically for neonatal inter-healthcare transportation. Each zone should be allocated a 24 hour neonatal inter-healthcare facility transfer team. This would ensure a rapid dispatch and a focussed response team for the emergency intensive neonatal care transfers. Given the large percentage of repatriations from the only regional hospital in KZN, IALCH, which is located in the central zone, an additional transfer unit should be allocated for repatriation only. Having a standalone neonatal transfer team enhances clinical excellence and familiarity with transport specific process and equipment.

The following aspects should be taken into account for a specialised and dedicated transport team:

1) The team selection depends on the need of the neonate being transported.

2) All team personnel must be competent and properly trained in neonatal intensive care and the transport environment.

3) The most senior medical trained personnel must be delegated as the team leader.

4) All team personnel must be aware of the contribution expected of each other. Everyone involved in the execution of neonatal inter-healthcare facility

transfers needs to work collaboratively, in a timely manner, and understand their respective accountabilities.

5) For neonatal intensive care inter-healthcare facility transfers, it is highly desirable that the specialised personnel should be accompanied by a minimum of one team member at all times (excluding the driver), especially during transition for monitoring and care.

6) For repatriations, an ILS trained personnel with adequate and appropriate equipment as well as monitoring equipment should be suitable for this function as the neonates are stable, at this stage, and being returned to the respective facilities for supportive care or discharge.

7) An appropriately qualified transport co-ordinator must be allocated to the communication centre to supervise the transfer process and act as a liaison between the referring hospital, transportation team and the receiving hospital in order to expedite the transfer process.

6.2.3 Sophisticated transportation equipment

Equipment used for neonatal inter-healthcare facility transportation should be suited to the pre-hospital environment and aimed at optimizing functionality whilst reducing any risk to the neonate. Such equipment should be light weight, compact, durable, have adaptable electrical requirements, motion and g-force tolerant and fixation with adequate visual and audio alarms, and have a lack of electromagnetic interference. All equipment should be fully charged, checked for their completeness and functioning before leaving to undertake a transfer. It must be mandatory to complete a standard checklist during the shift takeover as well as pre-departure. This ensures that all equipment is in good working order, supplies and medication are present and within their expiration dates. Battery operated equipment should have fully charged battery power cables compatible with the ambulance plug sockets. The ambulance must be fitted with an inverter to charge equipment during transit if necessary. A portable battery pack attached to the transport stretcher is mandatory for power reserves away from the ambulance in case of emergencies or shortfalls. Power supply extensions must be carried to make use of external supplies when available.

Equipment should be of a high standard and serviced by designated equipment technologists who will repair and return them promptly and this should be documented in an equipment service and maintenance log. Oxygen and medical gas requirements should be determined and estimated in advance of the transport commencing. All equipment should either be fastened onto the transport stretcher or securely stored in appropriate compartments in the ambulance.

6.2.4 Training and development

Continuous education is essential to provide the transportation teams as well as the communication centre personnel with formal ongoing training. Knowledge and information regarding neonatal inter-healthcare facility transport should be promoted through various mechanisms such as:

- the Continued Professional Development (CPD) forums, which are accredited by the Health Professions Council of South Africa (HPCSA);
- lectures and group discussions;
- practicing with neonatal simulators to improve skills, especially in airway management and intravenous cannulation techniques;
- clinical practice in specialised neonatal facilities; and
- inter-disciplinary training with all role players in the transportation of neonates (doctors, nurses and support staff).

6.2.5 Standard operating policies

The DOH's (2010) Standard Operating Policies (SOPs) is intended to provide a framework for a referral system for health service in KwaZulu-Natal. This framework serves as a directive for the Operations and Planned Patient Transport sections of the EMRS. While these SOPs do exit, there are currently no uniform guidelines or policies within the health district of eThekwini or KZN EMRS for the inter-healthcare facility transport of neonates to assure quality of care. The researcher recommends

that the following policies be included in the DOH SOPs to help the EMRS in the inter-healthcare facility transfer of neonates;

- a policy for the transportation process;
- a policy for the transportation time frames, including sub time intervals and overall times;
- a policy for the criteria of emergency neonatal inter-healthcare facility transfer (for haemodynamic stabile neonates only);
- a policy for life over limb situations; and
- a policy for mortality during transportation.

6.2.6 Quality assurance

Neonatal inter-facility transport teams should engage in quality assurance to evaluate the appropriateness and quality of care of the overall transport performance of the emergency medical service. Specific cases should be reviewed to identify strengths, weakness, opportunities or deviations from standard practice. This provides an environment for team performances, system issues, re-evaluation of policies and procedures and adaptation to evidence based medicine. In addition to neonatal care, quality assurance programmes should include the performance of the communication centre, required registrations, certifications and licensing of EMRS personnel, maintenance of equipment and vehicles, and safety issues. Data collection provides an important part of quality assurance as it can be used as a quality improvement mechanism and an aid when published in a peer reviewed journal.

6.2.7 Conclusion

The EMRS provides an invaluable service to the people living in the eThekwini District and the combined effort of all those working within this organization has saved countless lives. The dedication of all team members is, therefore, without question. The inter-healthcare transport of neonates is a specialised field which

warrants special attention, as neonates are extremely vulnerable to predicted and unpredicted problems. It is the sincere hope of the researcher that the findings of this study will contribute to identifying the difficulties faced by those working in this field and thus be instrumental in findings ways of improving the service.

7. LIST OF APPENDICES

Appendix 1: Ethical clearance from the Institution Research Ethics Committee (IREC) DUT

Appendix 2: Permission letter from DOH KZN

Appendix 3: Letter of information and consent

Appendix 4: Questionnaire for the communication officer

Appendix 5: Questionnaire for the emergency care provider

Appendix 6: Data tool

Appendix 7: Patient report form

Appendix 8: A thorough understanding of the transfer process

Appendix 9: CD: statistical analysis

Appendix 1

DURBAN UNIVERSITY of TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

3 November 2011

IREC Reference Number: **REC 5/11**

Mr P Ashokcoomar
258 Houghton Road
Clairwood
Durban
4052

Dear Mr Ashokcoomar

MASTERS DEGREE IN TECHNOLOGY: EMERGENCY MEDICAL CARE

Title: An analysis of inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal

I am please to inform you that Full Approval has been granted to your proposal REC 5/11.

The Proposal has been allocated the following Ethical Clearance number **IREC 001/11**. Please use this number in all communication with this office.

Approval has been granted for a period of one year, after which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that ANY amendments in the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Prof T Puckree
Chairperson: IREC

Appendix 2

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : **HRKM173/11**
Enquiries : **Mrs G Khumalo**
Telephone : 033 – 3953189

08 December 2011

Dear Mr P Ashokcoomar

Subject: Approval of a Research Proposal

1. The research proposal titled **'An analysis of inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal'** was reviewed by the KwaZulu-Natal Department of Health.

The proposal is hereby **approved** for research to be undertaken at eThekwini District EMRS.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-3953189.

Yours Sincerely

[redacted]

Dr E Lutge
Chairperson, Health Research Committee
KwaZulu-Natal Department of Health
Date: 07/12/2011

Appendix 3

HEALTH RESEARCH ETHICS COMMITTEE (HREC)

LETTER OF INFORMATION AND CONSENT

Title of the Research Study: An analysis of inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal.

Principle researcher : Pradeep Ashokcoomar

Supervisor : Mr Raveen Naidoo

Co-Supervisor : Prof. J.K. Adams

Brief Introduction and Purpose of the Study:

I am conducting a research project in order to complete a Master of Technology degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology. The purpose of this study is to undertake a descriptive analysis of the inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal.

Outline of the Procedures:

The study will be undertaken in the eThekwini Health District of KwaZulu-Natal. A total of 120 neonatal transfers will be collected over approximately four months. Only the provincial ambulance service, Emergency Medical Rescue Service in eThekwini Health District of KwaZulu-Natal will be included in the study. You will be requested to partake in the study by completing a questionnaire. It will take approximately 6 minutes to complete the questionnaire. The outcome of the study can be made available to you, if so required.

Risks or Discomforts to the participants:

There will be no risk or discomfort to study participants. The questionnaire is in no way meant to cause any form of embarrassment and will not hold any adverse consequences which will affect your career.

Benefits:

This study could be used as a quality improvement mechanism by identifying potential gaps or challenges experienced during the inter-healthcare facility transfer of neonates and to make recommendations into key issues for the future improvement of inter-healthcare facility transfer of neonates. A study of this nature is an essential component of providing appropriate emergency medical care and contributes to a limited body of knowledge in inter-healthcare facility transfer of neonates, within the eThekwini Health District of KwaZulu-Natal as well as South Africa.

Withdrawal from the Study:

There will be no coercion or pressure to participate and the participants may withdraw from the study at any time during the research. There will be no adverse consequences incurred upon the participants.

Remuneration:

The study is entirely voluntary. The participant will not receive any monetary or other types of remuneration for the participation of the study.

Costs of the Study:

There is no compensation for your participation and no cost will be incurred by you.

Confidentiality:

Confidentiality will be maintained by means of a code number, so that no names appear on the data collection forms. All personally identifiable information will be omitted during data collection thereby ensuring anonymity. Only chronological, demographical and clinical information will be collected for research purposes.

Research-related Injury:

The researcher will not be responsible for any research related injury/injuries during the study. There will be no compensation for such injury/injuries.

Persons to Contact in the Event of Any Problems or Queries:

Researcher	:	Mr Pradeep Ashokcoomar	0828096470
Supervisor	:	Mr Raveen Naidoo	031 3735203
Co-Supervisor	:	Prof. J.K. Adams	031 3735291
HOD	:	Mr. S. Naguran	031 3735203

Statement of Agreement to Participate in the Research Study:

I, _____ (full name), ID number _____, have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by Mr. Pradeep Ashokcoomar to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Participant's name (print) _____

Participant's signature: _____ Date: ___/____/____

Researcher's name (print) Mr. Pradeep Ashokcoomar

Researcher's signature: _____ Date: ___/____/____

Witness name (print) _____

Witness signature : _____ Date: ___/____/____

Appendix 4

CODE	

DURBAN UNIVERSITY of TECHNOLOGY

QUESTIONNAIRE FOR THE COMMUNICATIONS OFFICER

Dear Colleague,

Thank you for agreeing to participate in my study. Please note that your answers will be kept confidential. This study aims to undertake a descriptive analysis of the current neonatal inter-healthcare facility transfer system employed by the Emergency Medical and Rescue Service, in eThekwini Health District KZN. A study of this nature is an essential component of providing appropriate emergency medical care and contributes to a limited body of knowledge in inter-healthcare facility transfer of neonates, within the eThekwini Health District of KwaZulu-Natal as well as South Africa.

