A descriptive retrospective audit of the obstetric conditions which occur in mothers of babies with neonatal encephalopathy at Mowbray Maternity Hospital in 2016

By

Liesl Bertha Kay Dietrich

(DTRLIE001)

This minor dissertation is submitted to the

University of Cape Town

as a requirement for the M.Phil. (Maternal and Child Health) degree

Faculty of Health Sciences

School of Child & Adolescent Health

University of Cape Town

July 2019

Supervisor – Professor Sue Fawcus

Co-supervisor – Dr Lucy Linley

DECLARATION

I, Liesl Bertha Kay Dietrich, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signature:

Signed by candidate

Date: 10 July 2019

PLAGIARISM DECLARATION

"This thesis/dissertation has been submitted to the Turnitin module (or equivalent similarity and originality checking software) and I confirm that my supervisor has seen my report and any concerns revealed by such have been resolved with my supervisor."

Name: Liesl Bertha Kay Dietrich

Student number: DTRLIE001

Signature:

Signed by candidate

Date: 10 July 2019

DEDICATION

I would like to dedicate this dissertation to my husband, Gavin and my sons Matthew and Cameron for their immense support, sacrifice and love during this taxing time. This is also for my dad for unfailingly believing in me and my mom for all her prayers.

ACKNOWLEGEMENTS

I would like to thank my supervisor, Prof Sue Fawcus, for her assistance, inspiration, infinite wisdom and her endless patience.

Thank you to Dr Lucy Linley for her guidance as co-supervisor and Adelaide Masu for her assistance with the statistics and analysis.

I would like to show appreciation to my friends and family for their encouragement and support.

And finally, I thank the MMH Records Department staff for eagerly retrieving the patients' folders for me.

CONTENTS

Page number

LIST OF ABBREVIATIONS

aEEG	Amplitude-integrated electroencephalography
AFE	Amniotic fluid embolism
APH	Antepartum haemorrhage
BANC	Basic antenatal clinic
BMI	Body mass index
BMV	Bag mask ventilation
CHBAH	Chris Hani Baragwanath Academic Hospital

CNS	Central nervous system
CP	Cerebral palsy
CS	Caesarean section
CTG	Cardiotocograph
EMS	Emergency medical services
GA	Gestational age
GDM	Gestational diabetes mellitus
GSH	Groote Schuur Hospital
HCW	Health care worker
HIE	Hypoxic ischaemic encephalopathy
HIV	Human Immune-deficiency Virus
IA	Intermittent auscultation
IGT	Impaired glucose tolerance
IOL	Induction of labour
IPPV	Intermittent positive pressure ventilation
IPR	Intrapartum resuscitation
IUGR	Intra-uterine growth restriction
LBW	Low birth weight
LW	Labour ward
MMH	Mowbray Maternity Hospital
MOU	Midwife obstetric unit
MSL	Meconium stained liquor
NE	Neonatal encephalopathy
NICE	National Institute for Health and Care Excellence

NICU	Neonatal intensive care unit
NRFS	Non-reassuring fetal status
NVD	Normal vertex delivery
OMBU	Onsite midwife birthing units
OT	Operating theatre
PET	Pre-eclampsia
PFS	Pinard fetal stethoscope
PNMR	Perinatal mortality rate
PPIP	Perinatal Problem Identification Programme
PROM	Prolonged rupture of membranes
RSA	Republic of South Africa
SA	South Africa
UK	United Kingdom
VBAC	Vaginal birth after Caesarean section
WHO	World Health Organisation

LIST OF TABLES AND FIGURES

ABSTRACT

Introduction: Neonatal encephalopathy (NE) is an important condition which may result in mortality or severe and permanent morbidity placing much strain on busy under-resourced health care services, parents and families, and the greater community. There is much debate on its aetiology; whether it is caused by antepartum conditions or intrapartum obstetric complications (known as sentinel events); and the relative contribution of intrapartum hypoxia. Unlike perinatal mortality, NE rates are not routinely audited by maternity facilities. At Mowbray Maternity Hospital, a formal audit was conducted in 2008, which measured the NE rate, focussed on obstetric factors associated with NE and identified avoidable factors in the care provided. It was thought to be of clinical value to repeat this audit to identify whether there were any trends in rates and the pattern of obstetric factors.

Aims and objectives: The aim was to describe the obstetric factors occurring in patients who delivered neonates at MMH, diagnosed with NE. Specifically, it was planned to determine the NE rate, to describe obstetric factors occurring in these patients and to assess the avoidable factors related to the patients, health system and clinical management.

Methodology: This was a retrospective descriptive study which included patients whose neonates were diagnosed with NE and were born at MMH in 2016. The diagnosis of NE was made according to the MMH NE protocol where NE is defined as a voltage suppression in amplitude-integrated electroencephalography (aEEG) or seizures; or clinical seizures or dystonic movements; or moderate to severe clinical signs of NE as defined by Shankaran and a level of consciousness which is decreased with abnormal tone.

The neonates' names were retrieved from a NE register in the neonatal unit and the corresponding mothers' folders retrieved. Data on relevant obstetric and clinical management factors were collected from the folders using a data collection tool developed in the Western Cape and all cardiotocographic tracings were assessed by the researcher. Ethics approval was granted by the University of Cape Town Human Research Ethics Committee (UCT HREC) prior to the commencement of the study. STATA 14 was used for the analysis.

Results: In 2016, 53 neonates with NE were identified out of 9,702 live births (LB) at MMH. The NE rate was 5.5 per 1000 LB. Of the 53 neonates, 48 maternal patient files were retrieved and analysed. There were 58% who had been referred to MMH from the midwife obstetric units (MOUs), and 42% fully managed at MMH. All patients were booked for

antenatal care, the mean age was 27.5 years and 50% were nulliparous. The mean gestational age at delivery was 39 weeks. The majority (87.5%) experienced labour, spontaneous in 72.9% and induced in 14.6%. Antenatal complications occurred in 77.1%, the most frequent being prolonged pregnancy (25%) hypertensive disorders (18.8%), antepartum haemorrhage (8.3%) and prelabour rupture of membranes (8.3%). Obstetric problems in labour included prolonged second stage of labour (25% of patients who had a second stage of labour); multiple vaginal examinations (28.6%) and prolonged first stage of labour (17.9%). Fetal monitoring at the MOUs was done according to protocol in 70% of patients in the latent phase but only 12.5% of those in the active phase of labour. At MMH, all patients in labour had Cardiotocograph (CTG) monitoring with 90.6% of CTGs being pathological and 6.3% suspicious, as assessed by the researcher. Meconium stained liquor occurred in 40.5% of patients. The mode of delivery was normal vertex, (27.1%), Caesarean sections (58.3%) and assisted vaginal delivery (14.6%). Most CS (71.4%) were done for pathological CTGs. Sentinel events occurred in 15 (31.3%) patients; approximately two-thirds occurring intrapartum and one- third antenatal. Sentinel events included shoulder dystocia (10.4%), prolonged second stage of labour (10.4%), abruptio placenta (6.3%), cord prolapse (2.1%) and eclampsia (2.1%). Of the 37 (68.7%) without a sentinel event, 75.8% had a pathological CTG. Considering avoidable factors, there was an ambulance delay in 42.9%, and a delay in accessing theatre for 53.6% of patients requiring a CS. Poor quality CTG tracing and monitoring occurred in 20.8% of patients; and for 34.4%, the researcher identified an abnormal CTG but it was not detected by the attendant health care workers.

Discussion and conclusion: The NE rate for MMH is 5.5 per 1000 LBs, this is higher than the 3.7 found in the previous 2008 MMH study, despite a higher CS rate. Possible reasons for the increase include changes in case ascertainment, increased workload with same staff component, or a shift from perinatal hypoxic mortality to morbidity, notably NE.
This NE rate compares with other lower resource settings and the previous MMH audit, as does the high proportion of intrapartum obstetric sentinel events. This is in contrast to findings from high resource settings.

Areas for service improvement include regular and ongoing intrapartum care training, including fetal heart monitoring, for medical and nursing staff; and addressing the health system issues identified.

1. INTRODUCTION

Neonatal encephalopathy (NE) is an important condition which may cause severe morbidity and mortality. Hypoxic Ischaemic Encephalopathy (HIE) is one cause for NE in which perinatal hypoxia, cerebral ischaemia and asphyxia are thought to be causal for the encephalopathy. Sixty percent (%) of neonates with moderate and /or severe NE either die or have long term sequelae including cerebral palsy and epilepsy. Furthermore, children with no motor affectation may have decreased cognition causing difficulty and problems with learning abilities requiring additional support at school (Kurinczuk, White-Koning & Badawi, 2010: 329; Gane et al., 2013: 119).

The World Health Organisation (WHO) estimates that 23% of neonatal deaths globally are due to hypoxia and reports that hypoxia at birth is the fifth leading cause of mortality for children under five years of age (Bryce et al., 2005: 1150; Gane et al., 2013: 119). Moreover, 30% of NE cases occurring in developed countries are due to intrapartum hypoxia whereas 60% of NE cases in the developing world are due to hypoxia (Kurinczuk, White-Koning & Badawi, 2010: 337).

It has been shown that various obstetric factors are present in the mothers of neonates with NE and that certain causes of HIE may be a result of substandard obstetric care. Hence, the obstetric factors which may be causal for cases with encephalopathy and possible avoidable factors need to be identified and demonstrated (Kalume Kalangula, 2008: 30-32). In so doing, there may be refinement in the management of obstetric patients in the antenatal and intrapartum periods and a possible resultant decrease in the NE rate; and thereby an improvement in neonatal outcome (Martinez-Biarge et al., 2013: e957).

In 2008, a study at Mowbray Maternity Hospital (MMH) in Cape Town described several obstetric factors associated with NE and identified avoidable factors (Kalume Kalangula, 2008). In this study, we planned to repeat the 2008 study to identify what the current situation was in respect to obstetric factors occurring in neonates with NE and possible avoidable or modifiable factors in the obstetric management at MMH and its satellite midwife obstetric units (MOUs).

2. LITERATURE REVIEW

2.1 INTRODUCTION

In this literature review a synopsis of neonatal encephalopathy (NE) and hypoxic ischaemic encephalopathy (HIE) is given. It highlights the obstetric factors occurring in neonates who are diagnosed with NE as well as its possible causes and avoidable or modifiable factors. The review sums up the challenges of ensuring quality obstetric practices and looks at the findings of various international, national and local articles on NE.

Information was obtained from a number of different sources including peer-reviewed journal articles, electronic databases, electronic journal articles, websites and previous research studies. Keywords used in the search for sources: NE, HIE, intrapartum care, obstetric care, brain cooling.

2.2 OVERVIEW AND DEFINITION OF HYPOXIC ISCHAEMIC ENCEPHALOPATHY AND NEONATAL ENCEPHALOPATHY

HIE and NE are often used interchangeably, however they are two separate entities each with its own definition.

2.2.1 HIE versus NE

NE is defined as a condition in which there is a neurological dysfunction shortly after birth in a term neonate. This is characterised by difficulty breathing, decreased tone, decreased reflexes and a decreased level of consciousness, with or without seizures.

HIE is a subset of NE. Hypoxia, cerebral ischaemia and asphyxia are important in the definition of HIE. Firstly, hypoxia is due to a lack, or little, oxygen in the blood supply. Secondly, cerebral ischaemia refers to the decreased amount of blood supplying the brain resulting in a decrease in glucose which, in turn causes injury of the neurons. Thirdly, asphyxia occurs when there is inadequate exchange of oxygen and carbon dioxide. Thus, there is an increase in carbon dioxide resulting in metabolic acidosis. Therefore, if there are low Apgar scores and a low blood pH together with a recent hypoxic-ischaemic cause for the encephalopathy, this phenomenon is called HIE (Kurinczuk, White-Koning & Badawi, 2010: 330).

2.2.2. HIE versus cerebral palsy

Cerebral palsy (CP) is described as a non-progressive disorder of development of posture and movements which is permanent. There is a decrease in motor activity associated with disturbances in the developing brain of a fetus or neonate. NE is described as having many causes, as alluded to previously, hypoxic injury in the intrapartum period being only one of them. It is further described that NE does not always lead to permanent damage, however it is said to be a prerequisite for linking intrapartum hypoxic injury to CP (Johnson, Blair & Stanley, 2011: 98).

2.3 INCIDENCE

It is difficult to determine the incidence of NE worldwide as different centres use differing definitions of NE and HIE. Moreover, some studies are population-based and other hospital-based. An estimated global incidence of NE from various studies ranges from one to eight cases per 1000 live births (Kurinczuk, White-Koning & Badawi, 2010: 330). The WHO reported that birth asphyxia-related neonatal deaths amount to about 920 000 every year. Put differently, 23 percent (%) of the world's neonatal deaths (four million) annually, are due to birth asphyxia (Bryce et al, 2005: 1150; Gane et al., 2013:119).

In a study published in 2015 done at the largest hospital in SA, Chris Hani Baragwanath Academic Hospital (CHBAH), the incidence of NE was found to be 8.5/1000 live births (Bruckmann & Velaphi, 2015: 302). Locally, as shown in the previous study of NE done at MMH, the incidence of NE in 2008 was 3,7/1000 live births (Kalume Kalangula, 2008: 29).

When investigating trends in incidence of NE, it is noted that the trends may also be influenced by interventions that reduce perinatal mortality. For example (e.g.), improved fetal monitoring in labour and risk assessment may lead to earlier intervention which reduce rates of still birth and early neonatal death from hypoxia, but may result in more live newborns with NE. In other words, rising NE rates could be due to a shift from mortality to morbidity. On the other hand, in the same setting, lower rates of NE could be associated with a higher hypoxic-related mortality.

2.4 OBSTETRIC FACTORS IN NEONATES WITH NE

Historically, there has been great debate as to whether HIE and NE have their origin in the antepartum or intrapartum period. It was previously shown in a West Australian study done by Badawi et al. (1998) that antepartum factors alone (69%) contributed much more towards babies with NE than intrapartum factors alone (4%) (Badawi et al., 1998: 1557). However, their definition of encephalopathy was different and broader than current definitions. They included babies who had seizures at up to one week postpartum and a cord pH was not an obligatory criterion for diagnosing NE. They also included certain babies with birth disorders and the older studies included neonates who had genetic or congenital abnormalities (Adamson et al., 1995: 598).

In the Kalume Kalangula study of 2008 done at MMH, the obstetric factors identified were divided into antepartum and intrapartum conditions. In the antenatal period, infections, prolonged rupture of membranes (PROM) and antepartum haemorrhage (APH), amongst others, contributed to NE. In the intrapartum period, prolonged second stage of labour was the greatest contributory factor for NE (Kalume Kalungula, 2008: 30-32).

