AUDIT OF NEONATAL TRANSFERS TO A TERTIARY CENTRE IN THE TSHWANE METROPOLITAN AREA.

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Abstract

Aim: This is an audit to determine the referral diagnosis, any resuscitation or interventional measures taken, the condition on arrival and the outcome of neonates transferred from Mamelodi Hospital to Pretoria Academic and Kalafong hospitals.

Methods: Data was collected of all neonates transferred from Mamelodi hospital to the neonatal intensive care units (NICU) at Pretoria Academic and Kalafong hospitals between September 2003 and October 2004. The data was analysed for referral criteria, pre-transport resuscitation, condition on arrival and outcomes.

Results: There were 42 neonates enrolled in the study. The most common reason for referral was prematurity (71.4%). Forty six percent of the full term baby referrals were for birth asphyxia. Hypothermia was found in 79% of all patients on arrival at the tertiary care NICU. There were no intravenous lines in 52% of patients, while 23% had hypoglycaemia on arrival at the receiving hospital. The mortality rate was 26.1% with five of 12 full term neonates and six of 30 preterm neonates dying.

Conclusion: The study highlights the need for adequate pre-transport stabilization of neonates, which include interventions to avoid hypothermia and insertion of intravenous line with 10% Dextrose solution to prevent hypoglycaemia. There is a need to train health care staff to effectively resuscitate neonates to prevent or minimise birth asphyxia. Mothers in pre-term labour should be referred early to centres that can manage premature babies. This data will be used to develop transport protocols for transfers of high-risk neonates.

Opsomming

Doel: Dit is ‘n oudit om die verwysing diagnose, ressussitasie voor vervoer, kliniese toestand met aankoms en die uitkoms van verwysde neonate van Mamelodi hospitaal na Pretoria Akademiese – en Kalafong hospitale te bepaal.
Metodes: Data is gekollekteer en geanaliseer vir alle neonate, wat verwys is van Mamelodi hospitaal na die neonatale-intensiewe-sorg-eenhede te Pretoria Akademiese – en Kalafong hospitale tussent September 2003 en Oktober 2004.
Resultate: Daar is 42 neonate ingesluit in die studie. Die mees algemene rede vir verwysing was prematuriteit (71.4%). Voltermynbabas is hoofsaaklik verwys vir geboorte-asfiksie (46%). Hipotermie was gevind in 79% van al die pasiënte met aankoms in die tersiêre neonatale-intensiewe-sorg-eenhede. Daar was geen intraveneuse infuse geplaas in 52% van neonate, terwyl 23% hipoglukemies was met aankoms in die ontvangershospitaal. Die mortaliteit was 26.1% met dood as uitkoms in 5 van 12 voltermynbabas en ses uit 30 prematuurbabas.
Gevolgtrekking: Die studie belig die belang van stabilisasie van neonate voor vervoer, wat insluit ingrepe wat hipotermie sal voorkom, asook die plaas van intraveneuse lyne met 10% dekstrose water om hipoglukemie te voorkom. Daar is ‘n behoefte aan opleiding van gesondheidsorgpersoneel aangaande effektiewe ressusitasie van die neonaat om geboorteasfiksie te beperk. Moeders in vroegtydige kraam moet verwys word na sentra wat prematuurbabs kan hanteer. Die data sal gebruik word om vervoerprotokolle vir die oorplasing van hoë risiko babas te ontwikkel.

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Introduction

Mamelodi Day Hospital is a primary health care hospital, which serves a growing peri-urban population with a community characterised by high levels of poverty and poor access to health care. This township is situated 40 kilometres from the centre of Pretoria. In the census done by Statistics South Africa in 1987 the population was estimated at 250,000 [1]. There have been an increasing number of informal settlements in the area and the population density was estimated at 5254 people per square km in the census of 2001.

There are no neonatal intensive care facilities in Mamelodi Day Hospital. The primary referral unit is Pretoria Academic Hospital (PAH) with a tertiary neonatal intensive care unit (NICU) approximately 40 kilometres away. The bed occupancy of this unit is 125% for most of the year[2]. Neonates are also transferred to Kalafong hospital, a large regional hospital with a neonatal intensive care unit (NICU), which has a bed occupancy of more than 90% at any given time [3]. There are a limited number of NICU beds in both units with 4 beds in PAH and 6 beds in Kalafong hospital. In this resource limited setting, the use of tertiary care facility beds should be appropriate to ensure that all babies with a good chance of survival have access to these beds. This necessitates clear referral criteria and the condition of neonates should be optimised to improve outcome and reduce hospital stay.

Antenatal transport is still the ideal modality of transportation for high-risk fetuses, this necessitates early recognition of pregnancy-related complications, as well as early referral to reduce mortality [4]. This again depends on good antenatal clinic attendance and early recognition of problems by health care personnel. This can be accomplished in first world countries, while data from third world countries is not as encouraging. In first world countries the average number of antenatal clinic visits per woman is ten to twelve per pregnancy [5]. In developing countries antenatal clinic attendance levels are comparatively lower with an average of two to three visits per woman per pregnancy. The non-attendance at antenatal clinics has been found to be related to cultural factors as well as to high levels of poverty, but the relative contributions of these have not been studied as yet [6]. In South Africa pregnant women have had access to free health care since May 1994, but attendance levels do not yet match those of first world countries. The perinatal mortality rate in South Africa is currently 36.2 per 1000 with the highest incidence of low birth weight infants being in metropolitan areas with 19.6% [7].

Previous studies report that premature neonates of less than 1500 grams delivered in tertiary hospitals have a better outcome compared to those born in other health care facilities[8,9]. The use of surfactant and antenatal steroids has improved the survival of premature babies, who otherwise would have had a poor prognosis[10]. These premature neonates are, however, at a 15% higher risk of dying if born in a hospital without intensive care facilities[9]. This is related to transport complications suffered by very low birth weight infants, which includes intra-ventricular haemorrhages, as well as problems with temperature control. Identification of risks for preterm labour and education of expectant mothers on signs of labour are therefore crucial to allow early referral to appropriate facilities.