Instructions:
1. Please read each question carefully. Answer as honestly as possible to preserve true data for realistic analysis.
2. Simply tick ✓ one box only.
3. Questions with options will be specified, simply tick ✓ the correct box or boxes, if necessary.
4. If you ticked ✓ "other", please specify your answer.

SECTION A: TIME FRAMES AND CASE NUMBER

Case number : _____ Date : __/__/ 2011

Time of request : ____h____ *(in 24 hours)*

Time of dispatch : ____h____ *(in 24 hours)*

SECTION B: QUALIFICATION OF TELEPHONE OPERATOR

1. What is the emergency medical care qualification of the telephone operator who had taken the request for the neonatal transfer?

(Tick ✓ one box only) □ BLS □ ILS □ ECT
□ ALS □ ECP □ Other (specify) _____

2. How many years of operational experience does the telephone operator have?

(Tick ✓ one box only) □ None □ Between 3 years to 5 years
□ Under 1 year □ More than 5 years
□ Between 1 year to 3 year

3. How many years of communication centre experience does the telephone operator have?

(Tick ✓ one box only) □ Under 1 year □ Between 3years to 5 years
□ Between 1 year to 3 year □ More than 5 years

SECTION C: THE ACTIVATION PHASE

1. Who requested the neonatal transfer?

(Tick ✓ in one box only) □ Doctor □ Nurse □ Other (specify) _____

2. What equipment was requested for the neonatal transfer?

(You may tick ✓ more than one box if necessary)

□ Oxygen
□ Portable respiratory ventilator
□ Transport incubator
□ Hot box
□ Syringe drivers
□ Infusion pumps
□ Cardiac monitor
□ Saturation monitor
□ End tidal CO2 monitor
□ NIBP monitor
□ Temperature monitoring
□ Other (specify) _____

SECTION D: REFERRING AND RECEIVING MEDICAL FACILITIES

1. Which medical facility referred the neonate? *(Tick ✓ one box only)*

- ☐ Prince Mshiyeni Memorial Hospital
- ☐ R K Khan Hospital
- ☐ St Mary's hospital
- ☐ King Edward VIII Hospital
- ☐ Mahatma Gandhi Memorial Hospital
- ☐ Addington hospital
- ☐ McCords Hospital
- ☐ Inkosi Albert Luthuli Central Hospital
- ☐ Primary Health Clinic (specify) _____
- ☐ Other (specify) _____
- ☐ Kingsway Hospital
- ☐ Chatsmed Garden Hospital
- ☐ Parklands Hospital
- ☐ City Health Hospital
- ☐ St Augustines Hospital
- ☐ Entabeni Hospital
- ☐ Isipingo Medical Towers Hospital
- ☐ Nu Shifa Hospital
- ☐ Crompton Hospital

2. Is this a primary transfer? *(Tick ✓ one box only)* ☐ Yes ☐ No

3. Is this a return transfer? *(Tick ✓ one box only)* ☐ Yes ☐ No

4. Which medical facility received the neonate? *(Tick ✓ one box only)*

- ☐ Prince Mshiyeni Memorial Hospital
- ☐ R K Khan Hospital
- ☐ St Mary's hospital
- ☐ King Edward VIII Hospital
- ☐ Mahatma Gandhi Memorial Hospital
- ☐ Addington hospital
- ☐ McCords Hospital
- ☐ Inkosi Albert Luthuli Central Hospital
- ☐ Primary Health Clinic (specify) _____
- ☐ Other (specify) _____
- ☐ Kingsway Hospital
- ☐ Chatsmed Garden Hospital
- ☐ Parklands Hospital
- ☐ City Health Hospital
- ☐ St Augustines Hospital
- ☐ Entabeni Hospital
- ☐ Isipingo Medical Towers Hospital
- ☐ Nu Shifa Hospital
- ☐ Crompton Hospital

SECTION E: COMMUNICATION CENTER DISPATCH DETAILS

1. Was the request for the neonatal transfer dispatched within three minutes from the time received? *(Tick ✓ one box only)* □ Yes □ No

2. If the above question is no, what was the reason for not dispatching the neonatal within three minutes? *(You may tick ✓ more than one box if necessary)*

□ No ILS available
□ No ALS available
□ No ESV available
□ Other requests to dispatch before the transfer
□ The neonate is in a medical facility so there is no urgency
□ Other (specify) _____

3. What mode of transport was dispatched? *(You may tick ✓ more than one box if necessary)*

□ Ground ambulance
□ Fixed wing aircraft
□ Rotor wing aircraft
□ Other (specify) _____

GENERAL COMMENTS *(if necessary)*

_____

_____

_____

_____

_____

Thank you kindly for your cooperation and time. Should you have any questions pertaining to this questionnaire or the research, please feel free to contact the researcher. The details are as follows.

PRADEEP ASHOKCOOMAR

CELL NUMBER: 0828096470

CODE	

Appendix 5

DURBAN UNIVERSITY of TECHNOLOGY

QUESTIONNAIRE FOR THE SENIOR EMERGENCY

CARE PROVIDER UNDERTAKING THE TRANSFER

Dear Colleague,

Thank you for agreeing to participate in my study. Please note that your answers will be kept confidential. This study aims to undertake a descriptive analysis of the current neonatal inter-healthcare facility transfer system employed by the Emergency Medical and Rescue Service, in eThekwini Health District KZN. A study of this nature is an essential component of providing appropriate emergency medical care and contributes to a limited body of knowledge in inter-healthcare facility transfer of neonates, within the eThekwini Health District of KwaZulu-Natal as well as South Africa.

Instructions:
1. Please read each question carefully. Answer as honestly as possible to preserve true data for realistic analysis.
2. Simply tick ✓ one box only.
3. Questions with options will be specified, simply tick ✓ the correct box or boxes, if necessary.
4. If you ticked ✓ "other", please specify your answer.

Case number : _____ Date : ___/___/___

SECTION A: PREPARATION PHASE

1. TIME FRAMES *(in 24 hours)*

1.1. Time mobile to the referring hospital	H
1.2. Time at the referring hospital	H
1.3. Time mobile to the receiving hospital	H
1.4. Time at the receiving hospital	H
1.5. Time completed	H

2. QUALIFICATION

2.1. What is your emergency medical care qualification?

(Tick ✓ one box only) ☐ BLS ☐ ILS ☐ ECT

☐ ALS ☐ ECP ☐ Other (specify) _____

2.2. How many years of experience do you have in your present qualification?

(Tick ✓ in one box only) ☐ Under 1 year ☐ Between 3 years to 5 years

☐ Between 1 year to 3 years ☐ More than 5 years

2.3. How many years of operational experience do you have?

(Tick ✓ in one box only) ☐ Under 1 year ☐ Between 3 years to 5 years

☐ Between 1 year to 3 year ☐ More than 5 years

3. EQUIPMENT

3.1. Did you complete a pre-departure checklist before undertaking the neonatal transfer?

(Tick ✓ one box only) ☐ Yes ☐ No

3.2. If the question above is no, what was the reason?

(Tick ✓ one box only) ☐ No pre-departure checklist

☐ No pre-departure checklist available at the time

☐ Did not have time to complete a pre-departure checklist

☐ Other (specify) _____

3.3. Was the equipment requested readily available for the neonatal transfer?

(Tick ✓ one box only) ☐ Yes ☐ No

3.4. If the question above is no, what equipment was unavailable?

(You may tick ✓ more than one box if necessary)

☐ Oxygen ☐ Cardiac monitor

☐ Portable respiratory ventilator ☐ Saturation monitor

□ Transport incubator
□ Hot box
□ Syringe drivers
□ Infusion pumps
□ End tidal CO2 monitor
□ NIBP monitor
□ Temperature monitoring
□ Other (specify) _____

3.5. If question 3.3 is no, why was the equipment unavailable?

(You may tick ✓ more than one box if necessary)

□ The specified equipment was at another base.

□ The specified equipment was sent for repairs.

□ EMRS in this district does not have the specified equipment that was requested.

□ Other (specify) _____

3.6. Before undertaking the neonatal transfer, did you test all the equipment required?

(Tick ✓ one box only) □ Yes □ No

3.7. If the question above is no, what was the reason?

(Tick ✓ one box only)

□ You had forgotten to test the equipment.

□ There was no time to test the equipment.

□ The equipment was already tested on takeover.

□ Other (specify) _____

3.8. Was the battery operated equipment fully charged?

(Tick ✓ one box only) □ Yes □ No

3.9. If the question above is no, what was the reason?

(You may tick ✓ more than one box if necessary)

□ The equipment was not placed on charge.

□ The equipment was not maintaining charge.

□ The equipment was not on charge long enough.

□ There was no charge leads to charge the equipment.

□ Other (specify) _____

3.10. Was the specified equipment clean for the use of the transfer?

(Tick ✓ one box only) □ Yes □ No

3.11. If the question above is no, please specify _____

3.12. If you used a ventilator circuit, was the ventilator circuit in a sealed sterile pack?

(Tick ✓ one box only) □ Yes □ No

3.13. If the question above is no, what was the reason?

(You may tick ✓ more than one box if necessary)

□ The pack was already opened. □ The circuit was not disinfected.

□ The circuit was not autoclaved. □ There is no sterile packaging to pack the circuits.