In a study conducted by Martinez-Biarge et al. in Spain in 2011, it was shown that obstetric sentinel events (SE) were integral to the association of obstetric factors with NE. SE are described as acute events which can cause a formerly healthy fetus of a low risk pregnancy to have hypoxia and or ischaemic brain damage. The SE that they studied were uterine rupture, abruptio placentae, cord accidents and amniotic fluid embolism (AFE). They examined the incidence of NE in relation to three main groups namely, SE, non-reassuring fetal status (NRFS), and elective Caesarean Section (CS). They found that 71% of all the neonates who had NE, had an associated SE compared to 29% in the NRFS group. There were no babies with NE in the CS group. In addition, amongst the perinatal and neonatal morbidity in the SE group, uterine rupture accounted for most of the babies with NE, followed by abruptio placentae, then cord prolapse and lastly AFE. Further, the study showed no association between NE and various antenatal factors: maternal age, maternal disease (e.g. diabetes and hypertension), complications of pregnancy (e.g. pre-eclampsia and anaemia), intra-uterine growth restriction (IUGR) or chorioamnionitis (Martinez-Biarge et al., 2011: 1.e1 & 1.e4).

Martinez-Biarge et al. (2013) showed that, when comparing antepartum and intrapartum complications, the latter were significantly more associated with babies with NE. These included PROM, thick meconium stained liquor (MSL), SE, shoulder dystocia, tight cord

around the neck, abnormal cardiotocograph (CTG) and vacuum delivery. In contrast, there were no differences in family history (e.g. seizures), maternal conditions (e.g. thyroid disease) and complications during pregnancy (e.g. hypertension) between those mothers with babies with NE and those without. Moreover, a gestational age (GA) of less than 37 or more than 41 weeks and a birth weight of less than the tenth percentile, predisposed babies to NE. When looking at cases and controls and their exposure to antepartum and intrapartum factors alone and in combination, it was shown that at least one antepartum factor was present in both cases and controls. Whereas intrapartum factors alone or in combination with antepartum factors were present in 90% of babies with NE (Martinez-Biarge et al., 2013: e954 - e955).

2.5 FETAL HEART RATE MONITORING

Fetal heart rate (FHR) monitoring is of importance as it sets out to detect a compromised or hypoxic fetus timeously to allow for appropriate management of the patient. To ensure a favourable outcome, FHR monitoring, its interpretation and its management should be meticulous and accurate, and the health care worker (HCW) should be sufficiently trained to perform it (Mahomed et al., 1994: 497; Jagau, et al., 2017:135).

Various studies have been done to determine which methods are ideal for FHR monitoring in labour. These include continuous or intermittent cardiotocograph (CTG) monitoring, doptone use and Pinard fetoscope (PFS) use. These will now be discussed.

2.5.1 Low risk women

In a 2017 Cochrane Library review, CTG use was compared with intermittent auscultation (IA) of the FHR on admission to determine fetal well-being. It was found that admission CTG and IA made no obvious difference in the incidence of assisted vaginal delivery or perinatal mortality rate (PNMR). Furthermore, there were no clear differences between the effect of the two FHR monitoring methods on the incidence and severity of NE, nor the incidence of seizures in the first 28 days of life. It was thus concluded that the admission CTG was of no benefit to low-risk women and a recommendation was made that the admission CTG not be used for such women (Devane et al., 2017: 2).

The partograph was introduced to improve monitoring in the intrapartum period. It is a graphical documentation of the fetal and maternal condition and the progress of labour where

observations are documented at regular intervals. Specific to FHR monitoring, the partograph facilitates the timeous detection of fetuses that are hypoxic. In a study in 2017, it was shown that in an under-resourced and high burden of disease setting (MMH), the partograph was poorly completed even though HCW knew the importance of its use. Midwives suggested that too little time to manage many patients was the reason for inadequately completing the partograph. Further, they felt insecure about their knowledge and highlighted the need for continuous training. Of importance, this study showed that the partograph was completed better at the MOU level where hand-held devices were used for FHR monitoring, instead of CTGs (Jagau et al., 2017:130, 133-135).

Similarly, Mahomed et al. (1994), in Zimbabwe, showed that the doptone was better than the PFS in abnormal FHR detection and thus improved fetal outcome. Moreover, doptone use showed similar perinatal outcomes to CTG monitoring. They concluded that intermittent doptone FHR monitoring is best used in developing countries which are under-resourced (Mahomed et al, 1994: 500).

In SA, the guidelines specify that in the latent phase of the first stage of labour, the FHR must be routinely monitored and documented every four hours, whereas in the active phase, it must be done every 30 minutes, before and after a contraction. In the second stage of labour, the FHR should be monitored after every second contraction in low risk women (Department of Health, 2015: 48-49). In the Metropole West in the Western Cape Province it is recommended to monitor the FHR two-hourly in the latent phase of labour; the rest of the monitoring remains the same as discussed above (Department of Health Western Cape Government, 2011: 54).

2.5.2 High risk women

In addition to above, the National Institute for Clinical Excellence in UK (NICE) has published recommended care pathways for the intrapartum period. They recommend that continuous CTG monitoring be used in high risk patients only. These include patients with tachycardia of more than 120 beats per minute, temperatures of more than 38 degrees Celsius, suspected chorioamnionitis, severe pre-eclampsia or hypertension, etcetera (etc). Furthermore, the CTG tracing should be reviewed regularly and HCW should be well skilled in CTG interpretation and management of a patient with an abnormal CTG (National Institute for Health and Care Excellence (NICE) Pathways, 2019: 3-6).

2.6 AVOIDABLE FACTORS

The avoidable factors that may be present in patients who have delivered babies with NE, can be classified using the Perinatal Problem Identification Program (PPIP) tool, used in SA (see appendix 3). PPIP is an audit tool mostly used to identify avoidable factors in perinatal deaths at each maternity unit in SA. It determines the mortality rates of stillbirths and neonates, the causes of mortality, the number of deliveries and whether there were avoidable factors present that could have contributed to the outcomes. The avoidable factors are subdivided into patient-, medical personnel- and administrative-related factors. Examples of patient, and administrative factors respectively are a patient being unbooked for antenatal care (ANC), delay in transfer from a clinic to the referral hospital to escalate management and the operating theatre (OT) being occupied resulting in delay performing Caesarean Section (CS). In addition, specific to intrapartum care, two of the medical personnel-related avoidable factors are,

"fetal distress not detected intrapartum; fetus monitored" and

"fetal distress not detected intrapartum; fetus not monitored"

(Perinatal Problem Identification Program (PPIP), 2013).

In the study of Kalume-Kalangula in 2008, it was found that 65% of the cases of NE were associated with substandard medical care. Examples of the avoidable factors which they identified were inadequate FHR monitoring, delayed referral from the MOU and delayed management of prolonged second stage of labour (Kalume Kalangula, 2008: 29)

2.7 NE SCORING

Sarnat and Sarnat first introduced a NE classification system in the mid-1970s, which was used in many countries. Their classification of neonates with NE was divided into mild, moderate and severe, see Table 1. This system, however, was tedious and commanded good training in paediatrics.

Table 1: Sarnat and Sarnat score

Score Staging	Clinical grade	Symptoms	Outcome
I	Mild	Hyperalert, hyper-reactive May be tachycardic, have dilated pupils and jittery Symptoms should abate in 2 days and neurological exam be normal by 1-2 weeks	normal
II	Moderate	Lethargic, +- irritable, hypotonic Proximal and central weakness Low heart rate, small pupils, secretions Seizures and abnormal aEEG* common	At least 25% abnormal with CP
III	Severe	Unresponsive, flaccid, absent reflexes Seizures common Abnormal aEEG with suppressed background activity	>80% abnormal / death

MMH NE management guideline, 2016 quoted Sarnat (1976)

*amplitude-integrated electroencephalography

The Thompson NE score is a numerical tool which was introduced at the Neonatal Intensive Care Unit (NICU) at Groote Schuur Hospital (GSH) and is based on the Sarnat and Sarnat classification. It is a simple tool that may be used in developing countries and by junior staff. It is made up of specific signs that are found in neonates with dysfunction of the central nervous system (CNS), see Table 2.

This is used to determine the condition of a neonate after asphyxia at birth. As alluded to above, the set of clinical signs include neonatal tone, level of consciousness, fits, posture, Moro, grasp, suck, respiration and fontanelle integrity. The lowest score is nought (normal) and the highest is 22.

Table 2: The Thompson NE score

Score **Sign**	0	1	2	3
Tone	Normal	Hyper	Hypo	Flaccid
LOC	Normal	Hyperalert; stare	Lethargic	Comatosed
Fits	None	< 3/day	>2/day	
Posture	Normal	Fisting; cycling	Strong distal flexion	Decerebrate
Moro	Normal	Partial	Absent	
Grasp	Normal	Poor	Absent	
Suck	Normal	Poor	Absent +- bites	
Respiration	Normal	Hyperventilation	Brief apnoea	IPPV (apnoea)
Fontenelle	Normal	Full; not tense	Tense	

(Thompson et al, 1997: 758)

Neonates with maximum scores of one to 10 have mild NE; 11 to 14 have moderate NE and 15 to 22 have severe NE. A maximum score of more than 10 in the first week of life is predictive of abnormal sequelae. Furthermore, serial Thompson scoring is used to determine the clinical improvement of neonates. In addition, it was shown that this NE scoring system has a high predictive value in neurodevelopmental outcome. In a study published in 2017, it was shown that the Thompson score and the use of amplitude-integrated electroencephalography (aEEG) are similar in predicting developmental outcome. It was concluded that both these methods may be used in the selection of neonates with NE for therapeutic cooling (Weeke et al., 2017; Bhagwani et al., 2016: 16-18; Thompson et al., 1997: 757, 760-761).

The Fenichel classification of NE is shown below, for comparison. This score was used previously at MMH, and was thus used to identify cases for the previous Kalume Kalunga study (Kalume Kalungula, 2008: 5,9-10, 21).

Table 3: Fenichel's classification of severity of NE

Grade 1 (mild)	**Grade 11** (moderate)	**Grade 111** (severe)
Irritability 'hyperalert'	lethargic	Comatose
Mild hypotonia	Seizures ; marked abnormalities of tone	Prolonged seizures; severe hypotonia
Poor sucking	Require tube feeding	Failure to maintain spontaneous respiration

Fenichel JM. (1983) as quoted by Kalume Kalangula, 2008: 9-10).

In 2016, at MMH, the criteria used for identification of NE infants was based on Shankaran NE categories and signs (Table 4); Sarnat scoring and the Thompson score were used for assessing severity and monitoring progress (MMH, 2016).

Table 4: Shankaran NE categories and signs

Category	**Moderate encephalopathy**	**Severe encephalopathy**
Level of consciousness	Lethargic	Obtunded/stuporous/coma
Spontaneous activity	Decreased spontaneous activity	No spontaneous activity
Muscle tone	Hypotonia	Flaccid (profound hypotonia)
Posture	Distal flexion or extensor posture	Decerebrate
Suck or Moro (worst)	Weak suck or partial Moro	Absent
Autonomic nervous system		
Pupils	Miosis (fixed pinpoint)	Fixed dilated, slow, absent, unequal/deviated
Heart rate	Bradycardia (<100beats/min)	-
respiration	Periodic or shallow breathing/gasping	Apnoea requiring IPPV

Shankaran, 2005: 1575).

At MMH in 2016, strict criteria were used for the diagnosis of NE.

" Neonatal encephalopathy (was) defined by:

- aEEG voltage suppression or seizures OR
- clinical seizures or dystonic movements OR
- clinical signs of moderate to severe HIE (by Shankaran defined as abnormal signs in at least 3 categories).
- depressed level of consciousness plus abnormal tone. "

(MMH, 2016).

2.8 IMPLICATIONS OF NE

2.8.1 Complications and sequelae of NE

60% of babies with moderate or severe NE either die or have severe long- term impediment as shown in a study in India (Gane et al., 2013: 119). CP may be an important consequence of NE; affected children may have a host of complications including gastrointestinal pathology, nutritional and feeding problems, recurrent aspiration pneumonia, orthopaedic problems, epilepsy and may have a decreased life expectancy. In other children with NE who do not have CP, cognitive difficulties may be apparent. These may include learning difficulties like poor reading, inability to do mathematics, poor memory, language and communication skills (Eunson P, 2015: 48-49).

2.8.2 Therapeutic cooling

It has been shown that neonates with moderate or severe NE benefit from therapeutic hypothermia to decrease the risk of death and neurological insults at 18 months of age (Horn et al, 2013: e378; Edwards A. et al., 2010: e363). At MMH, the strict criteria used in diagnosis of NE are used for brain cooling, as shown in section 2.7. Neonates must be less than six hours old at the start of cooling.

All infants requiring cooling need to be admitted to the NICU. Timeous and careful assessment of neonates needs to be done to determine the risk of developing moderate to severe NE. The sooner babies are diagnosed with NE, the sooner cooling can be commenced with resultant better outcome.

Neurological monitoring must be done whilst therapeutic hypothermia is being administered. This is done by clinical examination using the Thompson NE score and the Sarnat score (Sarnat (1976) quoted by MMH NE guideline, 2016).

2.8.3 Social and financial burden

The percentage of NE in developing countries associated with evidence of hypoxic and ischaemia in the intrapartum period is double (60%) that of the cases of NE in developed countries (30%). This places an added burden on health care services, education and social services, to name but a few, and on already struggling and poverty-stricken countries. Furthermore, the family of a child with sequelae of NE have countless stresses e.g. they need someone to care for the child fulltime and often one parent needs to stay home to do so, with resultant decrease in family income. This, in turn, may negatively affect the quality of life of siblings. In addition, adults with neurological deficits may not be able to drive, may not have employment and may not be able to have meaningful relationships within society. Thus, to reiterate, there is a need for specialised child and adult care, specialised education and specialised housing which means an increase on the financial burden for both the family and government services (Eunson, 2015: 48-50).

2.8.4 Medico-legal implications

As discussed above, NE has serious long-term sequelae including death, CP, low cognition and poor neurodevelopmental attainment. As a result, the long-term cost of education and health care, etc. to parents is great. This may lead to medical litigation. In recent years, clinicians have been sued for sums exceeding 20 million rand, medical insurance for private specialists is exorbitant, and thus many have left the practise of obstetrics. If one highlights just one consequence, e.g. CP, there are many causal pathways and even if an intrapartum cause is disproved in court, it still subjects the clinician to legal and professional stress (Johnson, Blair & Stanley, 2011: 97-98; Kurinczuk, White-Koning & Badawi, 2010: 329).

2.9 FUTURE RESEARCH

It would be of interest to do a follow-up case-control study of the Kalume-Kalungula NE study of 2008 to determine whether the NE incidence, associated obstetric factors and obstetric management have changed or improved over the years. Further, a prospective study

to determine the long-term outcome of neonates diagnosed with NE at MMH will be compelling.

2.10 CONCLUSION

In conclusion, NE is an important condition affecting the neonate, mother and family, health services and society. This study sets out to identify the obstetric factors in neonates with NE and possible avoidable factors at MMH, a busy level 2 hospital in Cape Town, South Africa. In doing so, we may be able to improve obstetric practices which may, in turn, decrease the incidence of NE in our setting.

