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HYPOTHERMIA, ASSOCIATED FACTORS AND NEONATAL OUTCOME

BY

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ABSTRACT

Hypothermia in newborn babies is a problem in tropical countries despite warm environmental conditions and it contributes to neonatal morbidity and mortality.

This cohort study was done in the Neonatal Care unit, Muhimbili Medical Centre to determine the prevalence of hypothermia on admission, associated factors and neonatal outcome in terms of morbidity, weight loss, duration of stay in the neonatal unit and mortality. The study was conducted from July to October 1996 and the study population included all neonates admitted to the Neonatal Care Unit during the said period.

The prevalence of hypothermia on admission was found to be 22.4% and hypothermia was not recorded or reported to be a reason for admission in any of the neonates in this study, despite that 13.1% of the hypothermic neonates had severe hypothermia on admission. There was no low reading thermometer in the unit.

Hypothermia on admission was significantly associated with maternal intrapartum medications (P = 0.04), delivery by doctor (P = 0.000), delivery at Muhimbili Medical Centre Obstetrics Theatre (P = 0.000) or delivery in other hospitals(P = 0.00) , delivery by lower segment Caesarian section (P = 0.000) or by low cavity vaccum extraction (P = 0.01), low birth weight (P = 0.002), prematurity (P = 0.001), longer duration of transfer from place of delivery to the Neonatal Care Unit (P = 0.000) and inadequate clothing of the baby after delivery (P = 0.000). It was also

found that hypothermic neonates stayed longer in the Neonatal Care Unit than normothermic ones, they had more postnatal weight loss and increased risk of both morbidity and mortality.

It is concluded that hypothermia is a problem in the Neonatal Care Unit, Muhimbili Medical Centre and is associated with increased morbidity and mortality. Efforts should be made to raise awareness among health providers with more emphasis on prevention. Daily use of low reading mercury thermometers is recommended in order to detect severe forms of hypothermia that require more aggressive management.

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DECLARATION

I declare that this dissertation is my own original work and has not been submitted for similar degree in any other University.

RKisenge ..... 29th Sept, 1997 .....

RODRICK R. KISENGE DATE

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DEDICATION

This work is dedicated to my late Mum and Dad who would have liked to see this work. It is through their sacrifice and encouragement that I was able to attain this level.

ABBREVIATIONS

ABD	- Assisted Breech Delivery
APH	- Antepartum Haemorrhage
BF	- Breast-feeding
EPH Gestosis	- Edema, Proteinuria and Hypertension during pregnancy
GA	- Gestational Age
KAP	- Knowledge Attitude and Practice
LBW	- Low Birth Weight
LSCS	- Lower Segment Caesarean Section
LCVE	- Low Cavity Vacuum Extraction
MMC	- Muhimbili Medical Centre
OFC	- Occipital Frontal Circumference
RDS	- Respiratory Distress Syndrome
SD	- Standard Deviation
SPSS	- Statistical Package for Social Sciences
SVD	- Spontaneous Vertex Delivery
TBA	- Traditional Birth Attendant

INTRODUCTION AND REVIEW OF LITERATURE

Definition of hypothermia in newborn babies:

Hypothermia in the neonates is defined as body temperature below 36.5°C, with the normal range being 36.5°C - 37.5°C.[1] Hypothermia in newborn babies is classified into three groups according to the severity.

i) Cold stress - is defined as body temperature between 36.0°C - 36.4°C.

ii) Moderate hypothermia - is defined as body temperature between 32.0°C - 35.9°C

iii) Severe hypothermia - is defined as body temperature < 32°C.

Thermoregulatory Mechanisms in newborn babies:

The temperature control mechanisms in newborn infants, like in adults are aimed at maintaining a close balance between heat gain and heat loss. The newborn baby produces heat by metabolic activity in all body tissues and mainly through the non-shivering thermogenesis which is a cold induced increase in oxygen consumption in the production of heat.[2] The non-shivering thermogenesis utilises brown fat which accounts for about 2 - 6% of total body weight in human infants.[2,3] Brown fat is sympathetically mediated and is rich in mitochondria. It is found at the back of the neck, between the scapulae, in the mediastinum, along the aorta and surrounding the kidneys and adrenals. The newborn baby can also gain heat from the surrounding environment by convection, conduction and radiation if temperature of the baby is lower than that of the environment.[3]