□ Other (specify) _____

SECTION B: THE RETRIEVAL PHASE

1. Who handed over the patient to you?

(Tick ✓ one box only) □ A doctor □ The mother

□ A nurse □ Other (specify) _____

2. In your professional opinion, was the hand over at the referring hospital appropriate?

(Tick ✓ one box only) □ Yes □ No

3. If the question above is no, what was inappropriate about the handover?

(You may tick ✓ more than one box if necessary)

□ No post delivery event history □ No one to assist you take over

□ No clinical management history □ No pharmacological history

□ No documentation □ Incomplete documentation

□ Other (specify) _____

COMMENTS (*if necessary*)

_____

_____

_____

4. CLINICAL DEMOGRAPHICS

4.1. What was the maternal history?

(You may tick ✓ more than one box if necessary)

- □ Cardiac
- □ Hypertensive
- □ Anaemia
- □ Diabetic
- □ Eclampsia
- □ Pre-eclampsia
- □ HIV / AIDS
- □ Obstructed labour
- □ Malpresentation
- □ Ante partum haemorrhage
- □ None
- □ Other (please specify) _____

4.2. What was the gestational age?

(Tick ✓ one box only) □ Pre-term □ Post-term □ Term

4.3. What was the neonatal age?

(Tick ✓ one box only)

- □ From birth to 4 hours
- □ Between 4hours to 1 day
- □ Between 1 day to 7 days
- □ Between 7 days to 28 days

4.4. What was the weight of the neonate who was transferred?

(Tick ✓ one box only)

- □ Less than 1000g
- □ 1000g to 1499g
- □ 1500g to 1999g
- □ 2000g to 3999g
- □ More than 4000g

4.5. What was the gender of the neonate who was transferred?

(Tick ✓ one box only) □ Male □ Female

4.6. What was the transferring facility's diagnosis?

(You may tick ✓ more than one box if necessary)

- □ Pre-term
- □ Respiratory distress syndrome
- □ Meconium aspiration syndrome
- □ Hyaline membrane disease
- □ Low birth weight
- □ Birth trauma
- □ Neonatal sepsis
- □ Diaphragmatic hernia
- □ Perforated bowel
- □ Supportive care

□ Congenital Pneumonia
□ Aspiration
□ Congenital heart disease
□ Shock or suspected shock
□ Transient tachypnea of the newborn
□ Pulmonary hypertension
□ Asphyxia
□ Apnea
□ Infection or suspected infections
□Other (specify) _____

5. PRE TRANSPORT STABILISATION

5.1. Was the neonate at the referring facility stable for transfer?

(Tick ✓ one box only) □ Yes □ No

5.2. If the question above is no, what was the reason for the neonate being unstable?

(You may tick ✓ more than one box if necessary)

□ Desaturation
□ Cardiac related problems
□ Respiratory related problems
□ Temperature related problems
□ Neurological deterioration
□ Iatrogenic
□ Unknown reasons
□ Other (specify) _____

5.3. Did you attempt any skill intervention/s for the neonate before leaving the referring hospital?

(Tick ✓ one box only) □ Yes □ No

5.4. If the question above is yes, what skill intervention/s was/were attempted and was/were the skill/s successful or unsuccessful? *(You may tick ✓ more than one box if necessary)*

□ Oxygenation via bag valve mask	□ successful	□ unsuccessful
□ Intubation	□ successful	□ unsuccessful
□ Extubation and re-intubation	□ successful	□ unsuccessful
□ Re-strapping the endotracheal tube	□ successful	□ unsuccessful
□ Adjusting the endotracheal tube depth	□ successful	□ unsuccessful
□ Suctioning	□ successful	□ unsuccessful
□ Deep tracheal suctioning	□ successful	□ unsuccessful
□ Administration of pharmacological agents	□ successful	□ unsuccessful
□ Administration of electrical interventions	□ successful	□ unsuccessful
□ Naso- gastric tube insertion	□ successful	□ unsuccessful

□ Correcting drain occlusions □ successful □ unsuccessful

□ Cardiopulmonary resuscitation □ successful □ unsuccessful

□ Administration of fluids □ successful □ unsuccessful

□ Intra-venous cannulation □ successful □ unsuccessful

□ Intra-osseous cannulation □ successful □ unsuccessful

□ Umbilical vein cannulation □ successful □ unsuccessful

□ Other (please specify) _____

COMMENTS (*if necessary*)

_____

_____

_____

SECTION C: TRANSPORT PHASE

1. Did you attempt any skill intervention/s during transportation?

(Tick ✓ one box only) □ Yes □ No

2. If the question above is yes, what skill intervention/s was/were attempted and was/were the skill/s successful or unsuccessful?

(You may tick ✓ more than one box if necessary)

□ Oxygenation via bag valve mask □ successful □ unsuccessful

□ Intubation □ successful □ unsuccessful

□ Extubation and re-intubation □ successful □ unsuccessful

□ Re-strapping the endotracheal tube □ successful □ unsuccessful

□ Adjusting the endotracheal tube depth □ successful □ unsuccessful

□ Suctioning □ successful □ unsuccessful

□ Deep tracheal suctioning □ successful □ unsuccessful

□ Administration of pharmacological agents □ successful □ unsuccessful

□ Administration of electrical interventions □ successful □ unsuccessful

□ Naso- gastric tube insertion □ successful □ unsuccessful

□ Correcting drain occlusions □ successful □ unsuccessful

□ Cardiopulmonary resuscitation □ successful □ unsuccessful

□ Administration of fluids □ successful □ unsuccessful

□ Intra-venous cannulation □ successful □ unsuccessful

□ Intra-osseous cannulation □ successful □ unsuccessful

□ Umbilical vein cannulation □ successful □ unsuccessful

□ Other (please specify) _____

COMMENTS (*if necessary*)

_____

_____

_____

SECTION D: RECEPTION PHASE

1. POST TRANSPORT

1.1. Did you attempt any skill intervention/s post transportation?

(Tick ✓ one box only) □ Yes □ No

1.2. If the question above is yes, what skill intervention/s was/were attempted and was/were the skill/s successful or unsuccessful?

(You may tick ✓ more than one box if necessary)

□ Oxygenation via bag valve mask □ successful □ unsuccessful

□ Intubation □ successful □ unsuccessful

□ Extubation and re-intubation □ successful □ unsuccessful

□ Re-strapping the endotracheal tube □ successful □ unsuccessful

□ Adjusting the endotracheal tube depth □ successful □ unsuccessful

□ Suctioning □ successful □ unsuccessful

□ Deep tracheal suctioning □ successful □ unsuccessful

□ Administration of pharmacological agents □ successful □ unsuccessful

□ Administration of electrical interventions □ successful □ unsuccessful

□ Naso- gastric tube insertion □ successful □ unsuccessful

□ Correcting drain occlusions □ successful □ unsuccessful

□ Cardiopulmonary resuscitation □ successful □ unsuccessful

□ Administration of fluids □ successful □ unsuccessful

□ Intra-venous cannulation □ successful □ unsuccessful

□ Intra-osseous cannulation □ successful □ unsuccessful

□ Umbilical vein cannulation □ successful □ unsuccessful

□ Other (please specify) _____

COMMENTS (I*f necessary*)

_____

_____

_____

2. ADVERSE EVENTS ENCOUNTED DURING THE TRANSFER

2.1. Was/were there any physiological related adverse event/s to the neonate encountered during the transfer? *(Tick ✓ one box only)* □ Yes □ No

2.2. If the question above is yes, what was/were the adverse event/s?

(You may tick ✓ more than one box if necessary and specify)

□ Cardiac deteriorations (specify) _____

□ Respiratory deterioration (specify) _____

□ Neurological deterioration (specify) _____

□ Temperature related problems (specify) _____

□ Desaturation (specify) _____

□ Iatrogenic (specify) _____

□ Other (specify) _____

COMMENTS (*if necessary*)

_____

_____

_____

2.3. Was/were there any equipment related adverse event/s to the neonate encountered during the transfer? *(Tick ✓ one box only)* □ Yes □ No

2.4. If the question above is yes, what was/were the adverse event/s?

(You may tick ✓ more than one box if necessary and specify)

□ Oxygen supply (specify) _____

□ Ventilator (specify) _____

□ Endotracheal tube (specify) _____

 Incubator (specify) _____

 Hot box (specify) _____

 Venous cannulation (specify) _____

 Arterial cannulation (specify) _____

 Intra osseous cannulation (specify) _____

 Nasogastric tube (specify) _____

 Drains occluded (specify) _____

 Drains displaced (specify) _____

 Ambulance (specify) _____

 Other (please specify) _____

COMMENTS (*if necessary*)

_____
_____
_____

GENERAL COMMENTS (*if necessary*)

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Thank you kindly for your cooperation and time. Should you have any questions pertaining to this questionnaire or the research, please feel free to contact the researcher. The details are as follows.

PRADEEP ASHOKCOOMAR

CELL NUMBER: 082 8096470

CODE	

Appendix 6

DURBAN UNIVERSITY of TECHNOLOGY

DATA COLLECTING TOOL (TO BE COMPLETED BY THE RESEARCHER ONLY)

COMBINATION OF: ANNEXURE 5 – QUESTIONAIRE COMUNICATIONS OFFICER _____

ANNEXURE 6 – QUESTION EMERGENCY CARE PROVIDER _____

DATE: _____ CASE NO: _____ SHIFT: _____

SPECIALISED/VENTILATED NEONATAL INTENSIVE CARE TRANSPORT ☐ Yes ☐ No

TRANSFER UNIT: ☐ Yes ☐ No ZONE: _____

OBJECTIVE 1: CLINICAL DEMOGRAPHICS

1.1. TRANSFERRING FACILITY

☐ Prince Mshiyeni Memorial Hospital
☐ R K Khan Hospital
☐ St Mary's hospital
☐ King Edward VIII Hospital
☐ Mahatma Gandhi Memorial Hospital
☐ Addington hospital
☐ McCords Hospital
☐ Inkosi Albert Luthuli Central Hospital
☐ Primary Health Clinic (specify) _____
☐ Other (specify) _____
☐ Kingsway Hospital
☐ Chatsmed Garden Hospital
☐ Parklands Hospital
☐ City Health Hospital
☐ St Augustines Hospital
☐ Entabeni Hospital
☐ Isipingo Medical Towers Hospital
☐ Nu Shifa Hospital
☐ Crompton Hospital

1.2 PRIMARY TRANSFER ☐ Yes ☐ No

1.3. RETURN TRANSFER ☐ Yes ☐ No

1.4. RECEIVING FACILITY

- ☐ Prince Mshiyeni Memorial Hospital
- ☐ R K Khan Hospital
- ☐ St Mary's hospital
- ☐ King Edward VIII Hospital
- ☐ Mahatma Gandhi Memorial Hospital
- ☐ Addington hospital
- ☐ McCords Hospital
- ☐ Inkosi Albert Luthuli Central Hospital
- ☐ Primary Health Clinic (specify) _____
- ☐ Other (specify) _____
- ☐ Kingsway Hospital
- ☐ Chatsmed Garden Hospital
- ☐ Parklands Hospital
- ☐ City Health Hospital
- ☐ St Augustines Hospital
- ☐ Entabeni Hospital
- ☐ Isipingo Medical Towers Hospital
- ☐ Nu Shifa Hospital
- ☐ Crompton Hospital