3. AIMS AND OBJECTIVES

3.1 AIMS

This research aims to demonstrate the obstetric factors occurring in patients who delivered neonates who were diagnosed with NE and to determine the avoidable factors, as used in PPIP, at MMH in 2016.

3.2 OBJECTIVES

1. To determine the NE rate at MMH

2. To describe the obstetric factors in neonates who have NE

3. To assess the avoidable factors present in the obstetric management of the patients who have neonates with NE

4. To assess the avoidable factors related to patient and administrative factors in patients who have neonates with NE

5. To compare the results of this study with those of international and other national studies, particularly to the previous MMH study done in 2008

4. METHODOLOGY

4.1 STUDY DESIGN

A descriptive quantitative study design was used. It was retrospective in nature and described the obstetric factors occurring in patients whose neonates were diagnosed with NE over a specific time period, January to December 2016.

4.2 STUDY SETTING

MMH is a government hospital. It is one of the two regional hospitals in the Metropole West District, in Cape Town, SA. In this district there is one tertiary hospital, Groote Schuur Hospital (GSH), six MOUs and three district hospitals. Five MOUs (Guguletu, Hanover Park, Retreat, Mitchell's Plain and False Bay hospital MOU) and one district hospital (Mitchells Plain Hospital) refer patients requiring district or regional level of care to MMH. Furthermore, the MOUs are staffed by midwives who manage low risk pregnant patients in the antenatal, intrapartum and postnatal periods. If these patients become high risk, they are discussed with doctors at MMH for transfer. The MOUs are governed by strict management protocols and referral criteria. In addition, MMH serves the local community of the suburbs, Mowbray, Rondebosch and Claremont. MMH is an extremely busy hospital where there are approximately 10,000 deliveries per annum, with an average CS rate of 44% since 2010 (PPIP, 2013).

All neonates with NE in MMH's satellite facilities are referred to and managed at MMH; and a large proportion would have delivered at MMH due to their mothers having been referred prior to delivery.

4.3 STUDY POPULATION

The study population included patients who delivered at MMH in 2016. The setting is characterised as low to middle income with poor socio-economic circumstances.

4.4 INCLUSION AND EXCLUSION CRITERIA

4.4.1 Inclusion criteria

The neonates who were diagnosed with NE, from mothers who delivered at MMH in 2016, were included. They were identified by neonatal doctors, working at MMH. The inclusion criteria were defined by the neonatal management protocol for NE used at MMH, described in section 2.7 (MMH, 2016). They used a clinical management guideline which is based on Shankaran NE categories and signs, as described above. NE was suspected if there were any clinical signs of encephalopathy and the presence of significant intrapartum hypoxia as evidenced by either a base deficit of 10 or more on cord blood or on neonatal blood within the first hour of life; or a five-minute Apgar score of less than seven and still requiring assisted ventilation at 10 minutes of life. A diagnostic aEEG is performed on these babies. Their mothers must have had a GA of more than or equal to 36 weeks, or they must have had a birth weight of more than and equal to 1.8 kilograms (kg), if GA was unknown. NE is defined by voltage suppression on the aEEG or seizures; or clinical seizures or dystonia; or clinical signs of moderate to severe NE, as defined by Shankaran (2005: 1575); or decreased consciousness together with abnormal tone. The names of the neonates with NE were obtained from a NE register which is kept by the neonatologists as part of their routine care.

4.4.2 Exclusion criteria

These were neonates that have not been identified with NE at MMH during the same study period, including those with severe congenital abnormalities, uncontrolled bleeding, uncontrolled systemic hypotension and uncontrolled persistent pulmonary hypertension, despite treatment. Neonates with NE who were born elsewhere were also excluded.

4.5 SAMPLE SIZE AND CALCULATION

The sample size was a convenience sample, determined by the number of neonates diagnosed with NE who were born in 2016. The previous study in 2008 analysed one year's data which included 38 cases of NE, and it was thought reasonable that this study should repeat a one year data collection period.

4.6 DATA COLLECTION

All neonates who were diagnosed with NE were documented in an NE register in the neonatal unit. Their names were collected from the register and each corresponding mother's clinical notes was requested from the MMH Records Department. The maternal folders of the cases were reviewed by the researcher by using an encephalopathy data collection tool that is used in Metropole West (see Appendix 4). This was designed by a group of neonatologists and obstetricians who all gave input into what they thought was the essential data to collect in order to describe the obstetric factors found in neonates with NE in our setting. It has not been validated, but is currently in use in Metro West. The data collection tool is divided into different sections. These include the pregnancy history, referring facility information (if applicable), transportation, labour, FHR monitoring during labour, staffing, delivery in labour ward (LW), delivery by CS and avoidable factors.

The researcher reviewed the CTG recordings of each patient to assess whether they were normal, suspicious or pathological according to the NICE classification; and also whether the recordings were complete (NICE guidelines, 2017). In cases where there was a difference in the researcher's assessment and the attendant HCW's documented assessment in the patient file; and /or when no written assessment of the recording was present, this was documented separately and noted as an avoidable factor. For example, the CTG interpretation found as normal or abnormal by the researcher, was what was described under the results section of the dissertation. In cases where the researcher assessed the CTG to be abnormal and this had not been noted or incorrectly assessed by the attendant HCW, this was noted as an avoidable factor.

The length of time it took from ambulance dispatch to arrival at MMH, from CS decision to delivery and the duration of the first and second stage of labour were calculated by the researcher by looking at the time the clinical note entries were documented.

The researcher also assessed the case notes for avoidable or modifiable factors, using the PPIP classification described in the Literature review.

4.7 DATA ANALYSIS

A statistician was consulted to assist with the analysis. Data was entered onto Microsoft excel 2011 and STATA version 14 was used to analyse the data. Since the study was descriptive,

the data was presented as frequencies and percentages in tables. Data was grouped into background demographic data; medical comorbidity; antenatal complications; gestational age, labour and delivery details and details of any required intrapartum referral. Avoidable factors, identified in the perinatal mortality and morbidity meeting where the cases were discussed, were also listed and classified into patient related, administrative related and medical personnel related. Descriptive statistics were used in analysing the data.

4.8 POTENTIAL BIAS

There were various elements that were anticipated to cause bias. Firstly, MMH is a regional hospital which manages high-risk patients, thus the NE rate may be concentrated and potentially have a seemingly high incidence as the data was hospital-based and not population-based. However, this problem could be offset by using all deliveries in MMH plus satellite units as the denominator for calculating rates. Furthermore, the fact that data collection was retrospective and relied on entries in clinical notes, meant that if information had not been recorded or parts of the folders were missing, there would be incomplete data to enter.

4.9 GENERALIZIBILITY

The study was restricted to MMH because of the limiting factors of time and finance. The study will address the issues relevant to the hospital, but the data may not be generalisable to the entire Metropole West District or other contexts.

4.10 RELIABILITY AND VALIDITY

The data collected was hoped to be reliable. The data collection tool is being used at the coal-face in obstetric and neonatal practice and thus is practical and relevant.

4.11 RISKS AND BENEFITS

No patients were at risk as the study involved purely a folder review. Since anonymity was maintained in the data collection process, analysis and final write-up, patients were further

protected from risk. In conducting the study, there may be benefit for the institution (MMH) in that avoidable factors and preventative strategies may be identified. Moreover, clinical management may improve which will, in turn, be of benefit to the patients and communities.

4.12 ETHICAL CONSIDERATIONS

Since the subjects were identified retrospectively and data retrieved from patient folders, individual patient consent was not required. The University of Cape Town (UCT) Human Research Ethics Committee gave permission (UCTHREC ref 122/2018, see Appendix 1) before the research commenced. In addition, application for renewal of ethical approval was requested, see appendix 2.

In addition, the Departmental Obstetrics and Gynaecology research committee of UCT approved the study and the MMH research committee gave permission to review the relevant folders on the premises.

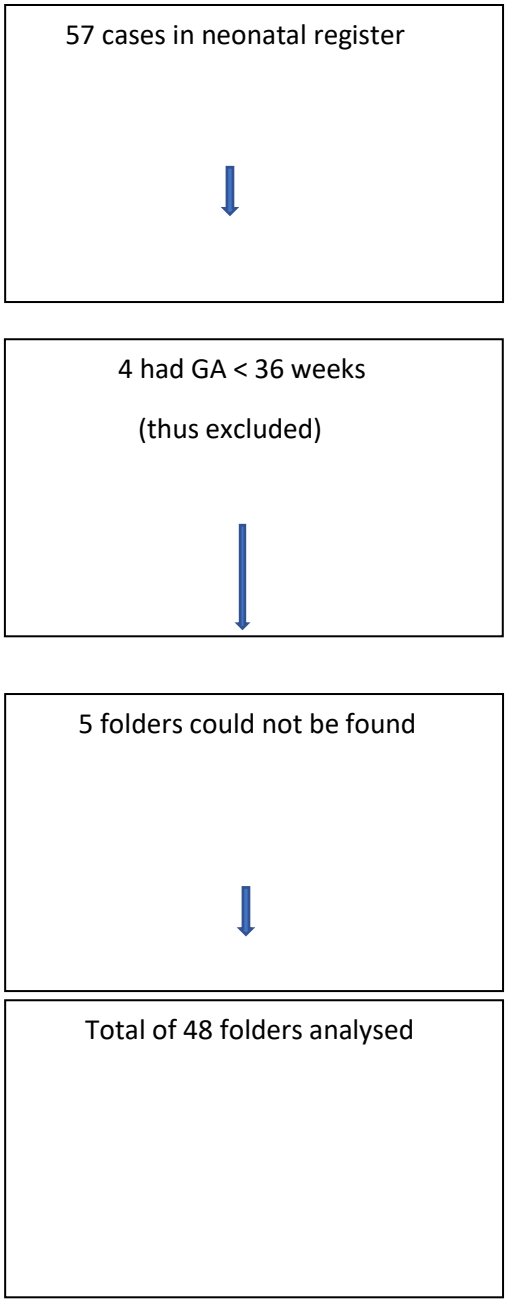
Anonymity and privacy were maintained. However, in the initial identification of the cases, the mothers' names had to be matched to each of them. Once this was done, all data collected was recorded in code. Furthermore, the data was stored on a password-protected computer and raw data and maternal folders were kept in a locked cupboard in a private, locked office. Thus, only the researcher had access to the data.

5. RESULTS

5.1 INCIDENCE OF NEONATAL ENCEPHALOPATHY (NE).

The number of MMH born neonates diagnosed with NE in 2016 at MMH was 57, as per the NE register. Five obstetric folders could not be retrieved, and 4 patients had a GA of less than 36 weeks, on folder review, see figure 1. Thus, 48 folders were audited and analysed.

Figure 1. Identification of cases



The total number of live births at MMH in 2016 was 9,702; and at MMH plus the MOUs which refer to it, was 17,751. The NE rate was thus calculated to be 5.5 per 1000 live births (LB) for MMH, and 3.0 for MMH and MOUs combined.

5.2 PATIENT DEMOGRAPHICS

The demographics of the patients included in the study are demonstrated in Table 5.

Table 5: Patient demographics N=48

Characteristics	**Mean (range), Median (range) or n (%N)**
Mean Age in years (range)	27.5 (15-40)
Age < 20yrs	10 (20.8%)
Parity = 0	24 (50%)
Median parity (range)	0.5 (0-5)
Booked for antenatal care	48 (100%)
Miscellaneous maternal medical condition	4 (8.3%)
BMI> 35 kg/m²	14 (29.2%)
Previous Caesarean Section	6 (12.5%)
Smoking history	9 (18.8%)
HIV positive	8 (16.7%)
VDRL positive	0
Drug/alcohol use	5 (10.4%)

There was a total of 48 patients, their age group ranged from 15 to 40 years with a mean of 27.5 years; and their parity from nought to five with a median of 0.5. There were 10 patients less than 20 years of age, and 24 (50%) who were nulliparous. There were 14 (29.2%)

patients who had a body mass index (BMI) of 35 and greater. All 48 patients had been booked for antenatal care. Of the 48 patients, 12.5% had had previous Caesarean Sections, 16.7% were human immune-deficiency virus (HIV) positive and none had syphilis. Four patients had miscellaneous medical conditions, namely, hepatitis B, chicken pox, urinary retention and previous back surgery. A history of smoking was obtained in 18.8%, and 10.4% used drugs or alcohol.

5.3 COMPLICATIONS IN THE ANTENATAL PERIOD

Complications in the antenatal period are shown in Table 6.

Table 6: Antenatal complications N=48

Complications	**Number (%)**
Nil	11 (22.9%)
Antepartum Haemorrhage (APH)	4 (8.3%)
Hypertensive disorder	9 (18.8%)
Maternal infection	1 (2.1%)
Prelabour PROM >18 hours	4 (8.3%)
GDM*/ IGT*	0
Suspected IUGR	1 (2.1%)
Abnormal FHR (not in labour)	3 (6.3%)
Multiple pregnancy	3 (6.3%)
Prolonged pregnancy	12 (25%)

*GDM – Gestational diabetes mellitus; *IGT – Impaired glucose tolerance

Antenatal complications were found in 37 (77.1%) patients. They ranged from one (2.7%) patient with a growth restricted (IUGR) fetus to 12 (25%) patients with prolonged pregnancy. Prolonged pregnancy was defined as more than or equal to 41 weeks gestation. The

gestational age of five (41.7%) of the 12 patients were determined by early ultrasound scan, three (25%) each by last normal menstrual period and booking palpation and one (8.3%) by late ultrasound scan. Nine (18.8%) patients had hypertensive disorders, of which six had pre-eclampsia (PET), two had gestational hypertension and one had chronic hypertension. There were 4 (8.3%) patients with prelabour PROM of more than 18, but less than 24 hours; but no patients with PROM more than 24 hours. Four had APH, three patients had an abnormal FHR detected by auscultation and three had multiple pregnancies. Of note, there were no diabetic patients with GDM or IGT. There was one patient with a maternal infection which was chicken pox. There were 11 (22.9%) patients who had no antenatal complications.

No patients had antenatally diagnosed congenital abnormalities, however, there were three patients who never had an ultrasound scan. None of the patients had had abdominal trauma in their pregnancy.

5.4 ONSET OF LABOUR

Table 7: Onset of labour details N=48

Characteristics	**Mean (range), or number (%N)**
Mean GA at onset of labour or delivery (weeks)	39 (36-45)
Delivered by CS before labour onset	6 (12.5%)
Spontaneous labour	35 (72.9%)
Induction of labour	7 (14.6%)

Table 7 shows that six (12.5%) patients were delivered by CS before labour onset, four were for pathological CTGs, one for eclampsia and one for previous Caesarean for abruptio placentae. There were 42 patients (87.5%) who underwent labour; 35 (72.9%) patients had spontaneous labour, and seven (14.6%) patients were induced. The mean GA at onset of labour or delivery was 39 weeks.