A newborn infant looses heat by convection, radiation, evaporation and conduction.[1,2,3] Heat is lost by convection from the exposed surface of the infant to the surrounding air. This loss of heat is largely determined by the difference in temperature between the body surface and the environment, it also depends on the movement of air current, such that if it is rapid then convective heat loss is high. Convection is the major source of heat loss when neonates are exposed to cool, draughty rooms.[1,3]

Newborn infants loose heat by radiation from the body surface to the cooler objects in the vicinity, even though they are not in contact. The heat loss by radiation is proportional to the difference between these surface temperatures but independent of the temperature and speed of the air in the environment. This heat loss is more marked when a neonate is exposed naked in a delivery room or a single walled incubator.

Heat loss by evaporation from a newborn baby occurs when fluid (amniotic fluid or water) evaporates from the wet skin or from the respiratory tract to the air. Under normal environmental conditions in a term infant, evaporative heat loss amounts to about a quarter of the resting heat production.[4] This loss of heat by evaporation is more pronounced in the first 30 minutes and it exceeds the ability of the neonate to produce heat for the maintenance of the normal body temperature hence resulting in a fall of body temperature. Preterm infants have high evaporative heat losses because their insensible water loss is high compared with term infants.[5,6,7] This loss of heat is a result of a high transepidermal water loss which is up to six times higher per unit

surface area in a newborn baby of 26 weeks gestation than in a term infants.[8,9] The high transepidermal water loss occurs because the immature infant's skin has a thin, poorly keratinized skin that offers little resistance to the diffusion of water.

The care of the newborn baby can cause an increase in evaporative heat loss by several mechanisms, which include, damage of the skin which can be caused by monitoring probes or electrodes.[10] Exposure of the baby to radiant energy is another mechanism which may cause an increase in evaporative heat loss.[6,11,12,13] This increase can be explained partly by the higher surface temperatures, greater air speeds and lower local humidity when infants are exposed to radiant energy since these three physical factors increase evaporative heat loss.[13] Loss of body heat by conduction occurs when there is direct contact of the skin with a cooler object or surface such as a table, weighing scale, or rubber sheets. Fortunately the amount of heat that a newborn infant looses by conduction is small unless the baby is in direct contact with a metallic surface.[1,3]

Certain characteristics of newborn babies put them at an increased risk of heat loss compared to adults. These include, a relatively large surface area in relation to the body weight which is approximately three times that of adult.[14] In addition newborn babies have a large head in proportion to the body size and it is estimated that up to 75% of the body heat loss in neonates can be through uncovered head. Another factor which contributes to increased heat loss in newborn babies, especially those with low

birthweight, is the thin layer of subcutaneous fat which usually acts as an insulating material for the heat loss through the skin.[14,15,16]

Response of the newborn baby on exposure to cold environment:

A newborn baby when exposed to a cold environment makes physiological and behaviour responses aimed at maintaining a constant core body temperature. These responses are initiated by hypothalamic and cutaneous receptors. Physiologically the infant readily increases heat production in response to cold stress without any increase in physical activity mainly through non-shivering thermogenesis that was described earlier. In response to cold, catecholamines are released which act directly on brown adipose tissue, stimulating oxidative phosphorylation and releasing energy as heat in the form of $Na\text{-}K^{+}$ activated adenosine triphosphate (ATP). A newborn infant can more than double his rate of heat production in this way.[4] Peripheral vasoconstriction also occurs in response to cold diverting blood from the infant's body surface to the core. This is well developed in term infants but limited in very immature infants in the immediate newborn period.[17]

Whereas a child and adult will wakeup and become restless when cold, the newborn infant may continue to sleep. Cold infants, however do change their behaviour by becoming more active, sleeping less and adopting a flexed posture, in an attempt to increase heat production and decreasing heat loss. These responses are also seen in pre-term infants.[2,3] At birth the newborn infant does not immediately respond to cold by increasing metabolism but with time this response will develop provided the

baby is healthy and well fed. Sick and low birthweight babies do not have the ability to respond to cold by increasing metabolic rate, and amount of heat produced or gained by crying or body movement is minimal. Further more, preterm and low birth weight babies have much less brown fat compared to term babies.[18]