The transportation of these high-risk neonates poses special challenges. The resuscitation and stabilization of a newborn requires special training, as well as vigilance for the development of complications. Hadley *et al* identified the problems with transportation of neonates, which were related to poor resuscitation and stabilization, including the failure to perform essential and non high-technological interventions such as the insertion of intravenous lines, adequate warming and prevention of hypoglycaemia[11]. These are the factors that have prompted the worldwide trend to developing dedicated retrieval teams for high-risk neonates, which has improved the morbidity and mortality of these neonates[12,13]. These transport teams comprise staff from tertiary neonatal units who are adequately trained to manage the stabilization and transportation of these infants. Unfortunately these resources are unavailable in developing countries and there are currently no dedicated transport teams available in the public sector in South Africa. This places local high-risk neonates at a disadvantage compared to their first world counterparts. More emphasis should therefore be placed on the adequate resuscitation and stabilization of infants prior to referral in order to optimise their condition and avoid preventable complications.

This audit was therefore done to determine the status of the current neonatal referral system in our local context. The primary aim of the study was to determine: -

1) Initial diagnosis
2) Resuscitation and interventions prior to transportation
3) Condition of arrival
4) Outcome of the neonate defined as discharged alive or death.

The secondary aim was to develop a pre-transport management protocol for the referral centre, to guide health care personnel in the stabilization and initial resuscitation of high-risk neonates. This would be done with the view to improve the outcomes of neonates and to avoid pre-transport related preventable complications.

Patients and Methods

The study was done as a prospective descriptive study, including all neonates transferred to the NICU at Pretoria Academic Hospital or Kalafong Hospital from Mamelodi Day Hospital. The study period was from September 2003 till October 2004.

The study data was entered on a data sheet designed for the study and the following was recorded:

- maternal data (including attendance or non attendance of antenatal clinic)
- the pre-transport diagnosis
- the resuscitation and interventions at the Mamelodi Day Hospital
- the condition on arrival at the referral centre
- the final diagnosis in the NICU
- the outcomes of the patients were noted and the end-point was either discharge or death (Addendum A).

The outcome data was collected from the hospital files of the patients as well as cross-referenced with the neonatal data capturing system of the NICU. The Ballard score was used to determine gestation, because antenatal clinic attendance levels were low and most women had not had antenatal fetal scanning and were unsure of their dates ruling out their use to determine gestational age.

All patients in the study were transported by a private ambulance service. The ambulance personnel decided on the level of skill of the personnel accompanying the patient. Depending on availability of qualified personnel, either a paramedic with Advanced Life Support or Basic Life Support skills or a NICU trained sister where the patient was intubated, accompanied the patient.

Pretoria Academic Hospital is approximately 40km away from Mamelodi, with a transit time between the hospitals being on average 20-25 minutes, depending on time of the day and traffic volumes. The average time between the call to the ambulance service and arrival at the Mamelodi hospital was between 50 and 80 minutes. The average transit time between the referring hospital and Kalafong Hospital is approximately 40-60 minutes. All patients requiring specialist obstetric (including caesarean sections) or neonatal care are referred to the two mentioned hospitals (PAH and Kalafong). A protocol on neonatal resuscitation was compiled to include the necessary interventions that need to be done in neonatal resuscitation (Appendix E).

The Research Ethics Committee of the University of Pretoria gave ethical approval for the study (Study number S145/2003). The researcher elicited the consent to conduct the study from the Chief Executive Officers at all three hospitals, where the research was conducted, as well as for access to the hospital records.

Results

There were fifty-three patients transferred from Mamelodi Hospital to the two tertiary NICUs at Kalafong and PAH during the study period. In total eleven patients were excluded from analysis due to insufficient data. The analysis was done on the data collected from the remaining forty-two patients. Consent was signed by twenty-two parents and was unobtainable in the rest. Consent for the use of the patient data, of those without parental consent (PAH), was obtained from the Chief Executive Officer at Pretoria Academic Hospital.

Gestational age and antenatal clinic attendance.

There were three twin pairs (six) and the rest (thirty six) were singletons. All infants were born by vaginal delivery. The majority were males 71.4%, with 28.6% females. The major reason for referrals was prematurity in 71% of infants. There were thirty preterm babies referred during the study period, defined as a gestation period of less than 37 completed weeks. Twelve of the referrals were full term deliveries, since the gestation period was more than 37 completed weeks of pregnancy. The Ballard score was used to determine gestational age.

Twelve of the mothers attended antenatal clinics (see table 1). In seven mother-child pairs (17.9%), the information of antenatal clinic attendance was unrecorded. There were twenty mothers who did not attend antenatal clinic at all. The mean number of antenatal clinic visits was 3.6 per mother of those who attended.

Table: 1 Antenatal clinic attendance

	Antenatal clinic attended	No clinic attended	No information	Total
Number	12	20	7	39
Percentage	37.5%	62.5%	17.9%	

Birth weight

The hospital protocol for Mamelodi hospital is to refer all neonates less than 1.7 kg. The weight range of these neonates was from 560 to 3580 grams (see table 2). Four infants were referred with birth weights of less than 1000g and only one of these survived. There were eight patients born with a birth weight of between 1000 and 1249 grams, all of whom survived. Two patients in this weight group had a delay in referral from the time the NICU was called to the time of arrival in the unit. There were eleven patients in the weight range of 1250 to 1499, and of these two died. All eight neonates in the range 1499 to 1990g survived. There was only one infant in the weight range 2000 to 2490g. This infant died due to pulmonary hypoplasia and also had features suggestive of Prune Belly syndrome. One other infant with non-specific dysmorphic features died in the weight range of between 2500 and 2990g. Eight neonates were above

3000g, and half of these died from hypoxia related complications after suffering severe birth asphyxia.

Table 2: Weight ranges for referrals

Weight	Total	Delayed referral	Alive	Died
<1kg	4		1	3
1- 1.249kg	8	1	8	0
1.25 -1.499kg	11	2	9	2
1.5 – 1.99kg	8		8	0
2.0- 2.49 kg	1		0	1
2.5- 2.99kg	2		1	1
>3kg	8		4	4
Total	**42**		**31 (73.8%)**	**11(26.2%)**

*Percentages of the total number of patients in brackets.

Referral diagnoses in premature babies

The most common referral diagnosis made by health care workers at Mamelodi Hospital in premature infants was respiratory distress in 41% (see table 3). Three of these were very low birth weight infants (less than 1 kilogram), who at the NICU were found to have severe hyaline membrane disease and subsequently died. Prematurity, as referral diagnosis, was the second most common referral diagnosis in 36.6% of cases. Three patients referred with the diagnosis of prematurity, no patients died after a delay in referral. Ideally these patients should have been referred immediately post delivery (as per referral protocol). The reason for not referring these

neonates earlier was unclear. All these neonates had been admitted to the ward at Mamelodi Hospital for a period of more than 24 hours, with one patient referred on day 2 another on day 9 and the last patient on day 14.

