

TREATMENT OUTCOMES OF Neonatal Asphyxia at a National Hospital IN DAR ES SALAAM, Tanzania

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ABSTRACT

Birth asphyxia is an important cause of neonatal morbidity and mortality in developing countries. Birth asphyxia continues to present a major clinical problem, and worldwide approximately one million newborn infants are affected annually.

The broad purpose of this study was to describe the care given to asphyxiated neonates at a neonatal unit at a national hospital in Dar es Salaam, Tanzania. A descriptive cross-sectional study involving 40 neonates, admitted to the participating national hospital with neonatal asphyxia, was done. A checklist was used to obtain data from each patient's records and another checklist to identify the availability of equipment.

Out of 190 neonates admitted to the neonatal unit, 40 (21.1%) suffered from neonatal asphyxia. Out of the 40 asphyxiated neonates, 25 (62.5%) were referred from peripheral hospitals. As many as 25 (62.5%) of these neonates died. Those with severe birth asphyxia had significantly increased chances of mortality ($p = 0.000$). The lack of resuscitative facilities, limited available technology and the shortage of skilled personnel posed challenges to manage cases of neonatal asphyxia effectively.

KEYWORDS: apgar score, neonatal asphyxia, neonatal mortality, neonatal resuscitation, Tanzania

INTRODUCTION AND BACKGROUND INFORMATION

Birth asphyxia is defined as a delay in establishing spontaneous respiration upon delivery of a newborn. It causes impaired gas exchange leading to progressive hypoxaemia and hypercapnoea with significant metabolic acidosis (Rennie & Robertson, 2002). As-

phyxia causes peripheral vasoconstriction, tissue hypoxia, acidosis, poor myocardial contractility, bradycardia and eventually cardiac arrest (Gomella & Cunningham, 2004).

Birth asphyxia is a global problem, especially in developing countries. Recent estimates indicated that neonatal mortality had reached 4 million worldwide with 23% of these deaths due to birth asphyxia. Up to 99% of these deaths occurred in low to middle income countries. Birth asphyxia, in the most severely affected infants, causes significant neuro-disability sequelae with high rates of mortality (Lawn, Cousens & Zupan, 2005).

The severity of asphyxia is widely assessed by the Apgar score, a method to assess the wellbeing of newborns at one and five minutes after birth. The score provides an estimate of the severity of asphyxia but not of its duration (Ryan, Gregg & Patel, 2003). The Apgar score helps to evaluate a newborn infant's condition at birth on the basis of five characteristics, namely: heart rate, respiratory effort, muscle tone, reflex irritability, and colour. For each parameter the infant receives a score of 0 if it is absent, 1 if it is present but abnormal, and 2 if it is normal. Traditionally, scores are assigned at 1 and 5 minutes after birth, but in prolonged resuscitation score can be assigned at any time to reflect the condition of the infant and the response to resuscitative efforts recorded in the baby's birth record. With perinatal depression, the Apgar characteristics generally disappear in a predictable manner: first the pink coloration is lost; next the respiratory effort; and then muscle tone, followed by reflex irritability; and, finally, heart rate. Return of these characteristics during recovery does not necessarily occur in the same order (Velkian & Walden, 2004).

Birth asphyxia is an important cause of preventable neonatal morbidity and mortality in developing countries, such as Tanzania and India. For example, of the 26 million births each year in India, 4–6% of neonates fail to establish spontaneous breathing at birth. Neonates can be saved if healthcare professionals are skilled in neonatal resuscitation (Deorari, Paul, Singh & Vidyasagar, 2000). In Uganda, the infant mortality is 83/1 000 live births and the mortality rate for children under five years is 124/1 000 live births (UNICEF, 2004). Birth asphyxia may account for 24–29% of neonatal deaths in resource poor settings (Black, Morris & Bryce, 2003), and neonatal deaths account for approximately half of infant deaths in Africa (Costello & White, 2001).