Factors associated with hypothermia in newborn babies:

Hypothermia in newborn babies has been associated with birth asphyxia, respiratory distress, metabolic acidosis, low birthweight, prematurity, increased risk of subsequent neurological handicap, infections and increased mortality.[19-27] Birth asphyxia for example, causes a variable reduction in metabolic responses to cold stress hence predisposing newborn babies to an increased risk of developing hypothermia. Healthy babies subjected to cold stress immediately after delivery have a low arterial oxygen concentration therefore an increased tendency to develop metabolic acidosis.[18] The incidence of respiratory distress is twice as high in infants who develop body temperature of $< 34.5^{o}C$ after birth than those with normal temperature hence this can contribute to increased mortality in hypothermic neonates. Hypothermia has also been shown to affect brain growth, and follow-up studies have suggested that there may be some association between hypothermia shortly after delivery and risk of neurological handicap later in life. This finding has been attributed to the fact that more calories are used in the production of heat in hypothermic neonates instead of growth.[21]

There is a direct association between hypothermia and neonatal sepsis and this can be a result of effect of hypothermia on the immune system. Hypothermia weakens the immune responses, which include leukocyte motility, phagocytosis and lymphocyte transformation. This apparent failure of the immune system as a result of hypothermia can explain the occurrence of rare infections like Candida peritonitis in hypothermic neonates.[27,28,29] Moreover newborn babies can have severe infections such as meningitis or septicaemia without a rise in body temperature. Since thermoregulatory mechanisms are operative at birth, this observation is sometimes ascribed to immunological defect or inability to form interleukin-1. However, there is evidence that febrile responses does develop soon after birth and lack of fever in hypothermic neonates can reflect a limited thermoregulatory capacity or effect of the environmental temperature at which the neonates are nursed.[28,29] Hypothermia in newborn babies is also known to predispose them to aspiration because of the lethargy which is a common finding in these babies. This lethargy impairs swallowing more than sucking reflex that is why some hypothermic neonates can suckle, although weakly, and then become cyanosed a few seconds later because of aspiration. Fortunately hypothermia is less common in breastfed babies because of close body contact with the mother.[30,31]

Hypothermia and cold injuries are among the main causes of neonatal deaths such that there is linear increase in neonatal mortality with fall in body temperature.[14,32,33] Several studies have shown that survival of the low birth weight and sick infants is greater when they are nursed in an environment were heat loss is

minimal and body core temperature is within the normal range.[19,32,33,34,35] In one prospective study which was done in India, there was a significant association between hypothermia at admission and mortality, in that study it was reported that 16% of babies admitted with body temperature below 36°C died within the first week compared to none of those admitted with body temperature of ≥ 36°C.[36] In another study on the outcome of neonates weighing less than 2500 gm referred to a Nigerian University Teaching Hospital over a period of thirty months, hypothermia, respiratory distress syndrome and birth asphyxia were the commonest problems encountered. These were also the predominant associated causes of death.[31]

Both mode and place of delivery have influence on the temperature of the newborn baby, for example infants delivered by mothers who received anaesthetic drugs during delivery are more prone to develop hypothermia because these drugs depress the thermoregulatory mechanisms hence impairing heat gain after delivery.[1] Maternal intrapartum medication, especially with sedatives impairs non-shivering thermogenesis hence predisposing a newborn infant to hypothermia after delivery.[38] If the place of delivery is not well prepared to prevent heat loss, it presents a particular hazard for neonatal hypothermia. Another problem that may result or cause neonatal hypothermia to worsen is the process of transferring a newborn infant from place of delivery to the neonatal unit, especially if the neonate is not well covered. It is advised to transfer the child while still in the mother's womb if any risk requiring intensive neonatal care is anticipated.[1,34,39]

Antenatal problems to the mother although may have no direct influence on the temperature of the newborn baby they may have indirect effect. For example maternal infections like malaria can result in delivery of premature baby and as it has been discussed earlier these babies are prone to hyporthermia. Other antenatal problems which may have an indirect effect on the body temperature of the neonate are those which are known to predispose a newborn baby to RDS such as Diabetes mellitus, since RDS is known to predispose newborn babies to hypothermia.