Four patients were referred with a diagnosis of aspiration pneumonia. Three of these four patients were referred after a few days' admission to Mamelodi hospital. Two of these patients were less than 1.5kg and should have been referred earlier as per Mamelodi's hospital protocol. In one patient reflux with aspiration was confirmed with a barium swallow, but in the other three patients, the history indicated respiratory distress immediately after a feed. Four infants were referred for apnoeic attacks. Of these one patient was subsequently diagnosed at the NICU as having hyaline membrane disease, one suffered a respiratory synctitial virus pneumonia, one had a congenital pneumonia secondary to prolonged rupture of membranes and the last one had reflux with aspiration pneumonia. Two patients were referred without a preliminary referral diagnosis.

Table 3: Referral diagnosis in premature neonates: **table includes all the referral diagnoses some patients referred with more than one diagnosis.**

Diagnosis	Number	Number with delayed referral	Outcome: Alive	Outcome: Died
Respiratory distress	13 (43.3%)		10	3
Prematurity	11 (36.6%)	3	8	3
Aspiration pneumonia	4 (13.3%)	3	1	0
Apnoeic attacks	4 (13.3%)		4	0
No diagnosis	2 (6.6%)		2	2
Congenital abnormality	1 (3.2%)		0	1

*percentages of total number of preterm neonates referred in parentheses.

Referral diagnoses in term babies

In term neonates the most common referral diagnosis was birth asphyxia, with half of the patients affected (50%) (See table 4). There were four deaths attributed to asphyxia-related complications. All of these neonates had convulsions; one patient had such severe convulsions that a thiopentone infusion was required. Two of the patients with birth asphyxia also had acute renal failure, secondary to the severe asphyxia.

The next most common referral diagnosis for term neonates was respiratory distress. There was no reason given for the cause of distress (33.3%) and all of these patients survived. All these patients were discharged from the NICU with the diagnosis of respiratory distress, having been treated for a possible congenital pneumonia. The incidence of meconium aspiration was the same as respiratory distress (33.3%). These patients did poorly, with half of them dying from hypoxia related complications with associated hypoxic ischaemic encephalopathy. One infant was referred with non-specific dysmorphic features and hydrocephalus without a clear syndromic pattern; this infant also had a multilobar pneumonia.

Table 4: Referral diagnosis for term neonates: includes all referral diagnoses with some patients having more than one diagnosis

Diagnosis	Number	Outcome: Alive	Outcome: Died
Birth asphyxia	6 (50%)	2	4
Respiratory distress	4 (33.3%)	4	0
Meconium aspiration	4 (33.3%)	2	2
Congenital abnormality	1 (8%)	0	1

*Percentages of total number of term neonates referred in parentheses.

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Pre-transport stabilisation complications.

The pre-transport stabilisation of patients was less than ideal. The most common complication on arrival in the intensive care unit was hypothermia (33, 79%) (see table 5). Hypothermia was defined as an axillary temperature of 36.4 degrees Celsius or less; with those with a temperature of between 36 and 36.4 regarded as mild, 35.0 to 35.9 as moderate and those with temperatures of less than 35 degrees Celsius as severe hypothermia. Twenty-five (59.5%) patients had mild to moderate hypothermia. Eight of forty-two infants (19.5%) had severe hypothermia. Of the thirty-three patients that were hypothermic the majority (25, 76%) were preterm infants. Three of the babies with severe hypothermia were very low birth weight premature neonates with birth weights ranging from 1.04 to 1.49kg, who were born before arrival at Mamelodi hospital. None of the infants had their temperature monitored prior to transfer including all the premature infants. In total there were seven (16.7%) neonates who were born before arrival to Mamelodi of which five were premature infants born before arrival with significant hyaline membrane disease of a grade two or more and all five survived.

In twenty-two patients (52 %) in the study no intravenous lines were inserted at the time of arrival to the referral centre. Of these seventeen patients were premature infants and five term infants. In two cases there had been failed attempts of inserting a peripheral line and there were no attempts made at insertion of umbilical lines in any of the infants. Eleven patients were hypoglycaemic on arrival to the NICU, of these four patients (36%) had no intravenous lines in situ. One child arrived with an umbilical catheter in-situ with a septic umbilical stump, where the catheter had been inserted four days prior to transfer. None of these patients had their glucose levels monitored prior to referral. There were nine patients that were hyperglycaemic on arrival to the NICU and eight of these hyperglycaemic infants were premature and only one full term infant; this was possibly stress related.

In total fourteen patients were referred without oxygen and of these the majority were preterm infants in twelve of the cases. Two patients were hypoxic on arrival and had received no oxygen. Both these patients were referred with a respiratory problem; one had aspiration pneumonia and the other meconium aspiration pneumonia. Two patients had failed intubations at the referral hospital, but their oxygenation was maintained with headbox oxygen; both these infants were premature infants of less than 1.5kg. One patient had to have the ambulance re-routed back to the referral centre due to a dislodged endotracheal tube, which was re-inserted. In total five patients were referred with endotracheal tubes inserted. All of these intubated infants were premature and four patients had good oxygenation with one patient requiring re-intubation on admission due to a dislodged endotracheal tube.

In three premature infants who were born on the day of referral there was a delay in transfer to the NICU. The reason for the delay was not elicited from the referral data. One patient had a serious delay of more than fourteen hours from the time the call was made to arrange the referral to the time the patient arrived at the NICU. This premature neonate was in a poor

clinical condition on arrival to the NICU, had no intravenous line and subsequently developed hypoglycaemia and hypothermia. Four patients did not have referral notes on arrival.

Table 5: Pre transport stabilisation complications

Problem	Total (%)	Preterm	Term	Comments
Hypothermia	33 (79%)	25	8	8 severe hypothermia <35 °C
No Intravenous line	22 (52%)	17	5	2 failed attempts
No oxygen	14 (33%)	12	2	2 failed intubation
Hypoglycaemia	11 (26%)	7	4	4 no intravenous lines.
Delay in transfer	3 (7.1%)	0	3	1 > 14 hours

Percentage of total number of patients in parentheses

Outcomes

There were no patients that died during transportation.

There were a total of eleven deaths, which was 26% of all referrals (See table 6). There were nearly equal numbers of full term and premature babies namely five full term and six premature babies (see figure 1), but full term babies had a much higher risk of dying (5 of 12 (41.6%) versus 6 of 30 (20%)).