There were seven patients who had induction of labour (IOL) for which five received misoprostol alone, and two had a combination of misoprostol and AROM. All IOLs were started at MMH. There were two IOLs for hypertensive disorders, and one due to a previous

SB, twins at 37 weeks, prolonged pregnancy and urinary retention, respectively. It was not clear why one of the seven patients had an IOL.

There were 35 patients who commenced labour spontaneously; 15 (42.9% of 35) were admitted directly to MMH in labour, whereas 20 (57.1% of 35) were initially admitted to an MOU and then referred to MMH.

5.5 LABOUR DETAILS (N=42)

Labour details are divided into maternal (Table 8) and fetal care (Table 9a and 9b) aspects.

Table 8 indicates the details of labour for the 42 patients who were in labour. The mean length of the first stage of labour (latent and active phase together) was 10 hours (597 minutes), and 17.9% had a prolonged first stage. Prolonged first stage was defined as greater than 18 hours, reflecting a latent phase of >12hrs and an active phase of > 6hours in keeping with SA national guidelines. In the data collection sheet, latent and active phases were not distinguished. The mean length of the second phase of the second stage of labour was 39 minutes, and for 25% the second phase was prolonged (greater than 60 mins). The length of Second stage of labour was measured from the onset of active pushing (‘bearing down’) efforts; and the definition of a prolonged second stage of .60 mins used for both primigravida and multigravida. Three patients were given an oxytocin infusion for aungmentation, 12 (28.6%) had more than 4 vaginal examinations.

Table 8: Maternal care aspects (N=42)

Characteristics	**Mean (range); number (percentage)**
Mean length of first stage (minutes)	597.0 (75-3445)
Prolonged first stage (>18hours)	7 (17.9% of 39) *
Mean length of second phase of second stage (minutes)	39 (2-103)
Prolonged second phase of second stage of labour (>60min)	6 (25% of 24)**
Temperature > 37 degrees C	2 (4.2% of 48)
Multiple PV exams (> 4)	12 (28.6% of 42)
Oxytocin infusion	3 (7.1% of 42)
Partogram usage in MOU labour referrals	15 (75% of 20)***

*Information lacking for 3 patients

**24 patients had a second stage of labour (24 had CS before second stage)

*** 20 patients in labour from the MOU

Information on use of the partogram was collected for the MOU patients who were transferred in labour, but not for the patients who commenced labour at MMH. It was noted that 15 of the 20 (75%) MOU in all patients in labour, two had temperatures more than 37 degrees Celsius.

The methods of FHR monitoring at the MOU and MMH are shown in Table 9a; and the results of fetal monitoring / assessment shown in Table 9b.

Table 9a: Methods of fetal heart rate monitoring

Method	**MOU patients (n= 20) (%)**	**MMH patients (n=48)*(%)**
IA	17 (85%)	0
CTG	3 (15%)	46 (95.8%)
IA and CTG	0	2 (4.2%)

*includes patients referred from MOU

5.5.1 *FHR monitoring of labouring patients at the **MOUs***

Intermittent auscultation (IA) by Pinard stethoscope or Doptone (hand-held sonographic device) was used in 85% (17 of 20) of patients in labour at the MOUs.

There were 20 patients in latent labour at the MOUs of which 11 (55%) had FHR monitoring two hourly, in accordance with protocol, while in six (30%) patients IA was not done adequately (this is also referred to under Avoidable factors, Table 14). Three (15%) patients had CTG monitoring at the one MOU which has a CTG machine. Two of the three patients went on to have CTG monitoring in active labour and one was transferred to MMH before the active phase of labour.

There were eight patients in the active phase of labour at the MOUs, only one (12.5% of 8) had the FHR monitored every 30 minutes in accordance with protocol, while five (62.5% of 8) had inadequate monitoring (this also referred to under avoidable factors, Table 14). Two (25% of 8) had CTGs. There were no patients who had a combination of IA and CTG use. All eight patients in active labour at the MOUs presented to the MOUs in latent labour.

Summarising method and quality of fetal heart monitoring at MOUs; all 20 patients who were admitted in spontaneous labour at an MOU were in the latent phase and all had fetal heart monitoring, the majority by IA. In 70% of patients in the latent phase of labour it was fully documented and according to protocol, but in 30% it was incomplete / not documented. In the active phase of labour, 37.5% had FHR monitoring fully documented and in 62.5%, documentation was incomplete.

Of the 28 women referred from MOUs to MMH, 10 patients had an abnormal FHR detected at the MOU; two had fetal bradycardia, two had fetal tachycardia and six were termed ‘fetal distress’.

5.5.2 *FHR monitoring of patients in labour at **MMH***

All 48 patients (including those referred from MOUs) had CTG monitoring at MMH. This included the 42 women in labour and the 6 who had a CS before labour.

Considering timing of commencement of monitoring for all 48 patients after admission, CTGs were started immediately upon arrival in 19 (47.5%) of 40 patients for whom there was documentation of the time of commencing a CTG. In 23 (57.5% of 40) patients the CTG was started any time from nine to 80 minutes after admission at MMH, with a mean time of 17 minutes. There were six (12.5% of 48) patients who had no documentation of the time the CTG was first started on arrival. There was a poor quality CTG trace in 10 (20.8% of 48) patients where there were many places on the CTG with loss of contact.

Considering the 42 patients in labour at MMH (which includes the 20 patients who were referred from the MOUs), CTG monitoring was used in all 42 (100%); in two patients IA was used in addition. No patient had IA alone at MMH. All MMH CTGs were assessed by the researcher.

The results of fetal assessment in labour are shown in Table 9b. Of the 42 CTGs, 10 could not be assessed due to poor quality. This meant that 32 CTGs were assessable (i.e. could be interpreted). Of these, one was normal and 31 were abnormal according to the researcher's assessment.

The researcher identified 29 (90.6%) of the 32 assessable CTGs (prior to delivery) as being pathological whilst two (6.3%) were suspicious according to the NICE guideline classification. Of note, the researcher's assessment coincided with the attending HCW in all assessable cases, except for 11, where the abnormality was not recognised by the HCW, either because the CTG was not reviewed (seven cases) or it was interpreted incorrectly (four cases). This is referred to in section 5.10 on HCW avoidable factors.

Of the 31 patients with an abnormal FH, 27 (87.1%) of them received intrapartum resuscitation. This included intravenous fluids, left lateral position and tocolysis with salbutamol.

Table 9b: Fetal assessment in labour at MMH (N=42)

Characteristics	**Number (percentage)**
Abnormal FH – pathological - suspicious	29 (90.6%) of 32 assessable CTG)* 2 (6.3% of 32)
Normal FH	1 (3.1% of 32)
Meconium stained liquor (MSL)	17 (40.5% of 42)
Intrapartum resuscitation	27 (87.1% of 31 with abnormal CTG)

*10 CTGs were poor quality and could not be assessed, leaving 32 which were 'assessable' and where an interpretation could be made

There were 40.5% of labouring patients with MSL.

Eight of 10 (80%) patients who had an abnormal FHR detected by intermittent auscultation at the MOUs prior to referral, had abnormal CTGs at MMH, one had a normal CTG at MMH and the other had no documentation of the FHR just before delivery.

5.6 MOU REFERRALS

Table 10 details the referrals from the MOUs. The total number of patients that were referred was 28, 58.3% of the patients included in the study. Twenty were intrapartum referrals, and 8 were not in labour. Some patients had more than one reason for being transferred, hence the number in the table does not add to 28. Five (17.9%) patients had prolonged first stage of labour. One (3.6%) was transferred for prolonged second stage of labour, two (7.1%) with MSL and 10 (35.7%) with an abnormal FHR. There were six (21.4%) referred with hypertensive disorders and two with prolonged pregnancies. The three miscellaneous reasons include maternal hepatitis B disease, a patient with a previous back operation and one with proteinuria only. Of the eight patients who were not in labour upon transfer, there were four with pre-eclampsia, two with prolonged pregnancy, one with APH and fetal bradycardia and one with fetal distress.

Table 10: Referrals from MOUs N=28

Reason	**Number (percentage)**
Prolonged first stage of labour	5 (17.9% of 28)
Prolonged second stage	1 (3.6% of 28)
MSL	2 (7.1% of 28)
Abnormal FHR	10 (35.7% 28)
Hypertensive disorders	6 (21.4% of 28)
Prolonged pregnancy	2 (7.1% of 28)
APH	1 (3.6% of 28)
Miscellaneous	3 (10.7% of 28)

Of the 10 patients who had an abnormal FHR, two had fetal bradycardia, two had fetal tachycardia and six were termed ‘fetal distress’. The patient who had a prolonged second stage of labour, was referred from a midwife who was managing a patient with a low risk pregnancy and labour at home. She resided in the MMH drainage area and was subsequently

managed in MMH's labour ward; the midwife called for doctor's assistance 50 minutes after bearing down efforts began.

Referral times for MOU Referrals

The time it took from when the MOU midwife booked the ambulance to when it was dispatched ranged from one to 102 minutes (min) (2 hours 42 min). The time the ambulance took from dispatch to arrival at MMH, after collection of patient from the MOU, ranged from 27 to 191 min (3 hours and 11 min). The mean time was 66 min (1 hour and 6 min). The mean time of the overall transfer decision to arrival at MMH was 104 min (1 hour and 44 min) and ranged from 34 to 230 (3 hours 50 min) min. There was no documentation of either booking time or arrival time in three patients.

5.7 MODE OF DELIVERY

Table 11: Mode of delivery N=48

Mode of delivery	**Number (percentage)**
Normal Vaginal Delivery (NVD)	12 (25%)
Breech delivery	1 (2.1%)
Caesarean section	28 (58.3%)
Vacuum extraction	6 (12.5%)
Forceps delivery	1 (2.1%)

Table 11 describes the mode of delivery for all 48 patients. There were 12 normal vertex deliveries (NVD) (27.1%), one (2.1%) vaginal breech and 28 (58.3%) CS. Assisted deliveries (six vacuums and one forceps) accounted for 14.6% of deliveries. There were eight attempted vacuum deliveries, two of which failed. Of the failed vacuum attempts, one ended up as a NVD and one as a forceps delivery. There were two forceps attempted in total, one was successful (one of the failed vacuum attempts), the other failed and ended up as a CS.

The indications for the assisted deliveries were all pathological CTG, except one which was done for prolonged second stage of labour. In all the assisted deliveries the prerequisites were met.

There was one vaginal breech delivery, this was the second twin of one of the patients with multiple pregnancy.

There were three sets of twins. One patient had NVDs for both twins, the other two patients required a CS each for the second twin, due to them having pathological CTGs.

5.8 CAESAREAN SECTION INDICATIONS

Table 12 describes the indications for the 28 CS which includes the six patients who had CS before labour and were described in the text following Table 7.

Table 12: Indication for Caesarean Section N=28

Indication	**Number (percentage))**
Prolonged first stage of labour	0
Prolonged second stage of labour	2 (7.1% of 28)
Suspected abruptio placentae	3 (10.7%)
Cord prolapse	1 (3.6%)
Failed assisted delivery	1 (3.6%)
Eclampsia	1 (3.6%)
Pathological CTG	20 (71.4%)

The majority of the CS (71.4%) were for pathological CTG. Two of the CS done for pathological CTG were for a second twin. There were three (10.7%) CS done for suspected abruptio placentae, two (7.1%) for prolonged second stage of labour and one (3.6%) each for cord prolapse, failed assisted (forceps) delivery and eclampsia.

5.9 SENTINEL EVENTS

Sentinel events refer to major obstetric complications known to be causally associated with NE. There were 15 patients with recognised sentinel events and 33 without. One patient had 2 sentinel events. Table 13a refers to the timing of the SE, while Table 13b details the different types of SE that occurred.

As seen in Table 13a there were 4 patients with antenatal sentinel events. These included one patient with eclampsia (2.1% of 48), and three with abruptio placentae (6.3% of 48).

Table 13a: Number of patients who had a sentinel event for NE; and the timing. N=48

Period	**Number of patients**
Antepartum	4
Intrapartum	11
No documented sentinel event	33

Intrapartum sentinel events included 5 patients with prolonged second stage of labour (10.4% of 48), one with cord prolapse (2.1% of 48) and five with shoulder dystocia (10.4% of 48). Four of the patients who had prolonged second stage of labour were high risk patients who started the second stage at MMH LW. The fifth patient who had a prolonged second stage of labour was initially a low risk, local patient managed by a midwife in labour at home. Three of the patients with prolonged second stage of labour had a vacuum delivery, and two needed a CS.

Table 13b: Type of sentinel events N=15

Type	**Number (percentage)**
Abruptio placentae	3 (6.3% of 48)
Eclampsia	1 (2.1%)
Prolonged second stage of labour	5 (10.4%)
Shoulder dystocia	5 (10.4%)
Cord prolapse	1 (2.1%)
No sentinel event	33 (68.8%)

Of the five patients who had shoulder dystocia, all the patients had a BMI of less than 35kg/m^2. The neonates' birth weights were 4005g, 3880g, 3820g, 3635g and 3600g respectively.

There were 33 patients with no documented sentinel event. Twenty-five (75.8%) of them had pathological CTGs, with no obvious obstetric reason.

5.10 AVOIDABLE FACTORS

The avoidable factors are demonstrated in Table 14.

Table 14: Assessment of avoidable factors / substandard care N=48

Avoidable factors	**Number (percentage)**
Patient-related:	
Infrequent ANC visits	1 (2.1% of 48)
Administrative-related:	
Transport delay	12 (42.9% of 28 transfers)
Delay in access to theatre (theatre occupied)	7 (25% of 28 CS)
Delay in access to theatre (no reason documented)	8 (28.6% of 28 CS)
Medical personnel-related:	
Delay in referral	1 (3.6% of 28 referrals)
Inadequate FHR monitoring at MOU in latent phase in active labour	 6 (30% of 20 in latent labour at MOU) 5 (62.5% of 8 in active labour at MOU)
MMH: Poor quality CTG tracing and monitoring Fetal distress not detected in labour, despite fetal monitoring *	 10 (20.8% of 48) 11 (34.4% of 32 assessable traces in labour)
Delay in doctor's assessment on patient arrival (>60min)	10 (20.8% of 48)
Anaesthetic delay	1(3.6% of 28)

*This included CTG not being reviewed (7 cases) or CTG misinterpreted (4 cases)

Avoidable factors were sub-divided into patient related, administration related and medical personnel related, in accordance with the classification used by the Perinatal Problem Identification Programme (PPIP).

5.10.1 Patient related avoidable factors

There was one (2.1%) avoidable factor which was patient related, this was infrequent antenatal visits.

5.10.2 Administrative related avoidable factors

For twelve (42.9%) of the patients transferred to MMH, there was a transport delay (ambulance dispatch time to MMH arrival time of more than 60 min). There were 15 patients (53.6% of those having CS) who had a delay in performing emergency CS of more than one hour from the decision to do it. For seven (25%) theatres were occupied with other emergencies, and in eight (28.6%) there was no documentation of the reason for the delay.