Measurement of temperature in newborn babies:

Proper measurement of the body temperature is important in the assessment of infants heat balance. A low reading mercury thermometer should be used for all measurements since an ordinary thermometer only reads down to 35°C and will not detect severe hypothermia, (low reading thermometers go down to 25°C). Taking axillary temperature is recommended because of safety, hygiene and simplicity. It involves no risk to the infant and if properly done, reflects body core temperature although it takes a little longer than rectal temperature. Studies done in Iowa city showed that there is no significant difference between axillary and rectal temperatures to justify the risks associated with taking temperature rectally.[40] In taking axillary temperature the infant should lie on the back or side and thermometer be placed up in the middle of the axilla.[41] The arm is then held firmly and gently against side of the infants body for at least five minutes. It is important to ensure that the skin of the axilla is in full contact with the bulb of the thermometer. The newborn infants should have

temperatures at least checked immediately after completion of the initial care, and upon arrival to the nursery or postnatal ward. For the healthy babies with their mothers, no further routine measurements are required but it should be explained to the mother that if the feet of the baby feel cold, then temperature should be checked. In case of sick, high-risk infants and those in warming devices a more frequent check in body temperature is necessary.

Prevention of hypothermia in the newborn infants:

Hypothermia can be prevented by drying the infant immediately after birth, placing in close contact with the mother and clothing the baby. It is important to ensure that the delivery room is kept warm and free of draughts from open windows and doors, or from air conditioning systems. The ideal temperature of delivery room (or operating theatre in cases of operative delivery) is about 25°C (i.e., not too hot for the mother and her attendants, and not too cold for the infant).[3] If resuscitation is necessary after delivery, this should be carried out after the infant has been dried and a supplementary heat source such as radiant heater used during resuscitation. Full term infants showing no signs of distress may be dressed with several layers of loose clothing, and their head covered with a clean cap. Trapped air is a very efficient insulator, keeping the warmth in and the cold out, so it is important to avoid a tight wrapping which may restrict breathing and reduce the efficiency of heat retention and insulation by trapped air.[2] Early initiation of breastfeeding is another effective way of

preventing hypothermia in the newborn infant. This is by the transfer of heat from mother to the infant through body contact, provision of calories for heat production and the act of sucking itself which is a physical exertion to the newborn baby; increases metabolism hence heat production.[42,43]

It is advised that bathing the infant, if his temperature is normal should not be before 2 - 6 hours after delivery.[1] If cultural practices in some areas demand bathing, or if the baby is particularly soiled with blood or meconium, then it should be done in a warm room or corner of the room, using warm water, it should be quick and gentle and the infant dried with warm towel, dressed and given back to mother to continue breast-feeding.

Situational analysis of hypothermia in the Neonatal Care Unit, MMC:

As it has been explained before hypothermia is a problem, not only in temperate regions, but also in the tropics and subtropics and it contributes significantly to morbidity and mortality of newborn babies. However, the exact prevalence of this problem at MMC is not known and is probably not given the required priority, taking into consideration the lack of personnel and equipment. It is an acceptable fact that prevention of hypothermia is relatively simple and can be achieved within the existing resource constraints. One prospective study which was done in the Neonatal Care Unit, MMC,

prevalence of hypothermia on admission to the Neonatal Care unit MMC, associated risk factors, proportion of neonates with normal temperature on admission who develop hypothermia while in the ward, and outcome in the neonatal period. It is expected that this study will add information on hypothermia in newborn infants.

Rationale of the study:

Hypothermia carries a significant morbidity and mortality and it is common even in tropical countries despite warm environmental conditions. It is also known that even a single episode of hypothermia at birth is significantly associated with increased morbidity and mortality. However there are no reliable data on this easily preventable problem in the country including in the Neonatal Care Unit, MMC. It is because of these facts that this study was conducted.

Hypothesis:

1. Hypothermia is common in the Neonatal Care Unit, MMC.
2. Neonates with hypothermia on admission have increased morbidity and mortality compared to those with normal temperature.

OBJECTIVES:

Broad Objectives:

To determine prevalence, associated factors and neonatal outcome of newborn babies admitted to the Neonatal Care Unit, MMC with hypothermia.