In the preterm group (See figure 1), the causes of death were due to sepsis and necrotizing enterocolitis in two babies. Two extremely low birth weight infants (less than 1000 grams) had severe hyaline membrane disease with death as the outcome. One of these also suffered from

cold stress, which contributed to the death. One infant was not considered for ventilation due to a gestational age of 25 weeks and a birth weight of 560 grams. The remaining death occurred in a premature baby with pulmonary hypoplasia and a possible Prune-belly syndrome.

The most common cause of death in the term infant group was birth asphyxia in 36%. Four of the five deaths in term infants were due to hypoxia related complications. In all four patients, there had been a prolonged second stage of labour. The other term infant who died, had non-specific dysmorphic features with abnormal eyes, a flat nasal bridge, and a non-communicating congenital hydrocephalus.

Thirty-one patients (74%) were discharged home. Four patients were known to have serious long-term neuro-developmental problems at the time of discharge.

Figure 1. Summary of outcomes of neonates included in the study.

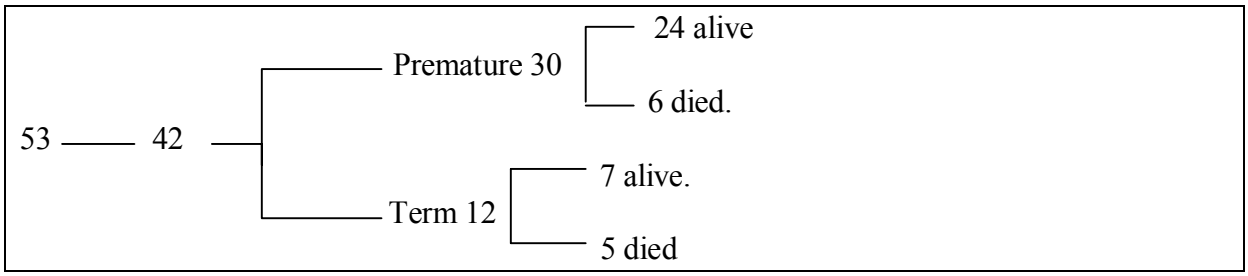

Table 6: Summary of death causes

Case No	Gestational age (weeks)	Weight	Number of days alive	Diagnosis
1	38	2.7kg	13 days	*BBA, multilobar pneumonia, hydrocephalus, dysmorphic, metabolic acidosis
2	26	996g	2(53 hrs)	HMD grade 4, cold stress
3	38	3.22kg	5 days	Birth asphyxia, renal failure, convulsions, cephalhaematoma, anaemia
4	38	3.16kg	4 days	Birth asphyxia, HIE, acute renal failure
5	33	965g	36 days	HMD, Intrauterine growth retardation, NEC, septicaemia
6	35	1.275kg	16 days	HMD grade 2-3, NEC, BBA, jaundice, Intrauterine growth retardation
7	38	3.26kg	10 days	HIE, meconium aspiration syndrome, prolonged second stage, HIV exposed
8	39	3.58kg	7 days	HIE, birth asphyxia, convulsions
9	29	1.3kg	30 days	Birth asphyxia, jaundice, polycythaemia-plasma exchange transfusion, nosocomial sepsis
10	36	2.3kg	19 days	Meconium aspiration syndrome,? Prune belly syndrome, hypoplastic lungs, dextrocardia.
11	25	560g	2 days	Extremely low birth weight, HMD grade 4

**BBA: Born before arrival; HMD: Hyaline membrane disease; HIE: Hypoxic ishaemic encephalopathy; NEC: Necrotizing enterocolitis*

Discussion

The most common reason for referral for neonates in this study was prematurity in 71% with 42.9% of referrals being infants of very low birth weight less than 1.5kg. This is a high percentage of premature infants referred- compared to first world countries. Prematurity still has a high prevalence in South Africa. In a previous study by Odendaal et al, the incidence of preterm labour was in 28% of all pregnancies[14]. They found that mothers usually presented in late stages of labour, where preterm deliveries were also associated with chorioamnionitis in 43% of cases, which prevented suppression of labour. The reason for the high incidence of premature infants in this study may be due to a selection bias, as these neonates have been referrals and do not reflect the deliveries of the whole population of in the Mamelodi area.

The diagnoses of the mothers were not recorded in this study. Previous studies have reported a high prevalence of preterm labour due to prolonged rupture of membranes, low antenatal clinic attendance levels as well as an increased incidence of maternal pre-eclampsia[14]. In previous studies antenatal clinic attendance has been shown to result in an improved outcome for infants [16,17]. Antenatal clinic attendance levels were low in this study with 62.5% of mothers not attending antenatal clinics at all. In a study by Cooper et al 56% of expectant mothers did not attend any clinics [15]. The low antenatal clinic attendance levels make identification of high-risk pregnancies impossible, where early identification of a high-risk fetus is crucial to have the benefit of antenatal transportation [5]. Expectant mothers must therefore be educated at the time of diagnosis of pregnancy about the importance of regular antenatal clinic attendance. A countrywide program, focusing on the importance of antenatal clinic attendance may be a solution. Screening for lower genital infections and urinary tract infections may also be beneficial to reduce the risk of infection related pregnancy complications[14]. At present this screening is not done routinely on all pregnant women in the public sector.

The high-risk fetus should ideally be transported antenatally[9,18]. Antenatal transport is associated with decreased mortality and decreased morbidity, as well as shortened length of hospital stay, when compared to neonates transported postnatally. Early detection of the high-risk fetus and maternal referral to a regional centre with facilities to care for the neonate should be encouraged. The concern of the psychological and physical isolation of an expectant mother from her support system, if the mother delivers in a health care facility far away from home during this vulnerable period, must be weighed against the chance of survival the neonate [19]. Postnatal transport of the newborn also results in separation of the mother-and-child pair, noting that if the two cannot be transported together, the bonding of the infant and mother may be affected.

In cases where antenatal transport is not an option the transport of the neonate must be optimised to obtain the best outcome. Unfortunately, even with the best transport teams and adequate resuscitation, very low birth weight infants with birth weights less than 1500 grams tolerate transport poorly. Cordero et al showed that delivery of an infant less than 1250g in a

regional perinatal centre had a 15% higher chance of survival, when compared with those born in a health care facility without a neonatal intensive care unit. This was statistically significant for those less than 1000g [9].