5.10.3 Medical personnel related avoidable factors

There was one (3.6% of 28) patient where the decision to refer from an MOU was delayed.
At the MOUs, there were six (30% of 20) who had inadequate FHR monitoring in latent phase and five (62.5% of 8) who had inadequate FHR monitoring in the active phase of labour.
At MMH, in 34.4% of the 32 assessable CTGs in labour, fetal distress was not detected even though the fetus was monitored.
There was a delay in a doctor assessing the patients upon arrival in 10 cases (20.8% of 48).
In one patient requiring emergency CS, surgery was delayed due to an anaesthetic difficulty with inserting an intravenous line and performing spinal anaesthesia.

5.10.4 Birth time and Shift handover

The nursing staff work 12 hour shifts i.e. 7am to 7pm on day shift and 7pm to 7am on night shift. We looked at how many neonates were born during the shift handover period (6am to 8am and 6pm to 8pm). Five (10.4%) neonates were born at this time in the morning (end of night shift) and three (6.3%) at night (end of day shift). Together this constituted 8 (16.7%) of the study group.

5.11 NEONATAL CHARACTERISTICS

These are shown in Table 15.

Table 15: Neonatal characteristics N=48

Characteristics	**Frequency (%)**
Maximum NE score*:	
Mild (1-10)	29 (76.3% of 38)
Moderate (11-14)	4 (10.5% of 38)
Severe (15+)	5 (13.2% of 38)
Gender:	
Female	17 (35.4%)
Male	31 (64.6%)
Birthweight:**	
Less than 2000g	1 (2.1% of 47)
2000-2499g	3 (6.4% of 47)
2500-3499g	29 (61.7% of 47)
More than 3500g	14 (29.8% of 47)
Apgar score*:**	
1 min Apgar less than 4	28 (59.6% of 47)
5 min Apgar less than 7	27 (57.4% of 47)
10 min Apgar less than 7	8 (34.8% of 23)

*NE score not documented in 10 neonates

** BW not documented in one neonate

*** Apgar scores not done for all neonates

5.11.1 Maximum Thompson NE score

The maximum Thompson NE score refers to the highest score recorded for the neonate during the hospital stay; and this was recorded in the neonatal NE book for 38 of the 48

(79.2%) neonates. There were 76.3% of neonates with a maximum NE score ranging from 1 to 10 (mild). There were 4 (10.5%) with moderate NE (11 to 14) and 5 (13.2%) of neonates had severe NE (15 and above).

5.11.2 Gender

There were 64.6% of the neonates who were male and 35.4% were female.

5.11.3 Birthweight

Most (61.7%) neonates weighed between 2500g and 3499g. There was one who weighed less than 2000g and 29.8% weighed more than 3500g.

5.11.4 Apgar score

The one and five minute Apgar scores were recorded in all neonates except one; while 23 neonates had a 10 min Apgar score recorded. 59.6% of the neonates had a one min Apgar score of less than four, 57.4% had a score of less than seven at five min and 34.8% had an Apgar score of less than seven at 10 min.

5.12. MAXIMUM NE SCORE AND SENTINEL EVENTS

A sub analysis was performed comparing the maximum NE score in patients with and without sentinel events. This is shown in Table 16

Table 16. Maximum NE score and occurrence of sentinel events (N=38)

Sentinel event	**Max NE <=10**	**Max NE >10**	**Total**
Nil	17 (68%)	8 (32%)	25 (100%)
Occurred	12 (92.31%)	1 (7.69%)	13 (100%)
Total	29 (76.32%)	9 (23.68%)	38 (100%)

Pearsons chi2 = 2.7959; p=0.095

There was a higher proportion (32%) of severe NE outcomes in patients with no sentinel events compared to those having a sentinel event (7.69%). However, there was no significant association between the occurrence of sentinel events and the maximum NE score.

6. DISCUSSION

A summary of the results of our study is discussed in this chapter. These findings will be compared to findings of other studies which were done in our local and national setting and in an international context.

6.1 INCIDENCE

The incidence of NE at MMH, and MMH together with the MOUs referring to it, was determined. The NE rate was 5.5 per 1000 LB for MMH in 2016, and 3.0 per 1000 LB at MMH when including live births from its catchment area in the denominator. The NE rate at MMH of 5.5 in this study has shown an increase compared to the 2008 MMH study done by Kalume Kalangula when it was 3.7 per 1000 live births. In 2016 there were 9,702 LB at MMH which is 540 (5.6%) higher than the number of live births in 2008 (9,162). The increase may well be due to increased identification of mild NE cases, with the strict use of the Shankaran criteria in the NE protocol, which was not used in 2008. It may also be as a result of an increase in workload, with more referrals from MOUs, which places an added burden to an already busy maternity hospital with limited resources. Furthermore, it may be due to a shift from mortality to morbidity. When we look at the perinatal mortality rate (PNMR), as measured in annual PPIP statistics, for neonates with birth weights of over 2500g in 2008 and 2016, it is clear that the PNMR for MMH in 2008 was higher with a rate of 7.5/1000 deliveries compared to that of 2.9/1000 deliveries in 2016. In addition, for the hypoxic neonatal deaths there is a slight difference in the proportion between the two years. In 2008, 71.4% (10 neonates) of all babies who died weighing more than and equal to 2500g had hypoxic deaths, whereas for 2016 it was 66.7% (four neonates). This may suggest that the higher NE rate in 2016 may be, in part, due to earlier HCW intervention which prevents fresh stillbirths from hypoxia. This would be consistent with the higher CS rate in our study compared to 2008, which is discussed more in section 6.8 (PPIP, 2013). Another reason for the increase in NE rate may relate to case identification. In the previous study the cases were identified by using the Fenichel criteria (1983) quoted by Kalume Kalangula, 2008: 5,9-10, 21).

The NE rate of 5.5 per 1000 LB is comparable to the hospital-based study by Itoo et al in Saudi Arabia which was 4.7 per 1000 LB. This falls in the range of NE rates (1.0 to 8.0) seen

from different studies done worldwide (Kurinczuk, White-Koning & Badawi, 2010: 330, 332).

It is difficult to determine the incidence of NE globally as some studies are hospital based and others population based. Also, different obstetric units and different countries may use different definitions of NE. It is not surprising that the NE rate in hospital-based studies are higher than the population based studies. This is due to the fact that high risk patients (who may have more risk factors) are referred to hospital. Hospital based international studies done in the past include, amongst others, the Saudi Arabia study as discussed earlier and the study done in Nigeria which had a NE rate of 26.2 per 1000 LB, which is much higher than our rate (Kurinczuk White-Koning & Badawi, 2010: 330, 332). Closer to home, a 2015 published study which was done at a large hospital in SA, CHBAH, had a NE rate of 8.7 per 1000 LB (as defined by need for bag mask ventilation at birth, Apgar score < 7 at five minutes and a base deficit > 12 mmol/L) which is also higher than our rate (Bruckmann & Velaphi, 2015: 299). Moreover, it was shown that in developing countries HIE constitutes 60% of NE cases, whereas in developed countries 30% of the NE cases are due to HIE (Kurinczuk, White-Koning & Badawi, 2010: 337).

6.2 PATIENT DEMOGRAPHICS

The descriptive study design, with no control group, did not allow an assessment of demographic risk factors for NE to be identified.

The patient demographics which were interesting in the current study were age, parity, obesity, smoking history booked and HIV status.

There were 10 patients (20.8% of 48) who were under the age of 20 years, this corroborates with the Gane et al. study done in India and the Martinez-Biarge et al. study done in the United Kingdom (UK). They showed that patients under 20 years of age were at increased risk of having babies with NE. In contrast, the previous MMH study showed that 38% of patients were under 20 years of age, nearly double that of our study.

Nulliparity occurred in 50% of patients in our study which is greater than the prevalence of nulliparity in the pregnant population in SA. This is in keeping with the Gane et al. and Martinez-Biarge et al. studies which demonstrated nulliparity to be a significant risk factor for NE. The previous 2008 MMH study showed that 65% were nulliparous patients but this

did not differ significantly from controls, reflecting that nullipara may be referred more in labour from primary care than multipara. Interestingly, primiparity had a low association with NE in the Nepal study (Gane et al., 2013: 120, 121; Martinez-Biarge et al., 2013: e954, e955; Kalume Kalangula, 2008: 23; Kurinczuk, White-Koning & Badawi, 2010: 335).

All patients in our study were booked, similar to the previous study which had 97% booked patients. This was a conflicting finding compared to the India, the West Australia and the Nepal study, respectively. They found that being unbooked and not having adequate healthcare in pregnancy predisposed their patients to having babies with NE. The Bruckmann & Velaphi study also had patients who had a high booking status, 95.6%, very similar to our 100%. This is an interesting finding which poses the question of the adequacy of the antenatal care in SA as most patients had access to care, yet had babies with NE; or it shows that in our setting, intrapartum factors play a much bigger role in developing NE. The latter is most likely. We shall expand on this later in the discussion (Gane et al., 2013: 120, 121; Kurinczuk, White-Koning & Badawi, 2010: 335; Bruckmann & Velaphi, 2015: 300).

Nearly 30% of patients had a body mass index (BMI) of >35. However this is a similar prevalence to recent BMI studies in the general Cape Town pregnant population so is unlikely to have any significance.

A smoking history was found in nearly 20% of patients. One patient who smoked cigarettes was one of the three who had an abruptio placentae; smoking is known to predisposes patients to abruptio placentae. Another smoker had a baby with a low birth weight (LBW) <2500g , one of four babies with LBW.

HIV occurred in 16.7% of our patients this, however, was similar to the Western Cape (WC) Province prevalence rate of 12.6% (Kanabus, 2018). Our HIV positive rate was nearly half of that of the CHBAH, which was 25.9% (Bruckmann & Valaphi, 2015: 300), but very similar to the 18% of the previous MMH study (Kalume Kalangula, 2008: 23).

6.3 ANTENATAL COMPLICATIONS

An antenatal complication was present in the majority (77.1%) of patients in the current study. This is in keeping with the previous 2008 study with 71% of cases having antenatal complications. The most frequent complications included prolonged pregnancy (25%) and hypertensive disorders (18.8%). Both of these are comparable to international studies. The

West Australian study showed that the risk of babies having NE increased as the pregnancy lengthened. In terms of hypertensive disorders, both our study and the 2011 Bruckmann & Velaphi study demonstrated similar proportions (18.8% and 19.6% respectively) of patients having babies with NE. This is supported by the West Australia and the India study which both had pre-eclampsia as a major risk factor. The Nepal study did not have an increase in NE observed in patients with hypertension. Similarly, in the previous study, a low proportion (9%) of patients with pre-eclampsia had NE, this is about half that of our study (Kalume Kalangula, 2008: 24; Kurinczuk, White-Koning & Badawi, 2010: 335-336).

APH in our study accounted for 8.3% of patients. Both the West Australia and India studies displayed a significant relationship between APH and NE, while Bruckmann & Velaphi and the Nepal study did not look at APH as a factor.

In addition, PROM played a role in NE as demonstrated in the current study (8.3%), the Nepal study and the India study (50% higher than controls).

We had 6.3% of our patients with multiple pregnancy (twins). This is higher than the incidence of twins in total MMH deliveries, and could be in keeping with the Nepal study which showed that twin pregnancy was their greatest risk factor for NE. In addition, The UK study also showed an increase in NE with twin pregnancies. Surprisingly, the previous MMH study reported no twin pregnancy.

Further, we had a low proportion (2.1%) of patients with infections in pregnancy and labour whereas the previous study had a higher proportion (12%); the West Australia study showed significant risk of NE in patients with infections (Kalume Kalangula, 2008: 24; Kurinczuk, White-Koning & Badawi, 2010: 335-336; Martinez-Biarge et al., 2013: e955).

Of interest, we had no patients with IGT as a complication. GDM and IGT were not factors considered in the studies mentioned above, except for the India study which showed an increase in DM in cases compared to controls, however, this was not statistically significant (Gane et al., 2013: 120).

In summary, this section on antenatal complications can describe the frequencies of the various factors but cannot, like some of the other studies referred to, identify risk factors due to the lack of a comparison group.

6.4 ONSET OF LABOUR

There were 87.5% (42) of patients in our study who were in labour, the vast majority (83.3%) of them were in spontaneous labour and 16.7% underwent IOL. In the study done in Nepal, IOL was a significant risk factor for NE while that in West Australia was not. However, the indications thereof in the former study were not studied and thus one can only postulate that the IOL indications were of such a nature to increase risk of NE. Similarly, in our study just over half of the IOL patients had indications (prolonged pregnancy, hypertensive disorders and twins) which are known to have an increased association with NE. These findings were in keeping with both the Martinez-Biage and the Gane studies (Kurinczuk, White-Koning & Badawi, 2010: 336; Martinez-Biarge et al., 2013: e995; Gane et al., 2013: 120).

Furthermore, 20 patients (57.1%) of the 35 patients in spontaneous labour were initially admitted to the MOUs and were subsequently transferred to MMH. Some of the reasons for transfer were slow progress in the first and second stage of labour, fetal distress and IUGR in labour. Referral times and transport issues will be discussed further in section 6.7.

6.5 MATERNAL CARE ASPECTS OF LABOUR

There was a total of 42 patients in labour in our study, 17.9% of these had a prolonged first stage of labour (latent and active phase) and in 25% of the patients who reached the second stage of labour, the second phase of active bearing down, was prolonged. This was much less than that found in the previous MMH study where 76% of the cases had prolonged first stage and 41% had prolonged second stage of labour. The use of oxytocin was also far less (7.1%) in the current study than that (38%) in the previous study. These findings are compelling as prolonged first and second stage of labour, particularly the latter, are known to have higher NE rates, however our study revealed a higher NE rate than the 2008 study despite having lower proportions of prolonged first and second stage of labour.

Looking at PROM, the current study and the 2008 study both had about 8% of cases complicated by this. The Nepal study showed that PROM was an important risk factor in NE, but this was not found in the West Australia study.

Partogram usage was only recorded in our study for the MOU patients who were transferred in labour (20 patients). It is unfortunate that this was not done for the patients known to MMH, thus we cannot comment and make adequate comparisons. It is satisfactory that 75%

of the MOU patients described above had the partogram completed. This differs from the conclusion of a study done (in the same district) by Jagau et al. in 2017 which showed that a much lower proportion of partograms were completed in the MOU setting (Kalume Kalangula, 2008: 25-26; Kurinczuk, White-Koning & Badawi, 2010: 336; Jagau et al., 2017: 135).

6.6 FETAL CARE ASPECTS OF LABOUR

The MOUs and MMH both had FHR monitoring for all their patients in labour. Of note all patients referred from the MOU in labour had been admitted in latent labour; this means that they did not present in advanced labour where there was no time for monitoring before delivery. The MOU referred patients all had monitoring by IA except for three patients who had CTGs and the latter had CTG monitoring in all patients. The use of these methods are appropriate for the risk of the patient i.e. low risk patients getting IA which is supported by the 2017 Cochrane review and the 2018 study by Smith et al. These publications showed that the admission CTG (aCTG) is of no benefit and one cannot justify its use; the use of the CTG and the use of IA revealed no differences in the outcome of obstetric and neonatal care (Devane et al., 2017: 2; Smith et al., 2018: 114). In contrast, continuous CTG monitoring is recommended in high risk patients, thus the 100% use of CTGs at MMH is acceptable (Mahomed et al., 1994: 497).