Specific Objectives:

1. To determine the prevalence of hypothermia on admission among neonates admitted to the Neonatal Care Unit, MMC.

2. To determine factors associated with neonatal hypothermia before, during and after delivery.

3. To determine outcome of neonates with hypothermia on admission to the Neonatal Care Unit.

MATERIALS AND METHODS:

Study Setting:

This study was conducted in the Neonatal Care Unit, MMC. MMC is the National Consultant and Teaching Hospital situated in Dar es Salaam city, Tanzania. Neonatal Care Unit of MMC is the only special Neonatal Care Unit in the city of Dar es Salaam. The Unit has a capacity of 70 beds, with total annual admissions ranging between 5500 - 6000 neonates. Neonates admitted at the unit are those delivered at the centre and those from outside the hospital (other hospitals or home). The Neonatal Unit has been divided into four rooms all with double glazed windows, the warmest of the four rooms is Room one, with temperature of 30°C - 31°C and humidity of about 80%. This room is used for care of pre-term and low birth weight babies. The heating system in the unit utilises electrical heaters placed in each room (two in room one) and in addition there is one overhead radiant warmer fixed on the resuscitation trolley. Recently the unit has received two incubators that are used for the care of preterm babies in the unit. The study was done between July and October 1996, during that time the temperature of Dar es Salaam ranged between 23 - 30°C and the humidity was 60% - 70% (Tanzania Meteorological Department).

Study design:

The study was a cohort study.

Study Population:

The study population comprised all newborn infants admitted to the Neonatal Care Unit during the study period. All neonates with axillary temperature less than 36.5°C on admission were recruited in the exposed group and a neonate admitted subsequent to a hypothermic neonate was recruited in the unexposed group provided that axillary temperature was 36.5 - 37.5°C at the time of admission.

Exclusion:

Newborn infants with axillary temperature > 37.5°C on admission were excluded from the study.

Ethical clearance:

The study was approved by Higher degrees, Research and Publication Committee of Muhimbili University College of Health Sciences.

Data collection:

At recruitment information about age of the mother, parity, antenatal problems, medications given during labour, intrapartum problems, mode of delivery, place of delivery and birth attendant were obtained from admission records, the mother and nurse or midwife accompanying the neonate. This was followed by a routine physical examination, observation on how the baby was clothed, gestational age assessment by Dubowitz method[44] and axillary temperature measurement using a low reading mercury thermometer (Premier BS 691 YX S-NORM-NHS) with a scale between 25 - 40°C. The thermometer was shaken down to 25°C and placed in the right or left

axilla. With the bulb of the thermometer at the apex and half way between the anterior and posterior margins of the axilla. The arm was then held against side of the baby firmly but gently for five minutes to allow the temperature to stabilise. In the ward axillary temperature was recorded every six hours by the investigator or one of the two assistants (Trained Nurses). After use the thermometer was cleaned using cotton wool soaked in methylated ethyl alcohol to avoid cross infecting the neonates. Daily measurement of body weight (in grams) was done for all neonates in the study using standard beam balance (Seca) to the nearest 10 grams. All information obtained were recorded in coded questionnaires and temperature monitoring charts (Appendix I and II). Exit point from the study was when the infant was discharged from the ward or died. On discharge, the diagnosis, date of discharge and treatment given, if any, were recorded. In case of death, the cause of death as documented by death certifying doctor was recorded. Causes of death were classified according to the World Health Organisation (WHO) Manual of the International Statistics Classification of disease.[45] Postmortems were not done because of social reasons.

Newborn babies found to be sick or hypothermic were managed according to the management protocol of the Neonatal Care Unit, MMC. Infants who had normal temperature on admission but developed hypothermia during their stay in the ward were excluded in the final analysis and more neonates with normal temperature on admission were recruited in their place. These were excluded because the hypothermic episode could have affected their outcome as unexposed neonates.

For the purpose of this study an infant was considered to be adequately clothed if was found to be clothed with two or more cotton clothes covering the whole body including the head at the time of admission and anything less than this was considered to be inadequate clothing.