Premature neonates are a vulnerable population who require special attention with regard to resuscitation and careful attention to the maintenance of a thermoneutral environment. In this study there was an alarming number of patients presenting with hypothermia, with 79% of patients affected. The complications of hypothermia are well known, since these patients are at risk of developing peripheral vasoconstriction with secondary anaerobic metabolism, resulting in a metabolic acidosis, which again compromises the pulmonary vessels causing vasoconstriction and hypoxia[20]. This is associated with the further risks of generalized bleeding and pulmonary haemorrhage. The already compromised neonate also has increased metabolic demands and is at risk of developing hypoglycaemia. Measures to prevent heat loss of the newborn by proper drying off of the baby, immediate wrapping, and the use of caps and plastic wraps are inexpensive measures that can be used to ensure good control of temperature [20]. The transport incubator should also be adequately pre-warmed to maintain a temperature between 36.5 and 37°C during transport [21]. Whether the primary problem was inadequate warming at the referral centre or whether patients developed hypothermia during transportation, is difficult to determine in this study. Added to that is the fact that the temperature was not recorded in any of the patients in this study prior to referral. A significant portion of the patients (seven, 16.7%) were born before arrival at the referring hospital, which was a contributory factor. Five of these infants that were born before arrival were premature infants. A matter of concern during transfer was the fact that in three cases, the neonates were removed from the incubators in the ambulance and carried into the unit in blankets.

There was a high incidence of birth asphyxia-related deaths (46%). Early recognition of fetal distress and referral of mothers with obstructed labour as well as those with meconium stained liquor for specialist obstetric care is imperative to avoid poor outcomes in referrals to Kalafong and Pretoria Academic Hospital. In a study by Pieper et al 21 % of patients with birth asphyxia died[22]. The monitoring of labour is essential to avoid prolonged second stage of labour. The appropriate management of labour will result in improved outcomes for full term neonates half of whom presented with asphyxia related complications.

Significant problems were experienced with the intubation of very-low-birth-weight infants. The use of laryngeal masks in patients with difficult intubations can alleviate the problem of unsuccessful intubations at the referring centre prior transportation[23]. Inexperience with dealing with very small neonates was probably the reason for failure in prematures and therefore, training of staff in the resuscitation of premature neonates is essential in peripheral health care settings. In a study done in Malaysia over 2000 healthcare providers were trained in neonatal resuscitation [24]. The staff included the bulk of the nursing staff attending to neonates during delivery or in neonatal units [24]. This can be used as a model for training of staff (both nurses and doctors) to improve resuscitation and stabilization skills of the health care personnel at peripheral health care centres dealing with obstetric care. Such a resuscitation program should cover the identified deficiency areas such as temperature control, venous access and intubation of the preterm and high-risk neonates.

There was paucity in the monitoring of vital signs, with only 33.3% patients having had their saturations recorded prior to referral. Only a third (ten of thirty one) of the premature infants referred had their saturations monitored prior to referral. Only two patients (one preterm and one term infant) had had their blood glucose recorded prior to referral. There were no pre-transport temperature or blood pressure recordings for patients. Basic resuscitative measures to maintain oxygenation and fluid resuscitation were not followed before transport in the majority of patients. Delays are unavoidable and adequate stabilisation and optimisation of the infant in the primary centre is therefore vital. Leslie et al found that improved stabilisation prior to transport resulted in an improved condition of neonates on arrival at the neonatal units, especially with regards to the pH on arrival and temperature[28]. This would have had a great impact in our study population, as the most common complication was hypothermia. The use of checklists may be a method that is useful to ensure that all the information that is required, is obtained from the referring unit as well as ensuring that basic and standardised stabilisation procedures are followed [29].

Barry *et al* found that adverse clinical events occurred in 75 % of the patients they transferred prior to the introduction of specialized transport teams[25]. Twenty percent of these adverse events were regarded as life threatening. Complications could be avoided by having transport teams dedicated to the transportation of neonates. Thompson *et al* found that the transport nurses consistently demonstrated the ability to effectively assess, manage, stabilise and transport ill neonates [26]. There was no difference in teams led by nurses versus those led by doctors [28]. A neonatal transport team should therefore be established, comprising of neonatal intensive care trained nurses, who undergo a training course in neonatal transport. The use of nurses as team leaders in these teams creates opportunities for career advancement for nurses and helps in skills distribution.

Every telephonic consultation can be used by the receiving doctor as an opportunity to assess the severity of the illness of the neonate, as well as a teaching opportunity to strengthen the capacity of personnel at the referral site. A report back to the referral centre about the condition of the neonate on arrival to the neonatal intensive care unit is also an educational opportunity. A return transport system back to the referring centre, also adds to cost reduction and early involvement of the primary care physician.

The mortality of referred patients was twenty-six percent in this study. In developed countries the mortality of transported infants was found to be 19%[26]. The neonatal mortality attributed to intrapartum asphyxia is 13% of all deliveries [31].

The following limitations were identified in this study: the data collected did not include all the patients referred during the study period, the number of patients in the study was also small and the record of events during the ambulance trip was not obtained to assess intra-transport complications.

Conclusions and recommendations

- **Poor antenatal clinic attendance**

Antenatal clinic attendance is vital for early detection of high-risk pregnancies. More effort must be put into increasing awareness in women of childbearing age on the importance of antenatal clinic attendance at national and provincial level.

- **Early referral of mothers in preterm labour**

Mothers who are in preterm labour need to be referred earlier to a tertiary care facility to avoid transport related complications.

- **Appropriate management of obstructed labour**

Further effort must be put into improved management of labour and early detection of fetal distress, as well as early referral of mothers with obstructed labour from primary care facilities.

- **Training in neonatal resuscitation techniques**

There is a need for neonatal resuscitation courses to be arranged for the staff at primary care facilities with emphasis on initial resuscitation measures to be taken as well as intubation techniques for premature infants. The monitoring of vital signs is imperative and this needs to be included as part of such a course.

- **Telephonic consultation prior to transfer**

A telephonic consultation with an experienced practitioner in the receiving facility should be obligatory to ensure appropriateness of referrals and to discuss the interim management of every patient needing transfer. This will help to limit inappropriate referrals, for example extremely low birth weight premature babies that are regarded as non-viable, as well as help with advice whilst the transfer is being arranged.

- **Nurse-led neonatal transport teams**

Teams dedicated to neonatal transport need to be established. These teams will have a positive impact on the neonates transferred and will also afford a teaching opportunity for the primary care team involved in the stabilisation of the infants.