Tanzania's Ministry of Health, Social Welfare, Reproductive and Child Health (Tanzania's National Bureau of Statistics, 2005) reported that perinatal deaths contribute to a high neonatal mortality rate and high crude estimates ranging from 58–91 per 1 000 live births. There is a lack of information about the causes of neonatal deaths in low income countries. However, it has been estimated that 24% of these deaths are due to severe infections; 29% due to birth asphyxia; 24% due to complications from prematurity; and 7% due to tetanus (Black, 2003). A study by Klingebera, Olomi, Oneko, Sam and Langeland (2003) at Kilimanjaro Christian Medical Centre in Dar es Salaam, Tanza-

nia, found that 31 neonates (two-thirds of all neonatal deaths) had died from perinatal asphyxia. Results from a pilot survey done at a neonatal unit (Muhimbili National Hospital, 2008), indicated that from April to September 2008, 16–28% of the neonates had suffered from neonatal asphyxia.

A multicentre prospective study (Dilenge, Majnemer & Shevell, 2001) involving 4 267 deliveries in eight countries, including Tanzania, attempted to determine the incidence, maternal, service and logistic risk factors for neonatal asphyxia as determined by abnormally low Apgar scores. It was found that 30% of births were by primigravida mothers, of whom 67% were teenagers. A birth by a teenager had a higher risk for low birth weight (Dilenge et al., 2001). The overall incidence of low birth weight was 13.9%. The overall incidence of asphyxia of the newborn was 22.9%, while that associated with low birth weight (for babies weighing less than 2 500 g) was 29.3% compared with 21.5% among the normal birth weight babies. Low birth weight babies had a high neonatal mortality of 15.9% compared to 1.8% for normal birth weight babies, 24 hours after birth. The mean mortality at 24 hours post-delivery was 3.8%.

Obstetric complications are important risk factors for neonatal asphyxia. Key risk factors include prolonged labour and intra-partum accidents. The incidence of risk for asphyxia broadly was 21.3%, which is very close to the actual incidence of asphyxia of 22%. Lack of referrals and inappropriate resuscitation measures also contributed to increased risks of neonatal asphyxia (Dilenge et al., 2001).

Factors contributing to neonatal asphyxia occur before, during and after the delivery of the infant. In the prepartum phase for maternal age of greater than 35 years or below 16 years, the following conditions may occur: maternal infection, premature rupture of membranes, maternal diabetes, anaemia or haemorrhage. In the intrapartum phase, the following potential problems may occur: abnormal foetal positioning, premature labour, prolonged or difficult labour or foetal anomalies. Finally, in the postpartum phase, there may be congenital defects (cardiac, neurological) or abnormal heart rate.

The management of neonatal asphyxia requires the following actions: supportive care to maintain temperature, perfusion, ventilation and a normal metabolic state (glucose, calcium and acid-base balance); early detection by clinical and biochemical assessments of potential complications should limit such damage; rehydration for foetal exhaustion (intravenous line with 10% dextrose at 60ml/kg/ day); and a vitamin K 1 mg injection is recommended for all neonates (American Heart Association, 2006).

All neonates who have suffered from asphyxia should be closely monitored clinically. Cardiovascular system status assessment should include heart rate, colour, pulse-oximetry and temperature (American Heart Association, 2006). Resuscitation techniques, considered to be key interventions for improving the health status of neonates with

birth asphyxia, include suctioning, providing assisted ventilation and supporting cardiac functioning.

RESEARCH PROBLEM

According to the World Health Organization (WHO, 2004), between 4 and 9 million newborns develop birth asphyxia each year and an estimated 1.2 million related mortalities occur (Save the Children, 2001). The WHO (2004) reported the number of disability-adjusted life years (DALYS) to be 13 858 for the Africa region compared to the global DALY 41 684 which accounted for 33.2% of the world's burden of neonatal asphyxia. Tanzania, like other countries in the sub-Saharan region, had a high perinatal mortality rate ranging from 42–100 per 1 000 births (Tanzania National Bureau of Statistics, 2004). Most areas in Tanzania do not have access to paediatric intensive care units (PICUs) which could provide initial resuscitation and stabilisation. In the city of Dar es Salaam, similar challenges occur despite the availability of hospital services.

A number of factors may play a role in causing perinatal deaths in birth asphyxiated neonates, for example: lack of PICU nurses; lack of intensive care technologists; lack of basic paediatric critical care training for nurses to provide effective paediatric advanced life support; inadequate resuscitation efforts; paediatric nurses' inability to recognise critically ill neonates; lack of modern or advanced equipment; and lack of transport services to facilitate movement of babies from peripheral hospitals to neonatal units.