1.5. MATERNAL HISTORY

- ☐ Cardiac
- ☐ Hypertensive
- ☐ Anaemia
- ☐ Diabetic
- ☐ Eclampsia
- ☐ Preeclampsia
- ☐ Other (please specify) _____
- ☐ HIV / AIDS
- ☐ Obstructed labour
- ☐ Malpresentation
- ☐ Ante partum haemorrhage
- ☐ None
- ☐ Not documented

1.6. GESTATIONAL AGE

- ☐ Pre-term
- ☐ Post-term
- ☐ Term
- ☐ Not documented

1.7. NEONATAL AGE

- ☐ From birth to 4 hours
- ☐ Between 4hours to 1 day
- ☐ Between 1 day to 7 days
- ☐ between 7 days to 28 days
- ☐ Not documented

1.8. WEIGHT OF THE NEONATE

- ☐ Less than 1000g
- ☐ 1000g to 1499g
- ☐ 1500g to 1999g
- ☐ 2000g to 3999g
- ☐ More than 4000g
- ☐ Not documented

1.9. GENDER OF THE NEONATE □ male □ female □ not documented

1.10. DIAGNOSIS

□ Pre-term
□ Respiratory distress syndrome
□ Meconium aspiration syndrome
□ Hyaline membrane disease
□ Low birth weight
□ Congenital Pneumonia
□ Aspiration
□ Congenital heart disease
□ Shock or suspected shock
□ Transient tachypnea of the newborn
□ Birth trauma
□ Neonatal sepsis
□ Diaphragmatic hernia
□ Perforated bowel
□ Supportive care
□ Pulmonary hypertension
□ Asphyxia
□ Apnea
□ Infection or suspected infections
□Other (specify) _____

OBJECTIVE 2: TIME FRAMES

2.1 TIME FRAMES

2.1.1. TIME OF THE REQUEST	H
2.1.2. TIME OF DISPATCH	H
2.1.3. TIME MOBILE TO THE REFERRING HOSPITAL	H
2.1.4. TIME AT THE REFERRING HOSPITAL	H
2.1.5. TIME MOBILE TO THE RECEIVING HOSPITAL	H
2.1.6. TIME AT THE RECEIVING HOSPITAL	H
2.1.7. TIME COMPLETED	H

2.2 WAS THE TRANSFER DISPATCHED WITHIN 3 MINUTES FROM REQUEST □ Yes □ **No**

2.3 REASONS FOR NOT BEING DISPATCHED WITHIN 3 MINUTE □ Not applicable

□ No ILS available □ Other requests to dispatch before the transfer

□ No ALS available □ The neonate is in a medical facility so there is no urgency

□ No ESV available □ Other (specify) _____

2.4 MODE OF TRANSPORT

□ Ground ambulance □ Rotor wing aircraft

□ Fixed wing aircraft □ Other _____

OBJECTIVE 3: QUALIFICATION / PROCEDURES / EQUIPMENT

3.1 QUALIFICATION

3.1.1. QUALIFICATION OF THE TELEPONE OPERATOR

□ BLS □ ILS □ ECT

□ ALS □ ECP □ Other (specify) _____

3.1.2. OPERATIONAL EXPERIENCE OF THE TELEPONE OPERATOR

□ None □ Between 3 years to 5 years

□ Under 1 year □ More than 5 years

□ Between 1 year to 3 year

3.1.3. COMMUNICATION CENRE EXPERIENCE OF THE TELEPHONE OPERATOR

□ Under 1 year □ Between 3 years to 5 years

□ Between 1 year to 3 year □ More than 5 years

3.1.4. QUALIFICATION OF THE EMERGENCY CARE PROVIDER

□ BLS □ ILS □ ECT

□ ALS □ ECP □ Other (specify) _____

3.1.5. EXPERIENCE OF THE EMERGENCY CARE PROVIDER IN THE PRESENT QUALIFICATION

□ Under 1 year □ Between 3 years to 5 years

□ Between 1 year to 3 year □ More than 5 years

3.1.6. OPERATIONAL EXPERIENCE OF THE EMERGENCY CARE PROVIDER

□ Under 1 year □ Between 3 years to 5 years

□ Between 1 year to 3 year □ More than 5 years

3.2 PROCEDURES

3.2.1. WAS THE NEONATE AT THE REFERRING FACILITY STABLE FOR TRANSFER ☐ Yes ☐ **No**

3.2.2. REASON FOR THE UNSTABLE NEONATE ☐ Not applicable

☐ Desaturation ☐ Neurological deterioration

☐ Cardiac related problems ☐ Iatrogenic

☐ Respiratory related problems ☐ Unknown reasons

☐ Temperature related problems ☐ Other (please specify) _____

3.2.3. WAS/WERE THERE ANY SKILL INTERVENTION/S ATTEMPTED PRE TRANSPORT ☐ **Yes** ☐ No

3.2.4. WHAT SKILL INTERVENTION/S WAS/WERE ATTEMPTED PRE TRANSPORT AND WAS/WERE THE SKILL SUCCESSFUL OR UNSUCCESSFUL ☐ Not applicable

☐ Oxygenation via bag valve mask	☐ successful	☐ unsuccessful
☐ Intubation	☐ successful	☐ unsuccessful
☐ Extubation and re-intubation	☐ successful	☐ unsuccessful
☐ Re-strapping the endotracheal tube	☐ successful	☐ unsuccessful
☐ Adjusting the endotracheal tube depth	☐ successful	☐ unsuccessful
☐ Suctioning	☐ successful	☐ unsuccessful
☐ Deep tracheal suctioning	☐ successful	☐ unsuccessful
☐ Administration of pharmacological agents	☐ successful	☐ unsuccessful
☐ Administration of electrical interventions	☐ successful	☐ unsuccessful
☐ Naso- gastric tube insertion	☐ successful	☐ unsuccessful
☐ Correcting drain occlusions	☐ successful	☐ unsuccessful
☐ Cardiopulmonary resuscitation	☐ successful	☐ unsuccessful
☐ Administration of fluids	☐ successful	☐ unsuccessful
☐ Intra-venous cannulation	☐ successful	☐ unsuccessful
☐ Intra-osseous cannulation	☐ successful	☐ unsuccessful
☐ Umbilical vein cannulation	☐ successful	☐ unsuccessful

☐ Other (please specify) _____

COMMENTS (*if necessary*)

_____
_____
_____

3.2.5.WAS/WERE THERE ANY SKILL INTERVENTION/S ATTEMPTED DURING TRANSPORT ☐**Yes** ☐No

3.2.6. WHAT SKILL INTERVENTION/S WAS/WERE ATTEMPTED DURING TRANSPORT AND WAS/WERE THE SKILL SUCCESSFUL OR UNSUCCESSFUL ☐ Not applicable

☐ Oxygenation via bag valve mask	☐ successful	☐ unsuccessful
☐ Intubation	☐ successful	☐ unsuccessful
☐ Extubation and re-intubation	☐ successful	☐ unsuccessful
☐ Re-strapping the endotracheal tube	☐ successful	☐ unsuccessful
☐ Adjusting the endotracheal tube depth	☐ successful	☐ unsuccessful
☐ Suctioning	☐ successful	☐ unsuccessful
☐ Deep tracheal suctioning	☐ successful	☐ unsuccessful
☐ Administration of pharmacological agents	☐ successful	☐ unsuccessful
☐ Administration of electrical interventions	☐ successful	☐ unsuccessful
☐ Naso- gastric tube insertion	☐ successful	☐ unsuccessful
☐ Correcting drain occlusions	☐ successful	☐ unsuccessful
☐ Cardiopulmonary resuscitation	☐ successful	☐ unsuccessful
☐ Administration of fluids	☐ successful	☐ unsuccessful
☐ Intra-venous cannulation	☐ successful	☐ unsuccessful
☐ Intra-osseous cannulation	☐ successful	☐ unsuccessful
☐ Umbilical vein cannulation	☐ successful	☐ unsuccessful
☐ Other (please specify) _____		

COMMENTS (*if necessary*)

_____
_____
_____

3.2.7. WAS/WERE THERE ANY SKILL INTERVENTION/S ATTEMPTED POST TRANSPORT ☐ **Yes** ☐No

3.2.8. WHAT SKILL INTERVENTION/S WAS/WERE ATTEMPTED POST TRANSPORT AND WAS/WERE THE SKILL SUCCESSFUL OR UNSUCCESSFUL ☐ Not applicable

☐ Oxygenation via bag valve mask	☐ successful	☐ unsuccessful
☐ Intubation	☐ successful	☐ unsuccessful
☐ Extubation and re-intubation	☐ successful	☐ unsuccessful
☐ Re-strapping the endotracheal tube	☐ successful	☐ unsuccessful
☐ Adjusting the endotracheal tube depth	☐ successful	☐ unsuccessful
☐ Suctioning	☐ successful	☐ unsuccessful
☐ Deep tracheal suctioning	☐ successful	☐ unsuccessful
☐ Administration of pharmacological agents	☐ successful	☐ unsuccessful
☐ Administration of electrical interventions	☐ successful	☐ unsuccessful
☐ Naso- gastric tube insertion	☐ successful	☐ unsuccessful
☐ Correcting drain occlusions	☐ successful	☐ unsuccessful
☐ Cardiopulmonary resuscitation	☐ successful	☐ unsuccessful
☐ Administration of fluids	☐ successful	☐ unsuccessful
☐ Intra-venous cannulation	☐ successful	☐ unsuccessful
☐ Intra-osseous cannulation	☐ successful	☐ unsuccessful
☐ Umbilical vein cannulation	☐ successful	☐ unsuccessful

☐ Other (please specify) _____

COMMENTS (*if necessary*)

_____
_____
_____

3.3. EQUIPMENT

3.3.1 WHO REQUESTED THE TRANSFER □ Doctor □ Nurse □ Other (specify) _____

3.3.2. EQUIPMENT REQUESTED

□ Oxygen
□ Portable respiratory ventilator
□ Transport incubator
□ Hot box
□ Syringe drivers
□ Infusion pumps
□ Cardiac monitor
□ Saturation monitor
□ End tidal CO2 monitor
□ NIBP monitor
□ Temperature monitoring
□ Other (specify) _____