- **Pre-transfer check-list necessary to assess status of neonate for referral**

The use of pre-transport checklists can help to improve the service provided by the primary care centre by ensuring that all necessary interventions have been carried out while the transfer of the neonate is still being arranged.

- **Stabilisation and transport protocol**.

A stabilisation and transport protocol must be implemented.

- **Regular audit**

This serves to assess the performance of the whole system after implementation of the protocol, the transport checklist as well as the resuscitation course, to assess if there are any improvements in the outcomes of referred neonates.

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Addendum A: Study Protocol

Title: Audit of neonatal transfers to a tertiary centre in the Third World.

Authors: Masekela R, Kruger M. Department of Paediatrics University of Pretoria, South Africa.

Aim

The development of increased level II capacities is a critical element in the efficient use of designated level III bed space and provides a necessary alternative to the ethical dilemmas and financial ramifications of inappropriate use and potential disruption of level III units[1].

With the increasing challenges of providing the best quality of health care with limited resources, a study to determine the limitations and the preventable factors for high- risk patients delivered outside the referral centre.

An audit to determine the referral criteria, the initial diagnosis and resuscitation, interventional measures taken, the stabilization time, the transit time, the condition on arrival and the outcome of the transferred neonates.

Patients

An Audit of data from all patients delivered at Mamelodi Day Hospital (a) transferred to Kalafong Hospital Neonatal Intensive Care Unit (b) and Pretoria Hospital Neonatal Intensive Care Unit (c) over a period of one year.

Methods

Data will involve collection of hospital records at referral hospital (a), transport records and patient records at the two tertiary centres (b+c).

The pre-transport records will be reviewed for the reason for referral whether for respiratory failure (ventilation), surgical intervention, suspected cardiac disease, neurological problems, and congenital abnormalities, for diagnostic procedures or other.

The timing between the decision to transfer and the arrival of the Emergency Medical Services as well as the pre-transport stabilization including the type of resuscitation, use of intravenous fluids, blood glucose monitoring, antibiotic use, blood pressure monitoring, oxygenation and temperature.

The transportation time between the two centres will also be recorded for all patients including the condition of the patient during transportation and occurrence of any adverse events .The

equipment available in the transport vehicle, any occurrences of adverse events and the experience of the most senior transferring personnel to deal with the adverse events.

The condition of the patients on arrival to the Intensive Care Units and the outcomes of the patients based on the patients duration of hospital stay, need for ventilation, complications encountered and discharge or death.

Ethics

Ethical approval will be obtained from the University of Pretoria Research Ethical committee. Consent also to be obtained from the Chief executive officer of Mamelodi Hospital.

Data analysis

There will be comparison of the outcomes of the transferred patients with a control group of age-matched patients born at the referral centres.

Finances

The costs will include the transport between the facilities and the photocopies made of relevant materials used.

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Addendum B: Data capture sheet

Study number: S145/2003
Unique number:_____
Name: _____
Hospital number: _____
DOB___/_____/_____
Time of birth: h
Sex: Female □ Male □
Mode of delivery: NVD □ Breech □ Forceps □ Ventouse □
Gestational age: _____weeks Ballard score _____weeks
Apgar scores: 1 min_____ 5min_____ 10 min_____
Birth weight:_____

Maternal data

Age:
Parity: P_____G_____A_____
Antenatal History: Clinic_____ No visits _____
Maternal illnesses_____
_____
_____
Medications _____
_____
_____
Reason for transfer _____

Transport data

Mode of transport: Ambulance □
Other □ If yes state_____
Treatment given _____

Pre-transport information

BP _____ Saturations _____ Temp_____ Blood glucose_____ Not done □

Airway: Room air □
Nasal prongs □
Mask □
Rebreather mask □
Head box □
Intubated □

Intravenous fluids: Neonatalyte □ Ringer's lactate□ Normal saline □ 5%Dextrose □

Other □ state_____
Line in situ on arrival Yes □
No □
If not in situ state Dislogded □
Infiltrated □

Condition on arrival

BP _____ Pulse_____ Saturations_____ Temp _____Blood glucose_____

pH_____PO2_____PCO2_____HCO3_____BE_____

Resuscitation: Oxygen: None □
Nasal prongs □
Face mask □
Ambubag and mask □
Intubation □

Intravenous fluids: Ringer's lactate □
Normal saline □
Neonatalyte □
Other □ If yes state _____

Treatment: _____
_____
_____

Diagnosis: _____
_____
_____

Management: None □
Nasal prongs □
Ambubag and mask □
Headbox □
CPAP □
IPPV □
Intravenous fluids : Neonatalyte □
If other state _____

Reason for referral: Lack equipment □
Lack expertise □
Maternal □
Other _____

Outcome: Alive normal discharged □
Transfer back □
Died: 0-7 days □ 8-28 days □ >28 days □
Contact number:_____

Appendum C: Consent form

Patient Information sheet and consent form

Study title: Clinical study number S145/2003 is an audit study of neonates treansferred from Mamelodi Hospital to Pretoria Academic and Kalafong neonatal intensive care units to assess the impact o transportation on neonates.

Introduction

You are invited to volunteer for inclusion of your into our study. This information leaflet is to help you decide on whether you would like to participate in the study. Before you agree on your child's behalf you must fully understand what is involved. Any questions you may have regarding the study should be fully explained to you by the investigator. In the interest of your child's health, it is strongly recommended that you discuss with or inform your personal doctor of the possible participation of your child in the study.

What is the purpose of the study?

Your child has been transferred from Mamelodi hospital to the neonatal intensive care unit at Pretoria Academic Hospital or Kalafong Hospital. We would like to include him/her in our study, which aims to determine the outcomes of neonates transferred to our neonatal intensive care units.

What is the duration of the study?

If you allow your child to take part in the study he/she will be included in a group of neonates transferred from Mamelodi hospital to Pretoria Academic Hospital or Kalafong Hospital neonatal intensive care units over a period of a year. We will review relevant notes with regard to your child's condition pre-transportation, transport data and neonatal intensive care unit hospital notes.

What are my child's rights as a participant in the study?

Your child's participation is entirely voluntary and you may refuse his/her participation in the study. Your child's withdrawal will not affect in any way your child's access to medical care. The investigator reserves the right to withdraw your child from the study if it's considered to be in your child's best interest.

May any of these study procedures result in discomfort or inconvenience?