Poor management of birth asphyxiated neonates results in high perinatal mortality rates and neurological handicaps with increased burdens to healthcare workers, families and communities. In resource-poor countries such as Tanzania, assessment of avoidable perinatal deaths (those due to error or omission on the part of the health services) might help to identify priority areas for reducing neonatal mortality rates. Assessment also provides an indication of the performance of the healthcare workers. This could impact on the design of effective measurable interventions with available resources. Therefore, this study focused on the management of asphyxiated neonates at a national hospital in Dar es Salaam, Tanzania.

PURPOSE OF THE STUDY

The current study aimed to identify and describe maternal factors, birth factors and post-partum factors that were associated with neonatal asphyxia at the participating hospital's neonatal unit. It also attempted to evaluate the management of neonatal asphyxia cases.

DEFINITIONS OF KEY TERMS

An **Apgar score** is a method of rapidly assessing the general state of a baby immediately after birth. It is measured at one minute and five minutes after delivery.

Asphyxia is a life-threatening condition in which oxygen is prevented from reaching the tissues by obstruction of or damage to any part of the respiratory system, especially when the Apgar score is below 7.

An **infant** is a child from one month to one year of age.

A **neonate** is an infant at any time during the first four weeks of life. The word is particularly applied to infants who are new born or during their first week of life.

Resuscitation is the revival of a person who appears to be dead. It depends upon the restoration of cardiac and respiratory functions (Oxford Concise Edition Medical Dictionary, 2003).

RESEARCH METHODOLOGY

This study was conducted at a neonatal unit, to which neonates with birth asphyxia from municipal hospitals in Dar es Salaam are referred. The study was a descriptive cross-sectional survey looking into the management of asphyxiated neonates. The study targeted consenting women with full-term neonates admitted due to birth asphyxia at the participating neonatal unit. The sample was obtained through a convenience sampling method and included mothers who were available with their neonates at the time of the data collection period from January till March 2009.

The sample size was calculated using the following formula: $n = z^2 p (100 - p) / \epsilon^2$ where n = sample size, p = estimated prevalence of neonates admitted due to birth asphyxia, ϵ = margin of error on p . Based on previous pilot studies from the monthly reports in which the lowest prevalence was 16% and the highest 28%, p was set at 22% and the margin of error, ϵ , on p = 6%. Therefore, the sample size for this study comprised 190 neonates. The records of all neonates admitted to the neonatal unit during the three months were reviewed and neonates with a diagnosis of neonatal asphyxia were identified.

The records of all neonates admitted from January 1 to March 31, 2009 were reviewed to select neonates with birth asphyxia. The records for patients with neonatal asphyxia were perused using a checklist which addressed the following aspects: maternal information such as antenatal problems, mode of delivery; neonatal information such as gender birth weight and Apgar score. The availability of equipment for neonatal resuscitation was evaluated using a checklist with 14 items. Finally, the number of staff members

on duty was described for a period of 14 days, using available duty registers. All data were collected by one researcher.

The study was carried out in accordance with existing ethical guidelines. Research ethical clearance was obtained from the Senate Research and Publication Committee of Muhimbili University of Health and Allied Sciences. Written consent was obtained from each mother prior to enrolment in the study. Information was provided to the mothers, including a complete description of the aims of the study to ensure that they had adequate information to make an informed choice whether or not to participate in the study. All patients' personal information was deleted. Data were stored in a locked secure office. Research clearance was granted by the participating hospital.

RESULTS OF THE STUDY

Neonates with asphyxia

Out of 190 neonates admitted to the neonatal unit during the study period, 40 (21.1%) suffered from neonatal asphyxia. Of those who had neonatal asphyxia, 25 were males (62.5%) and 15 were females (37.5%). The majority 36 (90%) weighed > 2.5 kg. Table 1 summarises the severity of birth asphyxia neonates: 8 (20%) had mild birth asphyxia; 15 (37.5%) had moderate birth asphyxia; and 17 (42.5%) had severe birth asphyxia. Also table 1 shows the association between the severities of birth asphyxia with those who were either discharged home or who died. All 17 (100%) neonates with severe birth asphyxia died. In moderate birth asphyxia, 9 (60.0%) were discharged home and 6 (40.0%) died. In mild asphyxia, 6 (75.0%) were discharged home and 2 (25.0%) died.