3.3.3. PRE DEPATURE CHECKLIST □ Yes □ **No**

3.3.4. REASONS FOR PRE-DEPARTURE CHECKLIST NOT DONE □ Not applicable

□ No pre-departure checklist
□ No pre-departure checklist available at the time
□ Did not have time to complete a pre-departure checklist
□ Other (please specify) _____

3.3.5. EQUIPMENT REQUESTED READILY AVAILABLE □ Yes □ **No** □ Not applicable

3.3.6. WHAT EQUIPMENT WAS UNAVAILABLE □ Not applicable

□ Oxygen
□ Portable respiratory ventilator
□ Transport incubator
□ Hot box
□ Syringe drivers
□ Infusion pumps
□ Cardiac monitor
□ Saturation monitor
□ End tidal CO2 monitor
□ NIBP monitor
□ Temperature monitoring
□ Other (specify) _____

3.3.7. WHY WAS THE EQUIPMENT UNAVAILABLE ☐ Not applicable

☐ The specified equipment was at another base

☐ The specified equipment was sent for repairs

☐ EMRS in this district does not have the specified equipment that was requested

☐ Other (specify) _____

3.3.8. EQUIPMENT TESTED BEFORE DEPARTURE ☐ Yes ☐ **No**

3.3.9. THE REASON FOR NOT TESTING THE EQUIPMENT. ☐ Not applicable

☐ You had forgotten to test the equipment

☐ There was no time to test the equipment

☐ The equipment was already tested on takeover

☐ Other (specify) _____

3.3.10. BATTERY OPERATED EQUIPMENT FULLY CHARGED ☐ Yes ☐ **No** ☐ Not applicable

3.3.11. REASONS FOR NOT BEING FULLY CHARGED ☐ Not applicable

☐ The equipment was not placed on charge

☐ The equipment was not maintaining charge

☐ The equipment was on charge long enough

☐ There was no charge leads to charge the equipment

☐ Other (specify) _____

3.3.12. WAS THE SPECIFIED EQUIPMENT CLEAN ☐ Yes ☐ **No** ☐ Not applicable

3.3.13. WHY WAS THE EQUIPMENT NOT CLEAN

_____

_____

_____

3.3.14. WAS THE VENTILATOR CIRCUIT IN A SEALED STERILE PACK □ Yes **□ No**

□ Not applicable

3.3.15. REASON THE VENTILATOR CIRCUIT WAS NOT IN A SEALED STERILE PACK □ Not applicable

□ The pack was already opened.

□ The circuit was not disinfected.

□ The circuit was not autoclaved.

□ There is no sterile packaging to pack the circuits.

□ Other (specify) _____

OBJECTIVE 4: ADVERSE EVENTS ENCOUNTED DURING THE TRANSFER

4.1 WHO HANDED OVER THE PATIENT TO YOU

☐ A doctor ☐ The mother

☐ A Nurse ☐ Other (specify) _____

4.2 WAS THE HANDOVER APPROPRIATE ☐ Yes ☐ **No**

4.3 WHAT WAS INAPPROPRIATE ABOUT THE HANDOVER ☐ Not applicable

☐ No post-delivery event history ☐ No one to assist you take over

☐ No clinical management history ☐ No pharmacological history

☐ No documentation ☐ Incomplete documentation

☐ Other (specify) _____

COMMENTS (*if necessary*)

_____

_____

_____

4.4. PHYSIOLOGICAL

4.4.1. WAS/WERE THERE PHYSIOLOGICAL REALATED ADVERSE EVENT/S ☐ **Yes** ☐ No

4.4.2 WHAT WAS/WERE THE PHYSIOLOGICAL REALATED ADVERSE EVENT/S ☐ Not applicable

☐ Cardiac deterioration (specify) _____

☐ Respiratory deterioration (specify) _____

☐ Neurological deterioration (specify) _____

☐ Temperature related problems (specify) _____

☐ Desaturation (specify) _____

☐ Iatrogenic (specify) _____

☐ Other (specify) _____

COMMENTS (*if necessary*)

_____
_____
_____

4.5. EQUIPMENT REALATED

4.5.1. WAS/WERE THERE EQUIPMENT REALATED ADVERSE EVENT/S ☐ **Yes** ☐ No

4.4.2 WHAT WAS/WERE THE EQUIPMENT REALATED ADVERSE EVENT/S ☐ Not applicable

☐ Oxygen supply (specify) _____

☐ Ventilator (specify) _____

☐ Endotracheal tube (specify) _____ _

☐ Incubator (specify) _____

☐ Hot box (specify) _____

☐ Venous cannulation (specify) _____

☐ Arterial cannulation (specify) _____

☐ Intra osseous cannulation (specify) _____

☐ Nasogastric tube (specify) _____

☐ Drains occluded (specify) _____

☐ Drains displaced (specify) _____

☐ Ambulance (specify) _____

☐ Other (please specify) _____

COMMENTS (*if necessary*)

_____
_____
_____

GENERAL COMMENTS (*if necessary*)

_____
_____
_____
_____
_____
_____
_____
_____

Appendix 7

PROVINCE OF KWAZULU-NATAL HEALTH SERVICES

EMERGENCY MEDICAL SERVICES

PATIENT REPORT FORM

SERVICE NAME: EMERGENCY MEDICAL RESCUE SERVICES - KZN - PRACTICE NO. 009-004-0198951

PATIENT DETAILS

SURNAME:	ID NO:					
FIRST NAME:			INIT:			
ID No /DOB:		AGE:	SEX: M / F	RACE:		
DISPATCH PRIORITY:	P1	P2	P3	P4	TRANSFER	
INCIDENT LOCATION						
RECEIVING FACILITY						

	RECEIVED	MOBILE	AT SCENE	DEP SCENE	AT HOSP	AVAILABLE
TIME	:	:	:	:	:	:
KM						

INCIDENT DETAILS

DATE: YYYY/MM/DD	INCIDENT No.			
INCIDENT TYPE:				
CREW	QUAL	HPCSA No.		OTHER
No 1				PRIVATE
No 2				PRV
VEHICLE REG No:	Amb	PRV	OTHER	AMBU
ASSISTANCE FROM:				SAPS
CREW	QUAL	HPCSA No.		TRAFFIC
No 1				FIRE
No 2				RESCUE
VEHICLE REG No:	Amb	PRV	OTHER	HELI

CLINICAL NOTES

HISTORY / MECHANISM OF INJURY

CHIEF COMPLAINT:

TRANSFERRED BY:

GENERAL:

PREV HISTO	CARDIAC	RESPIRITOR	ASTHMA	EPILEPSY	DIABETIS	BP

MEDICATIONS:

ALLERGIES:

EXAMINATION

REG 1st Vehicle: REG 2nd Vehicle:

REG 3rd Vehicle: REG 4th Vehicle:

PROCEDURES (TICK IF APPLICABLE)

GENERAL			AIRWAY		CIRCULATION		
DRESSING	H I D	OXYGEN	REB	ET TUBE	SIZE	Tourniquet	TIME ON
COLLAR	RESTR STRAPS		VENT		POS (cm)	PASG	TIME ON
SPLINT	TRACTION		NEB		CUFF (Y/N)	ET Co2	
EXTRIC DEV	SPINAL IMMOB		OTHER		ORAL/NASAL	NG TUBE	SIZE
FULL SPINE	SCOOP	SUCTION	RIGID	CRICO	NEEDLE / SURG	URINE CATH	SIZE
STAIR CHAIR	BASKET		FLEX	Needle Dec	L / R	OTHER	
BLANKET		OP TUBE	SIZE	I/C DRAIN	L / R		

VITAL SIGNS

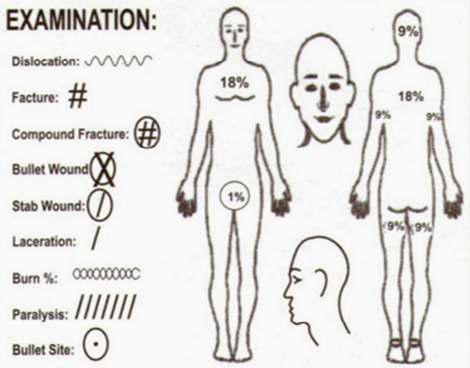
TIME		:	:	:	:	:	:
RESP RATE	bpm						
RHYTHM	reg/irreg						
DEPTH	↑/N/↓						
SYMMETRY	= / #						
% O_2	%						
O_2 Flow	L/min						
SATS	%						
PEEP	cm H20						
Tidal Vol	m						
PULSE RATE	bpm						
RHYTHM	reg/Irreg/ECG						
STRENGTH	↑/N/↓						
BLEEDING	Y/N						
B/P	Sys / Dias						
SKIN COLOR	Cyan / N / Pale						
MOISTURE	Dry / N / Clammy						
TEMP	↑/N/↓						
CAP Refill	<2 / >2s						
GCS MOTOR	6						
VERBAL	5						
EYES	4						
PUPILS SIZE	mm	L / R	L / R	L / R	L / R	L / R	L / R
REACT	Y / N	L / R	L / R	L / R	L / R	L / R	L / R
APGAR	10						
N.DEFICIT	Y / N						
HGT	mmol/l						
TEMP	C						
DEFIB/CV	Joules						
PACING	mA						
PASG	Legs / abd						
PRIORITY	1/2/3/4						

	NAME	SIGN	QUAL
MANAGED BY:			
HANDED OVER TO:			

QUALITY ASSURED BY:

PROVISIONAL DIAGNOSIS:

EXAMINATION:



ESTIMATED FLUID LOSS

TYPE	BLOOD	URINE	NG LOSS	I/C	OTHER
TIME					
VOLUME					

INFUSIONS

TYPE	SITE	VOL	TIME UP	TIME DOWN	NAME

MEDICATION

TYPE	DOSE	ROUTE	TIME	NAME

REMARKS:

I HEREBY REFUSE TRANSPORTATION. THE REPUCUSSIONS OF THIS HAS BEEN EXPLAINED TO ME BY THE STAFF I WILL NOT HOLD THE DEPARTMENT LIABLE FOR MY REFUSAL

NAME: SIGN:

ORIGINAL FOR EMS RECORDS

Appendix 8

THE TRANSFER PROCESS

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1 A thorough understanding of the transfer process

Various authors have acknowledged that the overall inter-healthcare facility transfer process is made up of five phases (Figure 11) which include the activation phase, the preparation phase, the packaging or retrieval phase, the transportation phase and the reception phase (Miller et al., 2008), policies in the Republic of South Africa (2005) and London (2003). The transfer process is, thus, a joint responsibility of the referring hospital, the transportation team and the receiving hospital. The responsibility is shared by all those who are involved throughout the process, from beginning to end, including the doctors, nurses, emergency care providers and support services. It is, therefore, important that they have a thorough understanding of the transfer process. It is essential that a systematic approach is undertaken in order to provide the best service.