No, this study looks entirely on the data provided by the caregivers of your child. No new procedures will be undertaken.

What are the risks involved in this study?

Your baby will not be at any risk during this study.

Informed consent

I hereby confirm that I have been informed by the investigator, Dr _____ about the nature, conduct, benefits and risks of clinical study S145/2003 I have also received, read and understood the above written information (Patient Information Leaflet and Informed Consent) regarding the clinical study.

I am aware that the results of the study, including personal details regarding my child's age, sex, date of birth initial and diagnosis will be anonymously processed into a study report.

I may, at any stage, without prejudice, withdraw my consent and participation in the study. I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study on behalf of my child

Dr _____ has provided me with a copy of the Patient Information Leaflet
and Consent Form regarding clinical study number _____ and has fully explained to me the nature, risks, benefits and purpose of the study. He/she has given met the opportunity to ask any questions concerning the study. It has been explained to me that at any time I will be free to withdraw my child from the study at any time, without any disadvantage to future care. I have understood everything that has been explained to me and I consent for my child to participate in this clinical study.

Parent/guardian(s) Name _____

please print

Parent/Guardian's signature _____ Date: ___/___/___

Patient's Name _____

please print

Investigator's signature _____ Date: ___/___/___

I, doctor _____ herewith confirm that the above patient has been informed fully about the nature, conduct and risks of the above study.

Witness' Name _____

please print

Witness' signature _____ Date: ___/___/___

INFORMED CONSENT FOR PARENT/GUARDIANS

(on behalf of minors under 18 years old)

Dr _____ has provided me with a copy of the Patient Information Leaflet and Consent Form regarding the study trial number _____ and has fully explained to me the nature, risks, benefits and purpose of the study. He/she has given me the opportunity to ask questions concerning the study. It has been explained to me that I will be free to withdraw everything has been explained to me and I consent for my child to participate in this clinical study.

Parent/Guardian(s) Name _____

please print

Parent/Guardian(s) Signature _____ Date: ___/___/___

Insurance and financial arrangements

Your medical scheme will not be financially responsible for any part of the study.

Some additional information

For the duration of the study, your child will be under the care of Doctor ……..…, If at any time during the study you have any questions or problems do not hesitate to consult him/her. The telephone number is …… through which you can reach him/her or another authorized person.

Confidentiality

All the information obtained during the course of the study is confidential. Data obtained may be reported in scientific journals and will not include any information that will identify our child as a patient in this study. In connection with this study, it might be important for domestic and foreign regulatory health authorities and the Research Ethics Committee of South African Medical Association, the Medicine Control Council as well as your doctor to be able to review your child's medical records. Therefore, you will also hereby authorize the investigator to release your child's medical records to doctors of the department of Paediatrics (Kalafong and Pretoria Academic Hospitals), domestic and foreign regulatory authorities, the Medicines Control Council and the Research Ethics Committee of the South African Medical Association. You understand that they will utilize these records only in connection with carrying out their obligations relating to this clinical study.

Any information regarding your child's test results or state of health as a result of your child's participation in this study will be held in strict confidence. You will be informed on any finding of importance to your child's health or continued participation in this study but this will not be disclosed to any third party in addition to the ones mentioned above without your written permission. The only exception to this rule will be cases in which a law exists compelling us to report individuals infected with communicable diseases. In this case, you will be informed of our intent to disclose such information to the authorized agency.

Patient's Signature * _____ Date _____

(*Minors competent to understand must participate as fully as possible in the entire procedure)

Investigator's Name _____ (Please print)

Investigator's Signature _____ Date _____

Witness's Name _____ (Please print)

Witness's Signature _____ Date _____

VERBAL INFORMED CONSENT (applicable when patients cannot read or write)

I, the undersigned, Dr …….. have read and have fully explained to the patient, name ……. And/or his/her relative, the patient information leaflet, which has indicated the nature and purpose of the study in which I have asked the patient to participate. The explanation I have given has mentioned both the possible risks and benefits of the study and the alternative treatment's available for his/her child's illness. The person informed has indicated that he/she understands that he/she will be free to withdraw from the study at any give time for any reason and without prejudice or jeopardizing the patient's treatment from the study to which he/she has agreed.

I hereby certify that the patient has agreed to participate in this study.

Patient's Name _____ (Please print)

Investigator's Name _____ (Please print)

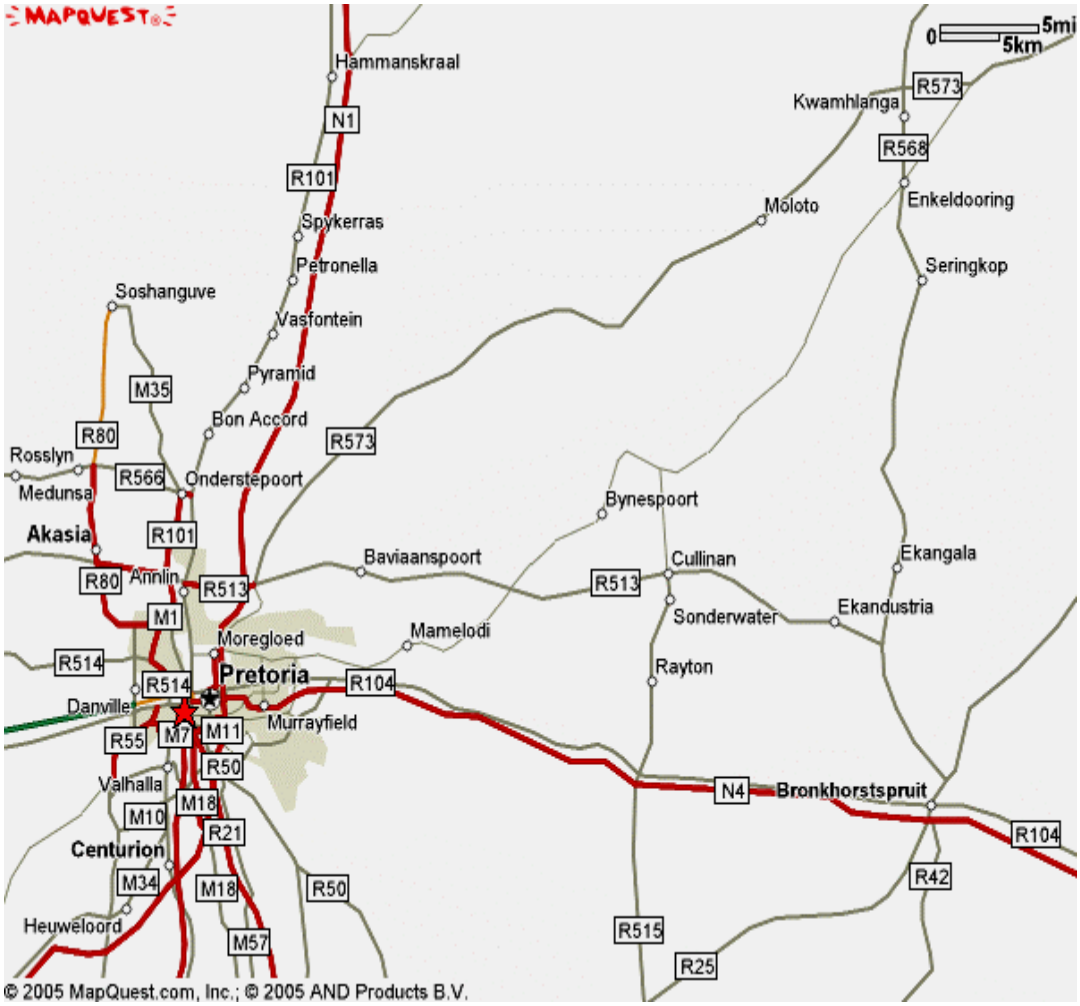
Investigator's Signature _____ Date _____