Table 1: Neonatal birth asphyxia, severity and outcomes (n = 40)

Categories of birth asphyxia	Discharged	Death	Total
Mild birth asphyxia	6 (75%)	2 (25%)	8
Moderate birth asphyxia	9 (60%)	6 (40%)	15
Severe birth asphyxia	0 (0%)	17 (100%)	17
Total	15	25	40

Mothers' characteristics

The mothers' ages ranged from 15 to 34 years, with 23 (60.5%) falling within the 15–24 years age group and 15 (39.5%) within the 25–34 years age group. (Two mothers' ages could not be ascertained, explaining why only 38 persons' ages were recorded.) Of the mothers, 22 (55.0%) were married; 25 (62.5%) had only a primary education; 4 (10.0%)

had a secondary education; and 11 (27.5%) had only acquired some informal education. These low levels of education might explain why 36 (90.0%) of the mothers were unemployed.

Association between maternal labour factors and neonatal asphyxia

Table 2 shows the association between maternal labour factors and birth asphyxia. Informal education, parity one and induced labour showed significant positive associations with neonatal asphyxia ($p < 0.05$).

Description of the mode of delivery

Of the birth asphyxiated neonates, 29 (72.5%) were delivered by spontaneous vertex deliveries; followed by lower segment caesarean sections 7 (17.5%); low vacuum extractions 3 (7.5%); and 1 (0.25%) assisted breech delivery. Only 15 (37.5%) of the birth asphyxiated neonates had induced labour, while 35 (62.5%) did not have induced labour, as also shown in table 2.

Table 2: Association between maternal factors and neonatal birth asphyxia

Factor	n	%	Factor	n	%
Marital status			Maternal diseases/infections		
Single	18	45.0	Anaemia	9	22.5
Married	22	55.0	Hypertension	11	27.5
			Diabetic	1	2.5
Education			Sickle cell anaemia	1	2.5
Informal	11	27.5	HIV	3	7.5
Primary	25	62.5			
Secondary	4	10.0	Mode of delivery		
			SVD	29	72.5
Parity			ABD	1	2.5
PARA-1	25	62.5	LVCE	3	7.5
PARA-2	6	15.0	LSCS	7	17.5
PARA-3 +	9	22.5			
			Induced labour		
			Yes	5	12.5
			No	35	87.5

Neonatal asphyxia management strategies

Table 3 summarises the treatments used in the neonatal unit when neonatal asphyxia was diagnosed. Suctioning and feeding were the most common interventions adminis-

tered to all 40 (100%) asphyxiated neonates, while epinephrine and sodium bicarbonate were never administered.

Table 3: Management strategies used in neonates with neonatal asphyxia

Strategy	Yes	Yes %	No	No %
Checking vital sign	6	15.0	34	85.0
Suctioning	40	100.0	0	0
Epinephrine	0		4	100
Sodium bicarbonate	0		4	100
Dextrose	18	45.0	22	55.0
Vitamin K	6	15.0	34	85.0
Feeding	40	100.0	0	

Staff allocated to the neonatal unit

The neonatal unit had an average of 156.3 neonates per day over the observed period of 14 days. On average, there were two to three doctors on duty while registered nurses varied from 3 to 8 (average of 5.5) per shift. On average, 15 of these neonates had neonatal asphyxia but this number varied from 11 to 32 on a single day. The average ratio of neonates with neonatal asphyxia to registered nurses was therefore 2.7:1. However, it was observed that the ratio was as high as 5.3:1 during one shift. Reportedly, there were 3–5 neonatal deaths due to asphyxia per day during the study period.

According to the unit's monthly statistics, the number of critically ill neonates in the participating unit ranged from 150–180 per day, exceeding the neonatal unit's bed capacity of 80. This huge overload of patient numbers might explain the high ratio of asphyxiated neonates per nurse per shift.

Equipment availability

Most of the resuscitative equipment was available in the neonatal ward during the study period, except intubation equipment, such as oxygen masks and ambu bags.