Sample Size:

Sample size was estimated using Epi Info Version 6 Computer Program, and it consisted of a minimum of 282 neonates, 141 exposed and 141 unexposed. In the calculation of sample size the following assumptions were made:

- Mortality is Normothermic group (unexposed) = 25%
- 95% confidence interval
- Power of 99%
- Risk ratio = 2
- Ratio Exposed : Unexposed = 1:1

Statistical Analysis:

Statistical analysis was done using SPSS (Window Version 6.1, SPSS Inc., Chicago 1994) and Epi Info,Version 6. Significance testing was done using Chi-square test, student t-test or Kruskal-Wallis test as appropriate. The statistic was considered significant if the P-value was < 0.05. Independent effect of variables found to be significantly associated with hypothermia on admission and poor outcome was analysed using logistic regression.

RESULTS:

A total of 1,632 newborn babies were admitted to the Neonatal Care Unit during the study period. Of these 747 neonates were recruited into the study. Of the 747 neonates, 366 had hypothermia on admission while 381 had normal body temperature. The prevalence of hypothermia on admission to the unit is 22.4% (i.e., 366 out of 1,632 neonates). Of the 381 neonates who had normal temperature on admission 15 (3.9%) developed hypothermia during stay in the Neonatal Care Unit and they were excluded in the final analysis. It was observed that low reading thermometers were not routinely used in the neonatal unit. No newborn baby had hypothermia indicated as reason for admission despite 13.1% of hypothermic neonates having severe hypothermia at the time of admission (Table 1).

Table 1: The Distribution of Hypothermic neonates.

ADMISSION TEMPERATURE	NUMBER	PERCENTAGE
Severe Hypothermia (Temp. <32°C)	48	13.1%
Moderate Hypothermia (Temp. 32 - 35.9°C)	113	30.9%
Cold Stress (Temp. 36-36.5°C)	205	56%
Total	366	100%

Table 2 shows mean age and parity of the mothers of 732 neonates who were included in the final analysis.

Table 2: Mean Maternal Age and Parity.

CHARACTERISTIC	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	t-test	P-VALUE
Maternal age (means ± SD)	24 ± 6	24 ± 6	0.45	0.79
Parity (means ± SD)	2 ± 1	2 ± 1	0.57	0.57

The mean maternal age and parity were 24 and 2 respectively, there was no statistical significant differences in terms of the two maternal characteristics between the two groups of neonates.

Table 3 shows relationship between maternal antenatal problems and temperature of the newborn infant at the time of admission.

Table 3: Maternal antenatal problems in relation to admission temperature.

ANTENATAL PROBLEMS	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Present	141 (50.9%)	136 (49.1%)	277
Absent	225 (49.5%)	230 (50.5%)	455
Total	366	366	732

$X^2 = 2.61$ (DF = 1) P = 0.1

As can be seen in Table 3 above there is no statistical significant difference between presence of maternal antenatal problems and body temperature on admission to the neonatal unit

Table 4 below shows antenatal problems of mothers of the neonates in the study.

Table 4: Maternal antenatal problems.

PROBLEMS	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Anaemia	84 (50.9%)	81 (49.1%)	165
Premature labour	52 (54.2%)	44 (45.8%)	96
EPHG	45 (60%)	30 (40%)	75
Previous scar	31 (49.2%)	32 (50.8%)	63
Malaria	30 (50.8%)	29 (49.2%)	59
Abruptio placenta	11 (52.4%)	10 (47.6%)	21
Polyhydramnios	10 (56.6%)	9 (47.4%)	19
Placenta praevia	8 (50%)	8 (50%)	16
Others	6 (50%)	6 (50%)	12
Total responses	277	249	526

Some mothers had more than one antenatal problem hence the total number of responses is different between the two groups. Antenatal problems grouped as others include bad obstetrics history(8), epilepsy(3), and rheumatic heart disease(1).

The effect of maternal intrapartum medications on body temperature of the newborn baby at the time of admission to the neonatal unit is shown in Table 5.

Table 5: Maternal intrapartum medications in relation to body temperature.

INTRAPARTUM MEDICATIONS	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Yes	81 (57.9%)	59(42.1%)	140
No	285 (48.1%)	307 (51.9%)	592
Total	366	366	732

$X^2 = 4.27$ (DF = 1) P = 0.04

Analysis shows statistical significance association between maternal intrapartum medications and hypothermia on admission, X2 = 4.27, P-value = 0.04.