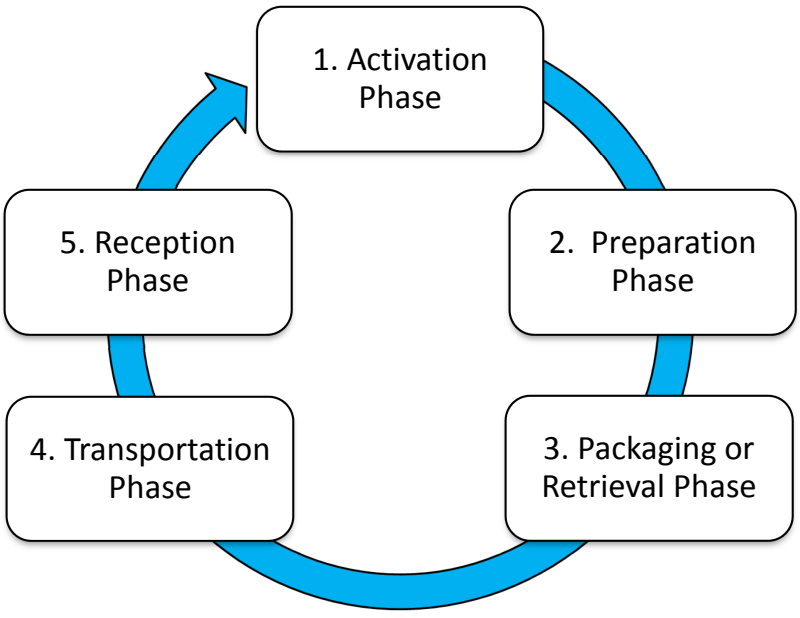

Figure 11: The phases of the transfer process

1.1 The activation phase

The activation phase (Figure 12) begins with the initial contact from the referring facility to the communication centre of EMRS, which is either by the referring doctor or the referring nurse. Good communication and co-ordination between the referring facility, the receiving facility and the transportation team is the basis of providing a safe and timely transport service to ensure that the neonate arrives at its destination in a stable state. The researcher recommends that the following steps should be taken:

1) The telephone operator (Figure 21, Box 2) must have a full understanding of neonatal transportation. When he/she receives the call from the referring doctor/nurse, all the necessary information must be recorded, which includes the neonate's name, age and weight, gender, diagnosis and vital signs. All other information regarding equipment required, medication, infusions, urgency of the transfer, and special conditions must also be noted. The hospital information must include details of the referring and receiving hospitals, such as the relevant departments as well as the names and contact numbers of the referring and receiving personnel.

2) This information must be immediately relayed to a transport co-ordinator (Figure 21, Box 3) who will be the clinical supervisor for screening and co-ordination. Transport co-ordinators should be ALS trained personnel who are fully knowledgeable of the most current resuscitation guidelines. The transport co-ordinators must screen the requests to ensure that all details have been completed to enable them to assess the severity of the cases and allocate the appropriate vehicles, equipment and team to transfer the neonates from one healthcare facility to another.

3) The composition of the team must be the responsibility of the transport co-ordinator. The team dispatched to the transfer must depend on the need of the neonate being transported.

4) The transport co-ordinator should also be responsible for selecting the most appropriate mode of transport by taking into account:

- the nature of the illness;
- the urgency of the transfer;
- the availability of the resources;
- mobilisation times;
- geographical factors;
- traffic and weather conditions; and
- the cost.

5) Prior to dispatching the ambulance, the communication centre must contact the relevant personnel at the receiving facility to confirm that the neonate will be accepted. An estimated time of arrival must be given to the receiving personnel to enable them to make the necessary preparation and be ready for the arrival of the transfer team.

6) Thereafter, all necessary information must be relayed to the team leader of the transfer team (Figure 21, Box 4) so that they can remain fully informed which will assist them to provide the best possible care for any particular case. No information regarding the transfer must be withheld from the team leader.

The communication centre must keep the referring, transportation and receiving personnel updated of any unforeseen changes that might occur during the transfer process.

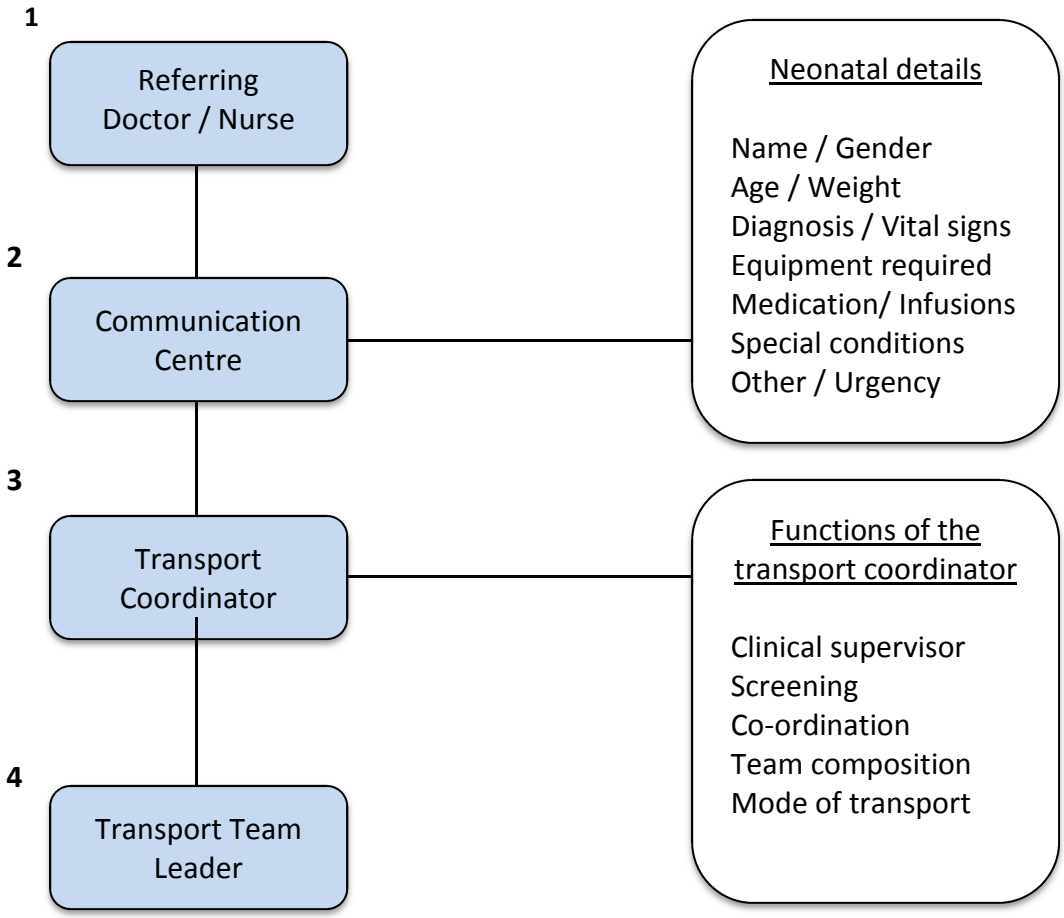

Figure 12: The activation phase

1.2 The preparation phase

The preparation phase (Figure 13) is undertaken by the transport team in preparation for the transfer, before proceeding to the referring facility. The most senior medically qualified person on that team is automatically delegated as the team leader. Although the team leader is ultimately responsible for the transfer, all team members need to work collaboratively and understand their respective accountability.

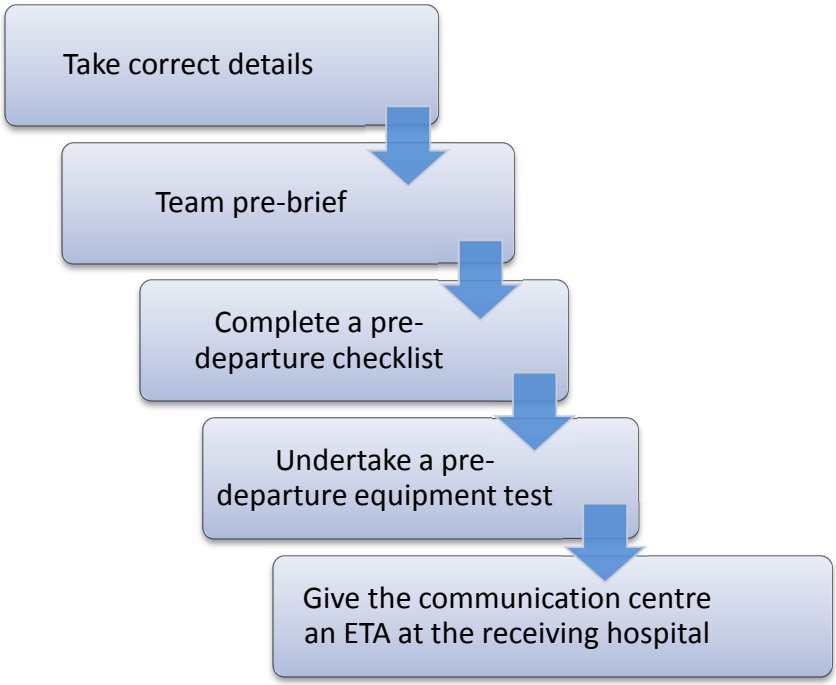

Figure 13: The preparation phase

The researcher recommends that the following steps should be followed:

1) The dispatch details given by the communication centre to the transport team leader must be audible, clear and understood. If they are not so, the team leader should immediately clarify to avoid any misunderstandings. The team leader must be familiarised with the neonate's condition, the treatment already undertaken, the equipment required and any other information vital for the transfer.