DISCUSSION

Birth asphyxia is a delay in establishing spontaneous respiration upon delivery of a newborn. The overall prevalence of asphyxiated neonates in this study was found to be 21.1%. This is higher than previously reported findings of birth asphyxia (10.4%) reported by Kawo Urassa, Killeo and Massawe (1995). The reason for this difference could be attributed to inadequate resuscitative facilities; lack of skilled personnel; and increased numbers of admitted asphyxiated neonates. The majority (70%) of asphyxi-

ated neonates were referred from peripheral hospitals. This may be due to a lack of neonatal units at peripheral hospitals.

The findings of this study demonstrated that 25 (62.5%) of the asphyxiated neonates died. This high mortality rate could be due to the fact that referrals from peripheral hospitals were delayed. This finding is in agreement with previous studies which reported that birth asphyxia might account for 24–29% of neonatal deaths in a resource poor setting where neonatal deaths account for approximately half of all infant deaths in Africa (Black, 2003; Darmstadt et al., 2005). This might also be due to lack of facilities for close monitoring in a neonatal unit.

This study's results showed that 27.5% (n = 11) of the birth asphyxiated neonates' mothers were younger than 24 years. Previous studies reported that birth asphyxia occurs more commonly in teenaged mothers, possibly due to the pelvic disproportions of these young women making deliveries more difficult and prolonged (Dileng, Majnemer & Shevell, 2001).

Women without formal education might find it difficult to benefit from reproductive health education. In this study, hypertension and anaemia were the most common maternal risk factors associated with neonatal birth asphyxia. These conditions could cause placental insufficiency, which reduces the oxygen supply to the foetus (Kattwinkel, 2004; Velkian & Walden, 2004). Induced labour was also significantly associated with birth asphyxia. This might be due to poor monitoring of care during the first and second stages of labour. However, the reasons for labour induction were unknown and these might have indicated why these neonates suffered from neonatal asphyxia.

Suction procedures, including mouth and nasal suctioning, were performed on all the asphyxiated neonates. Neonates with meconium aspiration were also suctioned but were not intubated due to lack of equipment. It was found that there were no endotracheal tubes available for neonates. Best practices suggest that if meconium is present in the amniotic fluid or on the neonate's skin, the nurse should intubate the neonate and perform suctioning through the trachea before performing the other resuscitation steps (Kattwinkel, 2004; Velkian & Walden, 2004).

In the present study it was found that 18 (45.0%) asphyxiated neonates had received 10% intravenous dextrose. Among the 40 neonates with asphyxia, only 6 had documented vitamin K injections. Epinephrine and sodium bicarbonate were not administered. This might have been due to a lack of skills of knowing when and how to administer these drugs.

According to existing guidelines (Kattwinkel, 2004; Velkian & Walden, 2004), epinephrine is indicated when the heart rate remains less than 60 beats per minute. Epinephrine increases the workload and oxygen consumption of the heart muscles, which in the

absence of available oxygen might cause unnecessary myocardial damage. Epinephrine should be given by the most accessible route that will deliver the drug to the heart muscles such as an endotracheal tube or the umbilical vein.

Sodium bicarbonate may be given if all other resuscitation measures have been pursued and there is no improvement in the neonate. Sodium bicarbonate corrects metabolic acidosis by providing CO₂ and water. It can be particularly effective if given early during resuscitation efforts (Kattwinkel, 2004; Velkian & Walden, 2004). The aforementioned resuscitative measures were not performed at the neonatal unit at the participating hospital probably due to a lack of adequate resources and inadequate training.

In the study, it was found that some of the resuscitation equipment, such as oxygen masks and neonatal intubation equipment, were unavailable. This resuscitation equipment is critical for saving the lives of asphyxiated neonates. A study done in Uganda (O'Hare, Nakakeeto & Southall, 2006) reported that basic neonatal resuscitation measures decrease the incidence of asphyxia and decrease mortality. Indeed, the practices at the participating hospital differed from the recommendations published in a study by the International Centre for Diarrhoea Disease Research (2006) which suggest that equipment must be available, in working order, and readily accessible. Providers must have both the necessary competencies to use the equipment as well as the prompt recognition of and action to treat birth asphyxia.

The study found that only 6 (15.0%) asphyxiated neonates had been monitored for vital signs, while for 34 (85.0%) the vital signs were not documented. Failure of monitoring of vital signs might be due to a lack of adequate numbers of nurses.