Looking at MOU practices, 70% of patients who were in spontaneous latent phase had FHR monitoring done adequately whereas only 37.5% had adequate FHR monitoring in the active phase of labour. This is in-keeping with the Jagau et al study which demonstrated that FHR monitoring was not done according to protocol (by use of the partogram) even though HCW understood the importance of correct and timely monitoring. In addition, that study showed that HCW felt that they had too little time in which to monitor adequately and some felt insecure in their ability of FHR documentation (Jagau et al., 2017: 135).

At MMH, there were several factors which affected adequate CTG monitoring and management of patients. These included a poor quality tracing of the CTG, with loss of contact of the probe on the patient's abdomen, incorrect interpretation by attending HCW, and infrequent reviews of CTGs. In approximately 74% of patients the CTG was fully documented, in accordance to protocol, in the clinical notes. In 26% of patients the CTG

were not reviewed or findings were not documented or described in the notes. All of these factors would lead to delayed response or action to FH abnormality.

Furthermore, 40% of our study patients had MSL which corroborated with the Bruckmann & Velaphi study which showed about 34% of cases and the Kalume Kalangula study showing 35% of cases having MSL. The Martinez-Biarge study had fewer patients (29%) with MSL. Moreover, about 94% of patients in our study had abnormal CTGs, this was much higher than the 47% of cases found in the Bruckmann & Velaphi study and the 73% of cases shown in the Kalume Kalangula study (Bruckmann & Velaphi, 2015: 300; Kalume Kalangula, 2008: 26; Martinez-Biarge et al., 2013: e955).

Approximately 87% of patients in our study with abnormal CTGs, had documented evidence of having received intrapartum resuscitation (IPR).

6.7 MOU REFERRALS

Metro West has a tiered referral system which is governed by well-defined referral criteria and requires emergency transport between levels of care. The MOUs manage the low risk patients in labour and all of the antepartum patients over 36 weeks gestation. Prior to this, the basic antenatal care (BANC) sites manage the low risk antenatal patients under 36 weeks. Once a complication is diagnosed, the MOU midwives will discuss the patients with the doctors at their referral hospital for possible transfer. The urgency of the referral will be discussed with the referral hospital and appropriate transport organised. The most urgent transport is the 'flying squad', which is no longer a dedicated obstetric ambulance, but refers to the most urgent ambulance which should arrive at the referring MOU to collect the patient within 30 minutes of request. It is indicated for conditions such as cord prolapse, eclampsia, haemorrhage, prolonged second stage and pathological fetal heart rate.

In our study, we had 10 patients with abnormal FHR who were referred. The time it took from ambulance dispatch time to arrival time at MMH, after collecting the patient from an MOU, ranged from 38 to 114 min, with a mean of 66 min. This is the norm for referrals in our setting where some MOUs are at least 20 kms from MMH; but a two hour delay in cases of abnormal FHR could prove critical for these neonates. If one looks at all the referrals, the dispatch to arrival time ranged from 27 to 191 min, with a mean of 66 min. Again 191 mins is too long for an urgent referral such as cord prolapse. It has been suggested in SA, that the

new model of maternity care should be for Onsite Midwife Birthing Units (OMBUs) instead of the current system of stand-alone MOUs that exist in Cape Town. OMBUs would allow for more rapid referrals and earlier intervention for obstetric emergencies.

6.8 MODE OF DELIVERY

Caesarean section was performed for 58.3% of the patients in our study. This figure is comparable with the study done in the United Kingdom (UK), by Martinez-Biarge et al., where 50% of the cases had emergency CS. However it is much more than the 38% found in both the previous MMH study and the Bruckmann & Velaphi study. In addition, much lower proportions of cases required CS in the Nepal and West Australia studies which were 6.7% and 9.5% respectively. The leading indication for CS in our study was pathological CTG (71.4%), in contrast to the 15% in the previous study. The indications for CS in our study and that of the previous study had interesting differences. The previous study cited CPD, failed vaginal birth after Caesarean (VBAC) and failed IOL as frequent indications for CS, requiring CS whereas we had none for these indications. Our main indications for CS, in addition to pathological CTG, were suspected abruptio placentae, cord prolapse, eclampsia and prolonged second stage. Our indications were mostly sentinel events and had a greater urgency for the need for CS. The indications for CS were not highlighted in the other studies described. It is difficult to interpret this finding on different indications for CS compared to the previous study; it could be that doctors are acting much earlier on CTG signs than previously and intervening before prolonged labour ensues, or it could be that there is a higher burden of high risk pregnancies with hypertension, abruptio placenta and IUGR all rendering the fetus more vulnerable to hypoxia. Assisted delivery, mostly ventouse delivery accounted for 14.6% of the deliveries in the current study, this is similar to the previous MMH study (15%), but nearly double that of the Bruckmann & Velaphi study (8.7%). The indications for assisted delivery in our study were all for fetal distress, except one which was for prolonged second stage of labour. In the current study 27.1% of patients had a vaginal delivery. This was about a fifth and a sixth less than that of the Kalume Kalangula study and the Bruckmann & Velaphi study respectively, however more or less in keeping with the Martinez-Biarge study (Martinez-Biarge et al., 2013: e955; Kurinczuk, White-Koning & Badawi, 2010: 336-337; Bruckmann & Velaphi, 2015: 300; Kalume Kalangula, 2008: 27).

It is possible that more CS are being done earlier for suspected perinatal hypoxia; this could reduce the fresh stillbirth and early neonatal death rates, but not reduce (or even increase) the NE rate. Also, earlier intervention could reduce the severity of the NE (i.e. from severe to mild) and thus would be an important intervention.

The findings of both an increased NE rate and increased CS rate needs to be explored further and compared with any trends in reduction of perinatal deaths due to hypoxia and also any changes in the severity of NE.

6.9 SENTINEL EVENTS

Major obstetric complications which may occur in a previously low risk patient are called sentinel events. These may result in hypoxic-ischaemic changes in the fetal and /or neonatal brain (Martinez-Biarge et al., 2011: 1.e1). In our study, there were sentinel events for only 31.3%, which is less than the previous MMH study and that by Martinez-Biarge. Martinez-Biarge et al. showed that sentinel events contributed to most (71%) of their neonates with NE, of which, uterine rupture and abruptio placentae were the most frequent sentinel events in their study. They concluded that intrapartum events superseded antepartum factors for the development of NE (Martinez-Biarge et al., 2011: 1.e4,1.e6). This fits with the Kalume Kalangula study where intrapartum factors contributed 59% and antepartum factors 12% respectively to NE (Kalume Kalangula, 2008: 27). Indeed, this was also what our current study demonstrated with two thirds of sentinel events occurring in the intrapartum period while about one third occurred in antenatally. The Western Australia study contradicted all the above studies in that they concluded that 69% of risk factors occurred in the antepartum period while intrapartum hypoxia alone, only contributed to 4% of NE (Badawi et al., 1998: 1557). Our study nor the previous, did not take record cord blood gases which were not routinely done and could have contributed to identifying intrapartum factors.

Looking more in-depth at the sentinel events, the most common occurring condition was prolonged second stage of labour in the previous MMH study (Kalume Kalangula, 2008: 29). However prolonged second stage of labour together with shoulder dystocia were equally the most frequent sentinel events in our study. Furthermore, what is interesting is that sentinel events contributed to 31.3% of all the neonates with NE in our study while in 68.7% of patients, there was no demonstrable sentinel event. Of the latter, 75.8% of the assessable CTGs were pathological. Moreover, in our study, the proportion of patients with

no sentinel event had higher (32%) NE scores compared to the proportion (7.7%) who had sentinel events. We can only postulate that with a sentinel event, which may be dramatic, the HCW is alerted, manages and intervenes quickly by expediting delivery, and this may result in neonates having lower NE scores.

6.10 AVOIDABLE FACTORS

It is important to look for possible factors that may have contributed to a poor outcome, in order for health care workers (HCW) to improve their management of pregnant patients. Further, it may help the healthcare system to optimise its resources (e.g. ambulance transport), and indeed, help us to empower our patients and educate them on possible danger signs in pregnancy. In SA we use PPIP to audit our perinatal morbidity and mortality. The programme was designed for us to record the number of deliveries in each district, report and record perinatal deaths, in particular looking at the causes of the deaths, but also to report the avoidable factors which were related to the deaths. These are divided into patient-, administrative- and medical personnel-related factors (PPIP, 2013). We classified the avoidable factors in the same fashion in our study for NE cases.

There was one patient related factor identified in our study, namely, infrequent visits to the ANC. There may have been an under-recording of patient related factors by attending HCW, however the previous MMH study also found a low number of patient related avoidable factors compared to those of the medical personnel.

The administrative avoidable factors were mainly due to problems with transport and availability of theatre facilities. There was an ambulance delay in nearly 43% of the cases, which is in vast contrast to 9% found in the previous study. This may be due to an increase in service demands due to more patients in the system, more deliveries and perhaps more referrals in general because of higher disease burden due to, for example obesity which has increased substantially over the past decade. Furthermore, MMH's increase in workload may be evidenced by 25% of patients having delayed access to the OTs because they were occupied. MMH has two OTs, one is closed after hours, but can be opened for a dire emergency, but this involves getting another anaesthetic doctor from GSH, mobilising nursing staff from other areas in the hospital, and having sufficient obstetric doctors to man two OTs. It is somewhat worrisome that in 28.6% of patients needing a CS, the reason for the delay was not documented. This needs to be addressed and one would hope that the delay

is not due to long turnover times in OT nor the non-urgency of staff in LW preparing the patient for OT. This needs to be explored further.

A large number of patients had inadequate FHR monitoring at both the MOU and at MMH. At the MOU, all patients had FHR monitoring in the latent and active phase of labour, however the quality was poor. Monitoring in the latent phase was inadequate in 30% and in the active phase it was 62.5% of patients. The latter may be an indication of too few nursing staff on duty to ensure appropriate half-hourly monitoring of the FHR. At MMH it was found that 27% of patients had a pathological trace that the HCW did not recognise to be a problem. This in turn would delay appropriate management with IPR and expediting delivery. Further, 20.8% of patients had a delay in the attending doctor's initial assessment (> 60 min) upon arrival at MMH. In summary, there were 75% of instances where medical related avoidable factors played a role, this was higher than in the previous study with medical personnel contributing to 65% of the avoidable factors. What could be the reason for this increase? Perhaps with an increase in workload, as alluded to above, adequate monitoring and the correct management of patients becomes compromised. This also needs to be explored further.

6.11 NEONATAL CHARACTERISTICS AND OUTCOMES

There were 64.6% male neonates who had NE compared to 35.4% of female in our study. This is comparable to the CHBAH study but differs from the study conducted in the UK where their female to male ratio was about 50/50. In our present study the average birth weight was 3169g which is similar to the CHBAH (3084g) study. The UK study had an average birth weight of 3320g, slightly higher than the SA studies.

The average Apgar score at one, five, 10 minutes were three, six, seven respectively. There were 57.4% of neonates who had a score of less than seven at five min and 34.8% had an Apgar score of less than seven at 10 min, compared to the Bruckmann & Velaphi study, they had about 68% of neonates with a five min Apgar score of less than seven and about 30% had scores of less than seven at 10 min ((Bruckmann & Velaphi 2015: 300; Martinez-Biarge et al., 2013: e955).

The maximum NE scores were recorded in 38 patients in our study. The majority (76.3%) had a mild NE score, according to the Thompson NE scoring system. A moderate NE score

was found in 10.5% of neonates whereas 13.2% had a severe NE score. Although there was a tendency for higher NE scores to be associated with absence of sentinel events, this was not statistically significant due to small numbers.

We did not assess the neonatal management or outcomes in our study thus cannot comment on these. This was not within the scope of this study which concentrated on obstetric factors occurring in NE.

We looked at the number of deliveries there were during the shift hand over period i.e. 6:00-8:00 am and 6:00-8:00 pm as, anecdotally, this time seems to be the troublesome time. This is when continuity of care is interrupted with possible resultant poor monitoring of the patients in labour. It was found that 16.7% of deliveries occurred at this time, about 10% after night shift and about 6% after day shift. This is not a large proportion of deliveries, but would be interesting to follow up, with a consideration of introducing staggering of nursing staff shifts.

6.12 LIMITATIONS OF THE STUDY

There are several limitations of this research study. It is a descriptive and retrospective study with no control or comparison group, so the risk factors for NE could not be assessed. Further, the study population was small in number, limiting further statistical analyses of sub-categories of data. Since it involved a retrospective folder review, not all the required data was available. Details of cord blood gases were not routinely documented.
The purpose of this research was to audit the obstetric factors in NE, and details of neonatal follow-up, and outcomes were not included. This means that obstetric factors, such as sentinel events, could not be related to neonatal outcomes.

6.13 RECOMMENDATIONS

It is recommended that ongoing partogram and CTG training for both nursing and medical staff occurs at regular intervals. This will be of value as MMH has a rapid turnover of staff particularly in LW and OT.

In addition, on-going antenatal training is recommended, particularly more awareness of prolonged pregnancy and the necessary referral for induction of labour needs to be made timeously. Furthermore, since a large proportion (50%) of the patients were primigravid,

HCWs should be vigilant when managing them in the antenatal and intrapartum period.
Similarly, since obesity made up nearly 30% of the study population, antenatal education of patients should include promoting a healthy lifestyle by restricting excessive high caloric diets and staff should pay special attention to their management.
Liaison with Emergency Medical Services (EMS) to improve emergency transport is needed.
Policy changes promoting OMBUs rather than stand-alone primary care MOUs should be considered in future planning.
Since many patients were delayed in accessing theatre for emergency CS, it may be advantageous to explore how it would be possible to have both theatres available 24 hours a day.
The importance of detailed documentation is indispensable, not only in helping to identify modifiable factors but also if there are medico-legal sequelae around such cases.
Future research on risk factors with a case control design and exploration of the health system factors identified is indicated.