2) The team leader must undertake a pre-brief transportation session to orientate the team members of the neonate's condition, equipment required and other transfer issues.

3) A pre-departure checklist must be completed to ensure that no equipment is left behind. It may also help to ensure that all preparations have been completed.

4) A pre-departure equipment test must be undertaken to ensure the equipment is clean and sterile, fully charged and in excellent working order.

5) Equipment selection is determined by the mode of transport and the neonate's condition.

6) The team must ensure that all equipment is well secured in the ambulance before departing to the referring hospital.

7) The team leader must inform the communication centre of the estimated time of arrival at the referring facility so that the referring personnel can be contacted and updated as to when to expect the transfer team so that they can have the neonate packaged and ready for transfer.

1.3 The packaging or retrieval phase

The packaging or retrieval phase (Figure 14) is when the transport team arrives at the referring facility to transport the neonate to the receiving facility. It is clear that during transportation, there is a whole spectrum of things that can go wrong and even a minor physiological change in the condition of the neonate may cascade into a life threatening complication. Therefore, the packaging or retrieval phase is the most important phase of the transfer process.

A considerable amount of stress is placed on neonates during transportation from one facility to another and they can easily deteriorate during the transfer, especially those requiring intensive care. While it is possible, it is not ideal to undertake invasive procedures during the actual transfer. Therefore, it is critical to ensure that the neonate is stabilised and properly packaged with meticulous attention to resuscitation pre-transport to minimize clinical instability and complications that might arise during the transfer in order to ensure good neonatal outcomes.

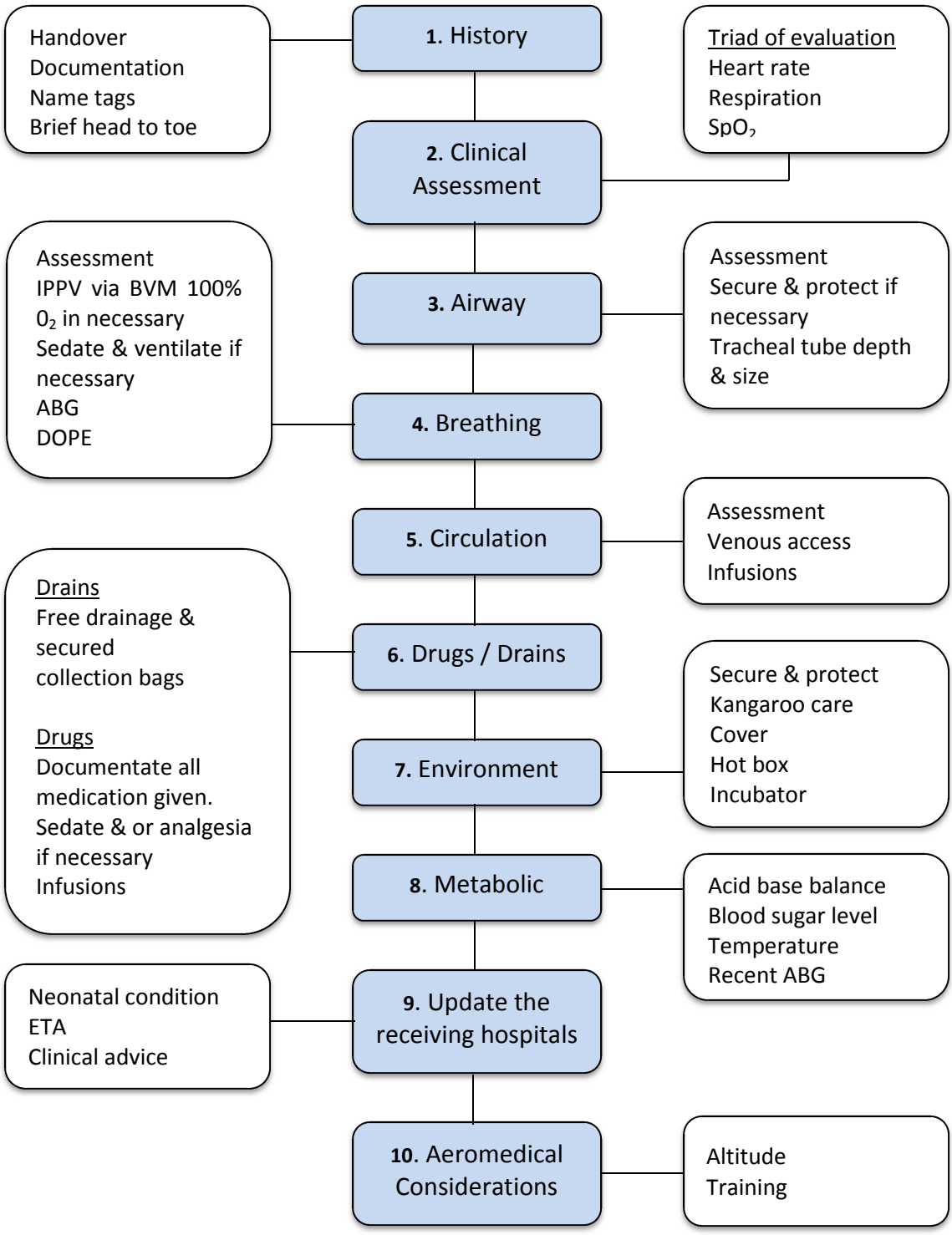

Figure 14: The packaging or retrieval phase

1. History taking

The team leader should be familiar with the treatment already undertaken and independently asses the neonate's condition (Figure 23, Box 1). These include the following:

- The team leader should listen to the doctor/nurse's hand-over and then read the medical notes and review the charts.
- All notes, referral letters, buy out letters, consent forms, x-rays, scans, bloods, specimens should be collected.
- The neonate should have two name tags. Both tags should be checked and verified.
- The team leader should perform a brief head-to-toe examination and annotate and enquire about any visual abnormalities, bruising or any concerns regarding the neonate.

2. Clinical assessments

According to International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (2010), subsequent evaluations and interventions are based on assessment of the triad of evaluation which are respiration, heart rate and SpO_2 (Figure 23, Box 2).

3. ***Adopt the ABCDE approach***. Advice on stabilisation may be obtained from the receiving facility, if necessary.

4. ***Airway***. The airway should be assessed and if necessary secured and protected. Intubation and ventilation prior to transport are mandatory if there are any concerns about the integrity of the airway or the adequacy of ventilation. For intubated neonates, tracheal tube position must be confirmed and the size and the depth of the tube annotated (Figure 23, Box 3).

5. ***Breathing***. Assess the neonates for breathing efforts and if not breathing adequately provide ventilation using BVM with 100% oxygen. Inspired oxygen may be guided by SpO_2 & $EtCO_2$. Intubated neonates should normally be sedated and ventilated. Before transferring the neonate onto the transport stretcher, attach the ventilator & monitoring equipment to assess the neonate. The neonate may take a while to stabilise on the transport ventilator. Following stabilisation on the portable ventilation at least one ABG should be performed prior to departure (Figure 23, Box 4).

   Remember ventilator emergency drills using the pneumonic "DOPE" which is,

   - Displacement of the tracheal tube;
   - Obstruction of the tracheal tube;
   - Pneumothorax; and
   - Equipment malfunction or failure.

   For pressure alarms on the transport ventilator immediately disconnect the ventilator at the catheter mount and IPPV the neonate using a BVM while investigating for the problem. If the ventilator displays a high pressure alarm then investigate from the neonate going out to the oxygen cylinder. For low pressure alarms investigate from the oxygen cylinder to the neonate.

   If a pneumothorax is present, chest drains should be inserted prior to departure. Underwater seals should normally be replaced by leaflet valves drainage system (Heimlich one way valves) which always allow for free drainage and should not be clamped closed.

6. ***Circulation*****.** Assess the status of circulation by pulse volume and capillary refill time. If the circulation is compromised, correct according to the latest resuscitation guidelines. Control any obvious blood loss. Venous access is mandatory. Secure all lines and have redundancy where possible. Remove any infusions not vital to the neonate's treatment, flush the line and then cap. All infusions should be running. If there is doubt about the setup of the infusion, consult the doctor and draw up new infusions (Figure 23, Box 5).

7. ***Drains or Drugs (medications).*** Nasogastric / orogastric tube, urine catheter or any other drains necessary for the transfer should be secured in place and free drainage allowed into collection bags. Collection bags should be emptied prior to transportation (Figure 23, Box 6).

   Assess the need for feeds or medication and administer them in appropriate doses and by the recommended route. Document the administration of all medication to avoid inadvertent repeat dosing and toxicity.

   Provide adequate sedation and/or analgesia if necessary. If inotropes or other vasoactive agents are required to optimise haemodynamic status, the neonate should be stabilised on these agents before leaving the referral unit.

8. ***Environment***. Ensure that the neonate is well secured and protected from the environment. Maintaining a thermal neutral environment for the neonate during transportation is essential to avoid thermal stress which may create metabolic effects. Use one of the following approaches, depending on the clinical condition of the neonate, to keep the neonate warm during the pre-hospital environment (Figure 23, Box 7):

   - Skin to skin care (kangaroo mother care).
   - Cover the neonate, including the head and limbs using clothes, simple blankets or space blankets.
   - Hot box. Use heat packs to maintain an appropriate temperature. Secure the neonate in the hot box to protect the neonate from sudden acceleration or deceleration of the vehicle.
   - Transport incubator. Transport incubator should be set at the appropriate temperature. Secure the neonate in the incubator to protect the neonate from sudden acceleration or deceleration of the vehicle or the G forces or turbulence of the aircraft.

9. ***Metabolic*.** Maintain an acceptable metabolic range. Contact the receiving facility for advice if necessary to determine the acceptable metabolic range (Figure 23, Box 8):

    - Acid base balance should be corrected to an acceptable range of the receiving facility. A recent arterial blood gas should be done before departure.
    - Blood glucose corrected to an acceptable range before departure.
    - Temperature maintained.

10. ***Before departure from the referring facility***, contact the receiving doctor (Figure 23, Box 9):

    - to give an update of the neonate's condition;
    - to provide and estimated time of arrival; and
    - to seek any clinical advice, if necessary.

11. ***Points to remember***. There is a rare need for haste. Meticulous resuscitation and stabilisation is required to minimize clinical instability and complications during the transfer.