The present study found that staff distribution in the neonatal unit was insufficient. An average of 156.2 neonates were cared for by 5.5 registered nurses and 2.3 specialist doctors. These findings were in contrast to the gold standard for critically ill patients set forth by the European Federation of Critical Care Nursing Associations in which the standard for critically ill patients is 1:1 (Bernat, Hernandez, Cudat, Tschugg & Poiroux, 2007). The diversity of special care needs requires that the unit be arranged for a graduated care infant population (Hockenberry, Wilson, Winkelstein, Kline & Wong, 2003). There should be adequate facilities and skilled personnel to provide 1:1 nursing care for each seriously ill infant, as well as a means for graduation to 1:3 or 1:4 in a convalescent area where infants require less intensive care until they are ready to leave the unit.

CONCLUSION

Most neonates' mothers were unemployed and had low levels of education. These mothers could have encountered problems with access to antenatal care and might not have understood the necessity of acquiring the best possible antenatal care and delivery ser-

vices. The neonatal unit was overpopulated with 150–180 patients in an 80-bed unit, and understaffed. This situation posed challenges for the rendering of effective nursing care to critically ill asphyxiated neonates.

The unit lacked equipment for resuscitating neonates, putting these babies' lives at risk. Although all asphyxiated neonates were reportedly suctioned and fed, only a few received vitamin K and 10% dextrose. Vital signs were recorded for a minority of these patients and neither epinephrine nor sodium bicarbonate was administered to any patient. The study's findings indicated a few areas where improvements might help to reduce the neonatal asphyxia mortality figures.

RECOMMENDATIONS

The prevention of neonatal asphyxia, and the unnecessary deaths which accompany this condition, must commence during antenatal care. If very young, single and uneducated mothers are at high risk of having babies prone to neonatal asphyxia, they should be identified as high risk during the antenatal care period and referred to an advanced midwife who could provide specialised maternal care and prevent neonatal complications. Nurses and midwives rendering ANC services should be trained to refer pregnant women with potential problems to higher level healthcare institutions for ANC and delivery and neonatal services.

Future studies should record the asphyxiated neonates' places of delivery and the duration of labour. The mothers' utilisation of specific ANC services should also be recorded, including the utilisation of traditional healers, traditional remedies and traditional midwives. These facts could provide indicators for areas to be addressed in order to reduce the incidence of neonatal asphyxia in future.

The neonatal unit should be re-organised in successive sections to accommodate neonates according to the severity of their condition. The allocation of nurses should be done according to the actual number of patients in the neonatal unit, not according to the constant number of beds.

The policy and guidelines for caring for asphyxiated neonates should be revised, taught to all nurses during in-service education sessions, implemented and audited. Every asphyxiated neonate's vital signs must be checked and recorded. Specific guidelines should specify what actions should be taken if the vital signs deteriorate. Guidelines should also specify when to administer dextrose, vitamin K, sodium bicarbonate and epinephrine.

Future research should identify reasons why only a few asphyxiated neonates received vitamin K and dextrose 10%; why none received epinephrine; and why none received sodium bicarbonate.

All birth and neonatal units must be equipped with essential resuscitation equipment, including ambu bags and oxygen masks, and competent staff members who can use this equipment effectively.

The Government of Tanzania should seriously consider opening more neonatal units at other hospitals in order to ease the patient overload on the participating neonatal unit and to facilitate access to such units. Tanzania's Department of Health should seek sponsors to subsidise the specialised training of local nurses and midwives in other countries to strengthen the nurses' and midwives' capacities.

Monthly audits of neonatal mortalities should be done. Aspects of care not recorded, should be addressed during inservice education sessions. Any reduction in neonatal asphyxia mortality rates should be emphasised and efforts made to improve these figures. A huge graph on the neonatal unit's wall should display this trend over time.

LIMITATIONS OF THE STUDY

The source of data was largely dependent on available records (patients' files). In the cases where these files were found to be incomplete, respective mothers were interviewed to obtain the required information. Additionally, this study utilised a relatively small convenience sample, limiting the generalisability of the results to other institutions.

The following were not recorded: mothers' places of delivery; the duration of labour; their utilisation of ANC services; and their utilisation of traditional healers and/or remedies.

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