Witness's Name _____ (Please print)

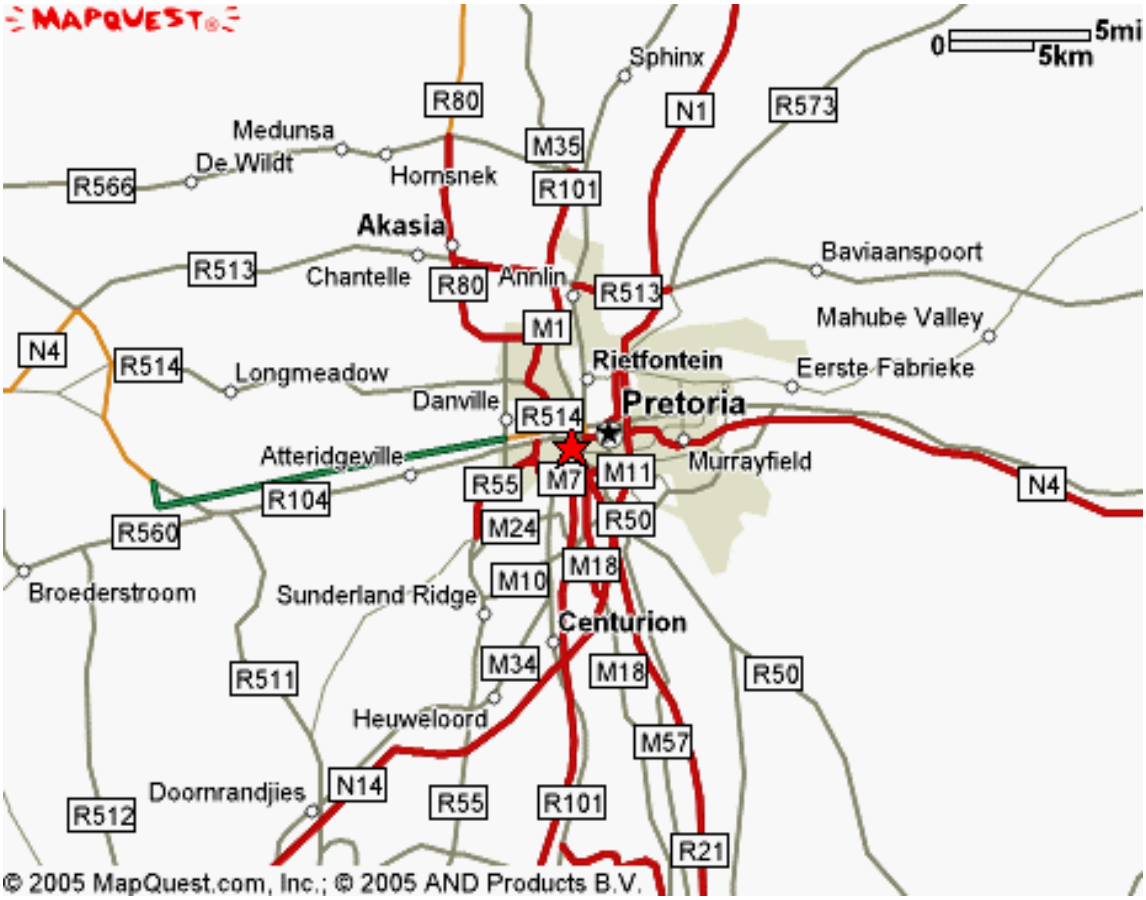
Witness's Signature _____ Date _____

Addendum D- Maps

Map Pretoria including Mamelodi and Pretoria



Map including Attridgeville where Kalafong Hospital is situated.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Mahube Valley
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R514
Longmeadow
Rietfontein
Eerste Fabrieke
Danville
R514
Pretoria
Atteridgeville
Murrayfield
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M24
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R560
M18
M10
Broederstroom
Sunderland Ridge
Centurion
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Heuweloord
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Doornrandjies
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Addendum E: Protocol for neonatal transfers.

Criteria for referrals of neonates to Pretoria Academic Hospital and Kalafong Hospital :-
All referrals must be made by telephonic consultation with doctor on call at the relevant hospital.
Neonates who require immediate referral are:

- All infants of less than 1.8kg
- All full term infants who have low Apgar scores of less than 5 at 10 minutes post delivery.
- All infants who require intubation post-delivery.
- All neonates who are dysmorphic.
- All infants who require surgical intervention post-delivery.
- All infants with apnoea or convulsions or failure to feed

The following patients should not be referred to a tertiary facility

- Infants who weigh less than 700 grams.

The following procedures should be done on all neonates post delivery and before transfer:

- All patients must have maternal data recorded on the transfer form to include maternal age, antenatal history, past medical history (including RPR and HIV status), medications and correct address as well as contact numbers.
- All vital data MUST be recorded including temperature, pulse rate, saturations and dextrostix.
- Data of the delivery must be recorded to include Apgar scores, birth weight, time of delivery and referral diagnosis.
- All patients must be transported in a warmed incubator or by means of skin-to-skin warming by the mother during transport if this is feasible.