    - Inter-healthcare facility transfer should only be undertaken with a **stable** neonate.
    - Inter-healthcare facility transfer of an unstable neonate should only be undertaken in a **life over limb** situation.

    If a neonate is unstable in a healthcare facility where there are specialised staff, equipment and support services available then the neonate is not going to be stable in the back of an ambulance where there are limited staff and transport equipment. Transportation of an unstable neonate will only lead to sudden and rapid deterioration. In the event of a life over limb situation, an agreement to transport has to be undertaken by the referring, transportation and receiving personnel to ensure that no one can be held accountable for

any necessary adverse events encountered during transportation. The transportation team should not be intimidated by the real or perceived power of other healthcare providers and should stay within their guidelines or policies, unless alternate arrangements are made and agreed upon by all role players in the best interest of the neonate.

12. Aeromedical considerations

The management of a neonate in aeromedical transport is slightly different from the management of a neonate during ground transport and that is predominantly because of the change in altitude and limited cabin space. The issues of isolation, unfamiliar environment, ambient pressure and altitude, temperature control, acceleration, deceleration, excessive ambient noise and vibration are all aeromedical problems that might affect the transportation of the neonate. It is important, therefore, that aeromedical crew and medical physicians must be familiar with these concepts (Figure 23, Box 10):

1) Personnel involved in aeromedical transfers must have a high level of expertise, experience, specialist knowledge and practical training and must meet the minimum aviation requirements.

2) Increased altitude affects the neonates physiology in a number of ways including:

    - A decrease in the barometric pressure results in reduced alveolar pressure of oxygen (decreased the partial pressure of gasses) and may lead to hypoxaemia. Increased inspired oxygen concentration is mandatory for all aeromedical transfers.

    - Decreased barometric pressure also leads to an increase (expands) in the volume of gas filled cavities in the neonate such as pneumothorax. Pneumothoraces must be drained.

    - A change in altitude lowers the environmental temperature resulting in hypothermia.

    - A change in altitude alters the drug metabolism

- The flight team personnel might also be affected by the environment and need to be familiar of their own performance and physical and mental state.

1.4 The transportation phase

The transportation phase (Figure 15) is the time from departure from the referring facility to the handover at the receiving facility. This phase begins from the time the transport team leaves the referring ward, and includes loading the neonate into the ambulance, the ambulance journey and unloading the patient from the ambulance to the handover at the receiving facility. To maintain a continuum of care or better care the standards of monitoring and clinical management should be equivalent to a neonatal intensive care unit environment.

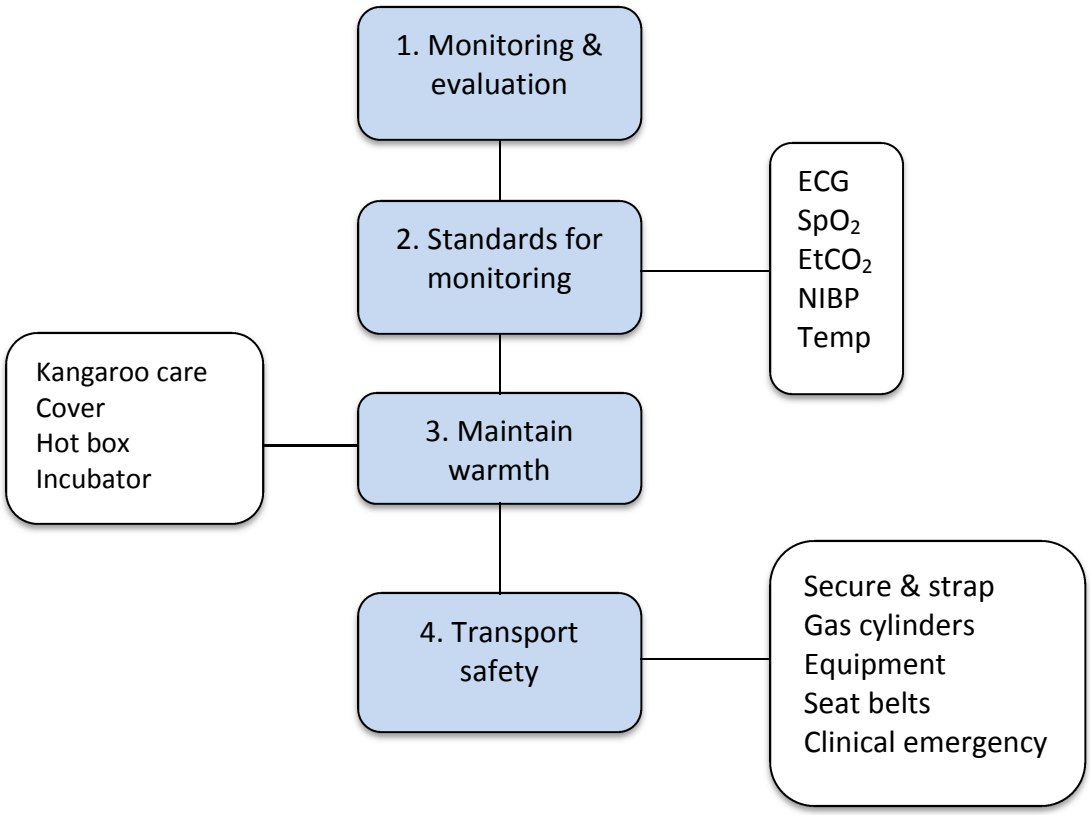

Figure 15: The transportation phase

1) Monitoring and evaluation must be continuous throughout the transfer. Any observations, interventions or changes in the neonate's condition must be documented and handed over to the referring personnel. The communication centre must also be kept updated so that the relevant information can be relayed to the receiving personnel.

2) The minimum standards required for monitoring all neonates during transportation by the International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (2010) are:

    - Continuous presence and neonatal monitoring by appropriate trained personnel
    - Electrocardiogram (ECG) monitoring
    - Non- invasive blood pressure (NIBP) monitoring
    - Non-invasive arterial saturation (SpO_2) monitoring
    - Non-invasive end tidal carbon di oxide ($EtCO_2$) monitoring
    - Non-invasive temperature monitoring

3) The neonate should be covered appropriately to maintain warmth. If the neonate is placed on a stretcher, hot box or incubator the neonate should be secured and strapped. If a mother is carrying the neonate the mother must be strapped as well.

4) Safety is paramount to the transport team and the neonate. All equipment should be secured to prevent loose items acting as missiles during sudden acceleration or deceleration of the vehicle or G forces or turbulence of the aircraft:

    - All equipment should either be fastened onto the transport stretcher or securely stored in appropriate compartments in the ambulance. Under no circumstance should equipment be left on top of a neonate or the incubator.

- Gas cylinders must be kept in secure housing at all times.
- Easy access must be allowed for the airway and intravenous lines.
- All equipment should be within hand reach of the attendant and the equipment should be positioned facing the attendant.
- Staff should remain seated in the ambulance at all times and wear the seat belts provided. In aeromedical transport, if a crew member needs to unbuckle the seat belt for whatever reason then the pilot must be informed immediately.
- If, despite meticulous preparation and pre-transfer stabilisation, an unforeseen clinical emergency should arise and the neonate requires intervention in a ground ambulance, it is better to stop the vehicle at an appropriate safe place than attempt to carry out the intervention in a moving ambulance.

1.5 The reception phase

The reception phase (Figure 16) is the handover at the receiving facility to the receiving personnel. The handover should be both verbal and written and include the all the events preceding the reception phase and the history of the neonate. The referring hospital should be prepared and ready to accept the neonate.

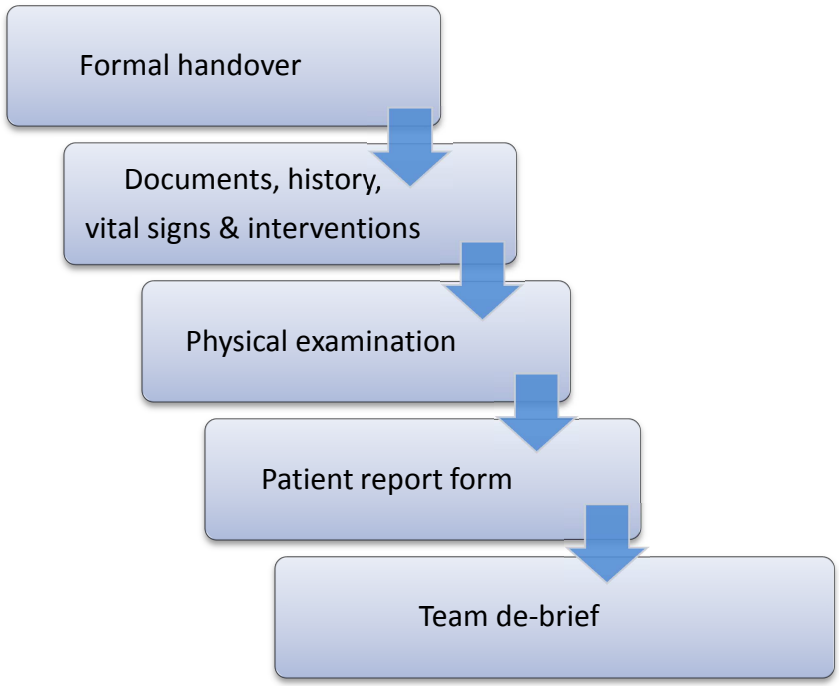

Figure 16: The reception phase

1) There should be a formal handover between the team leader of the transport team and the receiving personnel who will resume responsibility of the neonate's care.

2) The handover should include the neonate's history, vital signs, interventions, significant clinical events during transport, documentation and specimens.

3) A physical examination must be undertaken by the receiving personnel in the presence of the transport team leader. The vital signs and finding on handover must be documented on the transport patient report form and a signature must be obtained from the receiving personnel.

4) Clear records of all phases of transfer must be documented in the patient report form and a copy must be giving to the receiving facility.

5) Once the handover is complete the team leader must debrief the team members and address any concerns or situation that occurred. It is imperative to know the positive and negative aspects of all neonatal transfers to improve the efficiency and effectiveness of the transportation process and for future understanding. The communication centre must be updated. All equipment must be cleaned and sterilised.

Appendix 9

The CD of the statistical analysis is attached to the back cover of the dissertation.

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