7. CONCLUSION

In this study we have shown that the NE rate for MMH is 5.5 per 1000 LBs, this is higher than the previous 2008 MMH study, despite a higher CS rate. This is likely to be partly due to an increase in the identification of mild NE as mentioned. Whether this in fact also reflects a deterioration of care, or is associated with a concomitant reduction in perinatal hypoxic mortality needs to be explored. The study design was unable to identify demographic risk factors but of note, all patients were booked for antenatal care and none had congenital infections such as syphilis. Prolonged pregnancy and hypertension were the most common antenatal complications. The majority of patients who had infants with NE were in spontaneous labour arriving timeously at the facility, and half of these were referred during labour from MOUs. Sentinel events for NE occurred in 31.3%; one third were antenatal and two thirds were intrapartum. Although 68.7% had no sentinel events, it was noted that abnormal CTGs occurred in 75.8% of this group, indicating the importance of intrapartum factors in this cohort of NE cases. In particular, prolonged second stage of labour and shoulder dystocia were identified as the most frequent intrapartum sentinel events, with abruptio placentae, eclampsia and cord prolapse being other less frequent events. Important avoidable factors identified included inadequate FHR monitoring at the MOUs, poor recognition of abnormal CTGs at MMH, inter-institution transport delay, and delay in accessing theatre for emergency CS. The obstetric management in our district may improve with regular and ongoing intrapartum care training for medical and nursing staff and addressing the health system issues identified.

REFERENCES

Adamson, S., Alessandri, L., Badawi, N., Burton, P, Pemberton, P. & Stanley, F. 1995. Predictors of neonatal encephalopathy in fullterm infants. *British Medical Journal.* 311(7005):598-602. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2550662/pdf/bmj00608-0024.pdf (2019, April 6).

Badawi, N., Kurinczuk, J., Keogh, J., Alessandri, L., O'Sullivan, F., Burton, P., Pemberton, P. & Stanley, F. 1998. Intrapartum risk factors for newborn encephalopathy: the Western Australian case-control study. *British Medical Journal.* 317: 1554-8. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC28733/ (2019, June 27).

Bhagwani, D., Sharma, M., Dolker, S. & Kothapalli, S. 2016. To study the correlation of Thompson scoring in predicting early neonatal outcome in post asphyxiated term neonates. *Journal of Clinical and Diagnostic Research.* 10(11): 16-19. DOI:10.7860/JCDR/2016/22896.8882

Bruckmann, E. & Velaphi, S. 2015. Intrapartum asphyxia and hypoxic ischaemic encephalopathy in a public hospital: Incidence and predictors of poor outcome. *South African Medical Journal.* 105(4):298-303. DOI:10.7196/SAMJ.9140

Bryce, J., Boschi-Pinto, C., Shibuya, K., Black, E. & the WHO Child Health Epidemiology reference group. 2005. WHO estimates of the cause of death in children. *The Lancet.* 2005(365):1147-52. DOI:10.1016/S0140-6736(05)71877-8

Coetzee, J. 2013. Perinatal problem identification programme. Version 3 (computer software). (2019, June 29).

Department of Health. 2015. Guidelines for maternity care in South Africa. Pretoria: Department of Health. Available: https://www.health.gov.za/index.php/2014-03-17-09-09-38/policies-and-guidelines/category/

(2019, May 7).

Department of Health, Western Cape Government. 2011. Protocols for clinical practice at level 1 maternity care facilities in the Metro West (PMNS). Cape Town: Department of Health.

Devane, D., Lalor, J, Daly, S., Mcguire, W., Cuthbert A. & Smith, V. 2017. Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing (Review). *Cochrane Database of Systemic Reviews.* 2017 (1). DOI:10.1002/14651858.CD005122.pub5.

Edwards, A., Brocklehurst, P., Gunn, A., Halliday, H., Juszczak, E., Levene, M., Strohm, B., Thoreson, M. et al. 2010. Neurological outcomes at 18 months of age after moderate hypothermia for perinatal hypoxic ischaemic encephalopathy: synthesis and meta-analysis of trial data. *British Medical Journal.* 340:c363. DOI:10.36/bmj.c363

Eunson, P. 2015. The long-term health, social and financial burden of hypoxic-ischaemic encephalopathy. *Developmental Medicine and Child Neurology.* 57(3):48-50.

DOI: 10.1111/dmcn.12727.

Gane, B., Bhat, V., Rao, R., Nanakumar, S., Adhisivam, B., Joy, R., Prasad, P. & Shruti, S. 2013. Antenatal and intrapartum risk factors factors for perinatal asphyxia: A case control study. *Curr Pediatr Res.* 17(2):119-122 Available:

https://pdfs.semanticscholar.org/72cb/dfd276347bd8f87337aaa6a64662b897893d.pdf (2018, February 28).

Horn, A., Swingler, G., Myer, L., Linley, L., Chandrasekaran, M. & Robertson, N. 2013. Early clinical predictors of a severely abnormal amplitude-integrated electroencephalogram at 48 hours in cooled neonates. *Acta Paediatrica.* 102: e378-e384. DOI:10.1111/apa.12306

Jagau, A., Maughan-Brown, R., Fawcus, S., Crede, S.,Woods, D & Lawn, J. 2017. Fetal heart rate monitoring: the challenge in under-resourced settings. *African Journal of Midwifery and Women's Health.* 11(3): 130-136.

Available: http://www.magonlinelibrary.com/loi/ajmw

(2019, April 26)

Johnson, S., Blair, E. & Stanley, F. 2011. Obstetric malpractice litigation and cerebral palsy in term infants. *Journal of Forensic and Legal Medicine.* 18: 97-100.

DOI:10.1016/j.jflm.2010.12.002

Kalume Kalangula, S. 2008. An investigation of obstetric risk factors for neonatal encephalopathy in the Peninsula Maternal and Neonatal Services, Cape Town. M.Med. Thesis. University of Cape Town.

Kanabus, A. Information about tuberculosis, GHE, 2018, www.tbfacts.org (2019, June 1)

Kurinczuk, J., White-Koning, M. & Badawi, N. 2010. Epidemiology of neonatal encephalopathy and hypoxic-ischaemic encephalopathy. *Early Human Development.* 86(2010):329-338. DOI:10.1016/earlhumdev.2010.05.010

Mahomed, K., Nyoni, R., Kasule, E. & Jacobus, E. 1994. Randomised controlled trial of intrapartum fetal heart rate monitoring. *British Medical Journal.* 308: 497-500. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2542781/pdf/bmj00428-0017.pdf (2019, April 26).

Martinez-Biarge, M., Madero, R., Gonzalez, A., Quero, J & Garcia-Alix, A. 2011. Perinatal morbidity and risk of hypoxic-ischaemic encephalopathy associated with intrapartum sentinel events. *American Journal of Obstetrics and Gynaecology.* 2011(206): 1.e1-1.e7. DOI:10.1016/j.ajog.2011.09.031

Martinez-Biarge, M., Diez-Sebastian, J., Wusthoff, C., Mercuri, E. & Cowan, F. 2013. Antepartum and intrapartum factors preceding neonatal hypoxic-ischaemic encephalopathy. *Pediatrics.* 132(4):e952-e959. DOI:10.1542/peds.2013-0511

Mowbray Maternity Hospital. 2016. Hypoxic Ischaemic Encephalopathy – Management guideline. Unpublished internal document.

National Institute for Health and Care Excellence, 2017. Available:

https://www.nice.org.uk/guidance/cg190/chapter/Recommendations#monitoring-during-labour

(2019, April 16).

National Institute for Health and Care Excellence, 2019.

Available: https://pathways.nice.org.uk

(2019, May 5).

Sarnat, H. & Sarnat M. 1976. Neonatal Encephalopathy Following Fetal Distress: A Clinical and Electroencephalographic Study. *Arch Neurol.* 33(10):696–705. doi:10.1001/archneur.1976.00500100030012

Shankaran, S., Laptook, A., Ehrenkranz, R., Tyson, J., McDonald, S., Donovan, E., Fanaroff, A., Poole, W. et al. 2005. Whole-body hypothermia for neonates with hypoxic-ischaemic encephalopathy. *N Engl J Med.* 335: 1574-1584.

Available: https://www.nejm.org/doi/10.1056/NEJMcps050929

(2019, January 12).

Smith, V., Begley, C., Newell, J., Higgins, S., Murphy, D, White, M., Morrison, J., Canny, S. et al. 2018. Admission cardiotocography versus intermittent auscultation of the fetal heart in low-risk pregnancy during evaluation for possible labour admission – a multicentre randomised trial: the ADCAR trial. *BJOG.* 126: 114-121. DOI:10.1111/1471-0528.15448

Thompson, C., Puterman, A., Linley, L., Hann, F., van der Elst, C., Molteno, C & Malan, A. 1997. The value of a scoring system for hypoxic ischaemic encephalopathy in predicting neurodevelopmental outcome. *Acta Paediatrica.* 86: 757-61. Available:

https://onlinelibrary-wiley-com.ezproxy.uct.ac.za/doi/epdf/10.1111/j.1651-2227.1997.tb08581.x (2019, April 16).

Weeke, L., Vilan, A., Toet, M., van Haastert, I., de Vries, L. & Groenendaal, F. 2017. A comparison of the Thompson encephalopathy score and amplitude-integrated electroencephalography in infants with perinatal asphyxia and therapeutic hypothermia. *Neonatology.* 112(1):24-29. Available: https://www.karger.com/Article/FullText/455819

(2019, May 2).

APPENDICES

1.UNIVERSITY OF CAPE TOWN RESEARCH ETHICS APPROVAL LETTER

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6626
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

20 February 2018

HREC REF: 122/2018

Prof S Fawcus
Obstetrics & Gynaecology
H-floor, OMB

Dear Prof Fawcus

PROJECT TITLE: A DESCRIPTIVE RETROSPECTIVE AUDIT WHICH EXAMINES THE OBSTETRIC CONDITIONS AND AVOIDABLE FACTORS OCCURRING IN MOTHERS WHO DELIVERED NEONATES DIAGNOSED WITH NEONATAL ENCEPHALOPATHY, AT MOWBRAY MATERNITY HOSPITAL IN 2016 (MASTERS CANDIDATE - DR L DIETRICH)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 28 February 2019.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

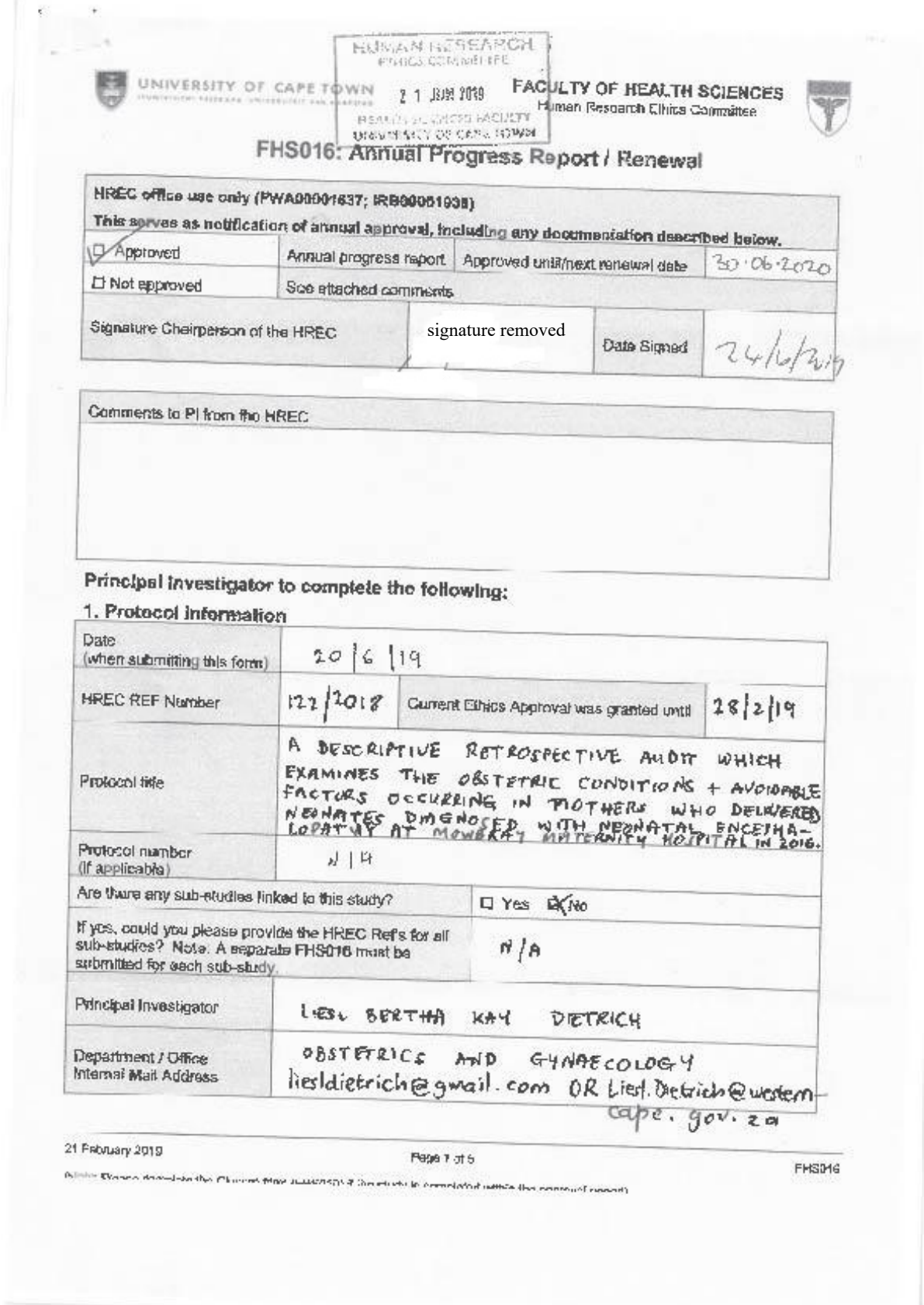
The HREC acknowledges that the student, Dr Liesl Dietrich will also be involved in this study.

Yours sincerely

Signature removed to avoid exposure online

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.

2. UNIVERSITY OF CAPE TOWN RESEARCH ETHICS APPROVAL LETTER - RENEWAL



HUMAN RESEARCH ETHICS COMMITTEE
21 JUN 2019
RESEARCH OFFICE FACULTY OF HEALTH SCIENCES UNIVERSITY OF CAPE TOWN

UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (PWA00001637; IRB00001938) This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30.06.2020
☐ Not approved	See attached comments		
Signature Chairperson of the HREC	signature removed	Date Signed	24/6/2019

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	20/6/19		
HREC REF Number	122/2018	Current Ethics Approval was granted until	28/2/19
Protocol title	A DESCRIPTIVE RETROSPECTIVE AUDIT WHICH EXAMINES THE OBSTETRIC CONDITIONS + AVOIDABLE FACTORS OCCURRING IN MOTHERS WHO DELIVERED NEONATES DIAGNOSED WITH NEONATAL ENCEPHALOPATHY AT MOWBRAY MATERNITY HOSPITAL IN 2016.		
Protocol number (if applicable)	N/A		
Are there any sub-studies linked to this study?	☐ Yes ☒ No		
If yes, could you please provide the HREC Ref's for all sub-studies? Note. A separate FHS016 must be submitted for each sub-study.	N/A		
Principal Investigator	Lies. BERTHA KAY DIETRICH		
Department / Office Internal Mail Address	OBSTETRICS AND GYNAECOLOGY liesldietrich@gmail.com OR Lies.Dietrich@westerncape.gov.za		

3. **PPIP** (Perinatal problem identification programme) **AVOIDABLE FACTORS**

Avoidable factors Code list version: Please note that PPIP does not allow you to enter a group heading. You must select an individual item which 3.00 describes the avoidable or modifiable factor.

Code Description

0100 PATIENT ASSOCIATED

0101 Never initiated antenatal care

0102 Booked late in pregnancy

0103 Infrequent visits to antenatal clinic

0104 Failed to return on the prescribed date

0105 Inappropriate response to rupture of membranes

0106 Inappropriate response to antepartum haemorrhage

0107 Inappropriate response to poor fetal movements

0108 Delay in seeking medical attention during labour

0109 Delay in seeking help when baby ill

0110 Declines admission/treatment for personal/social reasons

0111 Partner/Family declines admission/treatment

0112 Alcohol abuse

0113 Smoking

0114 Illegal drug use

0115 Assault

0116 Attempted termination of pregnancy

0117 Infanticide

0118 Abandoned baby

0199 Other patient associated factors

0200 ADMINISTRATIVE PROBLEMS

0201 Lack of transport - Home to institution

0202 Lack of transport - Institution to institution

0203 Lack of adequate neonatal transport

0204 No syphilis screening performed at hospital / clinic

0205 Result of syphilis screening not returned to hospital/clinic

Printed by PPIP3.0 on 1 24/09/2013 Page

Avoidable factors Code list version: Please note that PPIP does not allow you to enter a group heading. You must select an individual item which 3.00 describes the avoidable or modifiable factor.

Code Description

0206 No on-site syphilis testing available

0207 No Motherhood card issued

0208 No dedicated high risk clinic at referral hospital

0209 Inadequate facilities/equipment in neonatal unit/nursery

0210 Inadequate theatre facilities

0211 No accessible neonatal ICU bed with ventilator

0212 Inadequate resuscitation equipment

0213 Insufficient blood / blood products available

0214 Insufficient nurses on duty to manage the patient adequately

0215 Insufficient doctors available to manage the patient

0216 Personnel not sufficiently trained to manage the patient

0217 Personnel too junior to manage the patient

0218 Staff rotation too rapid

0219 Anaesthetic delay

0220 Theatre delay: staff not available

0221 Theatre delay: all theatres occupied

0222 Congenital abnormality not diagnosed: No ultrasound service available

0299 Other administrative problems

0300 MEDICAL PERSONNEL ASSOCIATED

0301 No response to history of stillbirths, abruptio etc.

0302 No response to maternal glycosuria

0303 No response to poor uterine fundal growth

0304 No response to maternal hypertension

0305 No response to positive syphilis serology test

0306 No response to apparent postterm pregnancy

Avoidable factors Code list version: Please note that PPIP does not allow you to enter a group heading. You must select an individual item which 3.00 describes the avoidable or modifiable factor.

Code Description

0307 No response to history of poor fetal movement

0308 No antenatal response to abnormal fetal lie

0309 Multiple pregnancy not diagnosed antenatally

0310 Physical examination of patient at clinic incomplete

0311 GP did not give card/letter about antenatal care

0312 Medical personnel overestimated fetal size

0313 Medical personnel underestimated fetal size

0314 Fetal distress not detected antepartum; fetus monitored

0315 Fetal distress not detected antepartum; fetus not monitored

0316 Antenatal steroids not given

0317 Poor progress in labour, but partogram not used

0318 Poor progress in labour, but partogram not used correctly

0319 Poor progress in labour - partogram interpreted incorrectly

0320 Fetal distress not detected intrapartum; fetus monitored

0321 Fetal distress not detected intrapartum; fetus not monitored

0322 Breech presentation not diagnosed until late in labour

0323 Multiple pregnancy not diagnosed intrapartum

0324 Incorrect management of hypertensive disease

0325 Incorrect management of antepartum haemorrhage

0326 Incorrect management of premature labour

0327 Incorrect management of cord prolapse

0328 Iatrogenic delivery for no real reason

0329 Management of 2nd stage: prolonged with no intervention

0330 Management of 2nd stage: inappropriate use of forceps

0331 Management of 2nd stage: inappropriate use of vacuum

0332 Neonatal resuscitation inadequate

Printed by PPIP3.0 on 3 24/09/2013 Page

Avoidable factors Code list version: Please note that PPIP does not allow you to enter a group heading. You must select an individual item which 3.00 describes the avoidable or modifiable factor.

Code Description

0333 Neonatal care: inadequate monitoring

0334 Neonatal care: management plan inadequate

0335 Baby managed incorrectly at Hospital/Clinic

0336 Baby sent home inappropriately

0337 Delay in doctor responding to call

0338 Doctor did not respond to call

0339 Delay in medical personnel calling for expert assistance

0340 Delay in referring patient for secondary/tertiary treatment

0341 Nosocomial infection

0342 Inadequate / No advice given to mother

0343 Congenital abnormality not diagnosed; U/S examination not performed

0344 Congenital abnormality not diagnosed; U/S examination was performed

0399 Other medical personnel associated factors

0400 INSUFFICIENT NOTES TO COMMENT ON AVOIDABLE FACTORS

0401 Insufficient notes

0402 File missing

0403 Antenatal card lost

4. HPIP MATERNAL CASE REVIEW

Criteria to be met for completion

A gestational age of ≥ 36 weeks (or ≥1.8kg if unsure gestation)

Encephalopathy meeting cooling criteria* with or without aEEG assessment

* <6 hours after birth: and absence of: severe congenital anomaly, uncontrolled bleeding, uncontrolled systemic hypotension, and pulmonary hypotension not responding to treatment

Suspected intra-partum hypoxia based on: 1st hour pH < 7.0 or BD ≥ 12 mmol/l; or 5-min Apgar < 7 or assisted ventilation at 10 min

Data to be entered after discussion at a multi-discipline morbidity review meeting that includes at least an obstetrician/MO with extensive obstetric experience/Family Physician specialist; a midwife and a paediatrician/ MO with extensive paediatric experience/Family Physician specialist

Form completed by:

Date Completed (Date):

Mother's Name and Surname: (assume already recorded as per ECCR)

Mother's Folder Number: (ditto)

Mother's Date of Birth: (ditto)

Baby's Folder Number: Able to be located via Clinicom

Date and time of admission to first intrapartum care facility: (Date; Time) (completed by form filler and NOT populated from Clinicom)

Delivery Date and Time (Date; Time) as above

Place of Delivery (At this facility/at home/in transit/another facility/unknown) as above

Pregnancy

Pregnancy History (Include this birth)(Gravity and Parity)

Previous Caesarean Section?(Yes/No)

Antenatal risk factors (tick all that may apply):

- ❑ Unbooked
- ❑ Gestational hypertension
- ❑ Diabetes mellitus/Impaired glucose tolerance
- ❑ Diabetes mellitus
- ❑ Small for gestational age

- ❑ Untreated/Incompletely treated syphilis at the time of delivery
- ❑ Smoker
- ❑ Substance abuse (including alcohol)
- ❑ Abdominal trauma during antenatal period requiring admission to hospital
- ❑ Antepartum haemorrhage
- ❑ Body Mass Index >35kg/m^2
- ❑ Multiple pregnancy
- ❑ Any anomalies on ultrasound (would need a section of free text to describe this)
- ❑ Other maternal disease (describe in free text section)
- ❑ Postdates (> 42 weeks with certain gestation)
- ❑ Other (describe in free text section)

Gestation at time of delivery (weeks)

Gestation assessed by:

- ❑ Dates
- ❑ SF Height
- ❑ Ultrasound before 24 weeks
- ❑ Ballard Score/Foot Length

Any risk factors for or features of clinical chorioamnionitis (tick all that apply):

- ❑ None
- ❑ Maternal Pyrexia >38 degrees during labour
- ❑ Maternal Tachycardia ≥120 bpm
- ❑ Fetal Tachycardia >160 bpm during labour
- ❑ Offensive liquor
- ❑ Uterine irritability/tenderness
- ❑ Membrane rupture at time of delivery >18 hours

REFERRING FACILITY:

BANC+ CLINIC/MOU/DISTRICT HOSPITAL/REGIONAL HOSPITAL

Any intrapartum care received at referring facility? (Yes/No)

Which institution?

Was there evidence of Fetal Distress on presentation to the facility?

(Yes/No/Insufficient Information)

Partogram correctly completed during labour?

(Yes/No*/Insufficient Information*)

[*will need to add to avoidable factors]

Evidence of Fetal Heart Monitoring (fetoscope/Doptone/CTG)?

(Yes/No*/Insufficient Information*)

[*will need to add to avoidable factors]

Abnormal fetal heart rate recorded?

(Yes/No/Insufficient Information)

Fetal Distress Possibility? (Abnormal Heart rate, MSL)

(Yes/No/Insufficient Information)

Recorded reason for referral

(reason)

Was the referral timeous (as judged by the M&M meeting?)

(Yes/No*/Insufficient Information*)

[*will need to add to avoidable factors at end of form]

Transport

Emergency Medical Transport to Hospital prior to delivery?(Yes/No)

Call to Metro date and time (date; time)

Dispatch date and time (date; time)

Labour Ward arrival date and time (date; time)

Birth Institution

Name: (Free text or drop down with option for Other with free text. List NSH/MMH/TBH/KDH/GSH/KBH/MPDH/Other)

First Nurse Assessment time (date; time)

First Doctor Assessment time (date; time)

Labour

Ever in Labour? (Yes/No)

If yes, Labour Initiation (Spontaneous/Induced)

If induced, methods used (leave blank if not induced)

- ❑ AROM
- ❑ Prostaglandin E1 (Misoprostol)
- ❑ Oxytocin
- ❑ Intra-cervical bulb-catheter
- ❑ Prostaglandin E2

1st Stage Duration (in hours) (leave blank if not known)

2nd Stage Duration (in hours and minutes) (leave blank if not known)

Augmentation with oxytocin ever used?

If oxytocin used for augmentation, was the use appropriate? (Yes/No*)

[*will need to add to avoidable factors]

Sentinel events during labour or delivery: (tick if appropriate)

- ❑ Cord prolapse
- ❑ Significant antepartum haemorrhage
- ❑ Eclamptic convulsion
- ❑ Clinical abruptio placentae

❑ Shoulder impaction

❑ Prolonged second stage

Meconium Stained Liquor ever? (Yes/No/Insufficient Information)

Intrauterine resuscitation ever indicated? (Yes/No/Insufficient Information)

Intrauterine resuscitation used? (Yes/No/Insufficient Information)

Intrauterine resuscitation methods employed? (tick for yes, leave blank if not applicable)

❑ Tocolysis if applicable (if yes specify salbutamol/nifedipine)

❑ Augmentation stopped

❑ Mother's position changed

❑ Fluid bolus 200ml given

Was there a documented response to the intra-partum resuscitation? (Yes/No/Insufficient Information)

Fetal Monitoring during labour

Fetal heart rate recorded at birthing institution? (Yes/No)

Frequency of FH monitoring (according to level of care of patient):

2 hourly in latent labour (low risk patient) or hourly (high risk) – n/a; not documented / partially done, always done

Half hourly in active labour (low risk) or every 15 minutes (high risk- preferably continuous CTG) – n/a; not documented/ partially done, always done

CTG used ever? (Yes/No)- branching algorithm

First CTG time (Leave blank if not performed/not documented)

Documented Evidence of intrapartum CTG review? (Yes/No/Insufficient Information)

Last performed CTG classification? (Normal/Non-reassuring/Abnormal)

On formal review, was there ever an error interpreting the CTG?

Describe (free text section needed)

On formal review, was the combination of clinical context and CTG interpretation acted on appropriately? (Yes/No/Insufficient Information)

Other—specify

Staffing

Most senior nurse caring for patient or documented as consulted during Labour

(Midwife/Registered Nurse/Enrolled Nurse/Agency Nurse/Nursing student/None/Never in Labour)

Most senior nurse present at Vaginal Birth

(Midwife/Registered Nurse/Enrolled Nurse/Agency Nurse/Nursing student/not a Vaginal Birth)

Most Senior obstetric doctor managing or consulted about intrapartum care? (Obstetrician/Family Medicine Specialist/Registrar/Medical Officer/Intern/No doctor involved intrapartum care)

Most Senior obstetric doctor present at Vaginal Birth? (Obstetrician/Family Medicine Specialist/Registrar/Medical Officer/Intern/No doctor present/not a Vaginal Birth)

Specialist Obstetrician consulted at any point in labour? (Yes/No)

Delivery

Any attempt made to perform an Assisted Vaginal Delivery using either Vacuum Extraction or Forceps? [Algorithm branch]

<u>Assisted Vaginal Delivery</u>

Attempted? (Yes/No)

Indication (Prolonged 2nd stage/ Maternal Exhaustion/Fetal Distress/Other)

Method (Vacuum/Forceps)

Were the necessary pre-requisites for instrumental delivery met and noted?

On review, indication for instrumental delivery correct? (Yes/No)

Adequate documentation describing procedure? (Yes/No)

Successful? (Yes/No)

Protocol adhered to? (Yes/No)

Mode of Delivery (Vaginal Vertex/Vaginal Breech/Elective Caesarean Section/Emergency Caesarean Section in labour/Emergency Caesarean Section not in labour/Assisted delivery (Forceps/Vacuum Extraction)) Branching algorithm

Caesarean Section

Decision time documented? (Yes/No)

Decision time (Date; time)

Decision time to delivery?

If Decision time to delivery time >60 minutes, what were the reasons (No reason given/Labour ward theatre occupied/All possible theatres occupied/Difficult surgery/Delay in preparing patient for theatre/Anaesthetic delay/Not known)

Indication for Caesarean Section? (Previous Caesarean Section/Abnormal placentation/Fetal Distress/Cephalopelvic disproportion/Maternal Choice/Malpresentation/Failed induction of labour/Failed attempt at Assisted Vaginal Delivery/Multiple pregnancy/Other_____)

Summary of Review

A. Likely cause of HIE (please circle more than one if the case) (multiple choices allowed)
--vulnerable fetus (eg IUGR, prolonged pregnancy)
-prolonged labour with evidence of fetal compromise
-prolonged second stage with evidence of fetal compromise
-cord accident
-abruptio placentae
-ruptured uterus
-eclamptic convulsion
-maternal collapse/severe maternal disease
-hyperstimulation syndrome on CTG without evidence of fetal recovery
-not related to intra-partum events

B. Modifiable Factors
(Please reference Avoidable Factors in PPIP Code list Version 3.0)
[To have option of adding multiple with drop down list in electronic form]

[Amended PPIP code list attached for these factors with additional codes addressing delays added using new codes 342-345)

Additional PPIP codes (under heading **300 Medical Personnel**) (multiple choices allowed)
342 Delay in patient being assessed on arrival at birthing institution
343 Abnormal CTG record not reviewed timeously
344 Incorrect CTG interpretation
345 Delay in definitive action/Caesarean Section once abnormality detected
346 No delays with everything performed timeously