Medications given to mothers during labour are shown in Table 6.

Table 6: Distribution of maternal intrapartum_medications.

MEDICATION	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Diazepam	79 (68.7%)	36 (31.3%)	115
Pethedine	70 (70%)	30 (30%)	100
Phenobarbitone	50 (58.8%)	35 (41.2%)	85
Oxytocin	31 (50.8%)	30 (49.2%)	61
Hydrallazine	20 (54.1%)	17 (45.9%)	37
Others	9 (47.4%)	10 (52.6%)	19
Total renponses	259(100%)	158(100%)	417

Medications used more commonly during labour were Diazepam, Pethedine and Phenobarbitone. Some mothers were given more than one medication during labour hence the total number of responses is different between the two groups.

Table 7: **Intrapartum problems in relation to admission temperature.**

ANTENATAL PROBLEMS	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Present	82 (48.8%)	86 (51.2%)	168
Absent	284 (50.4%)	280 (49.6%)	564
Total	366	366	732

$X^2 = 0.12$ (DF = 1) P = 0.73

There is no statistical significant difference between intrapartum problems and body temperature of the neonate at the time of admission to the neonatal unit.

Table 8 compares the body temperature at the time of admission in relation to the mode of delivery.

Table 8: **Temperature in relation to the Mode of Delivery.**

MODE OF DELIVERY	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	X^2	P-VALUE
SVD	190 (42.8%)	254 (57.2%)		
LSCS	147 (60.7%)	95 (39.3%)	20.2	0.000
ABD	14 (56%)	11 (44%)	1.68	0.195
LCVE	15 (71.4%)	6 (28%)	6.67	0.01

Statistical analysis shows that admission hypothermia was significantly associated with delivery by LSCS or LCVE.

The distribution of maternal and foetal intrapartum problems in the study is shown in Table 9. Some had more than one intrapartum problem, therefore total number of responses is different between the two groups.

Table 9: Distribution of maternal and foetal intrapartum problems.

PROBLEMS	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Fetal distress	56 (57.1%)	42 (42.9%)	98
Eclampsia	23 (56.1%)	18 (43.9%)	41
Poor progress of labour	16 (53.3%)	14 (46.7%)	30
Infected liquor	13 (50%)	13 (50%)	26
Malpresentation	15 (57.7%)	11 (42.3%)	26
Retained placenta	12 (46.2%)	13 (53.8%)	25
Prolonged labour	14 (58.3%)	10 (41.7%)	24
Postpartum H'ge	11 (50%)	11 (50%)	22
Cord complications	12 (57.1%)	9 (42.9%)	21
Others	8 (57.1%)	6 (42.9%)	14
Total responses	180(100%)	147(100%)	327

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Maternal intrapartum problems grouped as others included cephalo-pelvic disproportion(10), maternal death(3) and congestive cardiac failure(1).

Table 10 shows the relationship between body temperature at the time of admission to the neonatal unit and the place of delivery.

Table 10: Body temperature in relation to the place of delivery.

PLACE OF DELIVERY	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	X^2	P-VALUE
MMC Labour Ward	150(37.5%)	250(62.5%)		
MMC Obstetric Theatre	147(61%)	94(39%)	33.39	0.00
Other Hospitals	59(79.7%)	15(20.3%)	45.18	0.00
Home	10(58.8%)	7(41.2%)	3.14	0.08

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It is evident from Table 10 that most deliveries were from MMC Labour Ward. Statistical analysis shows that hypothermia on admission was significantly associated with delivery in MMC Obstetrics Theatre and delivery in other hospitals and neonates delivered at MMC labour ward were less likely to be hypothermic on

admission. There was no significant association between body temperature on admission and home delivery.

Table 11 shows the relation of body temperature on admission to the birth attendant.

Table 11: Body temperature on admission in relation to birth attendant.

BIRTH ATTENDANT	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Nurse	204	260	464
Doctor	161	104	265
Total	365	364	729

$X^2 = 19.02$ (DF = 1) P = 0.00

Most babies in this study were delivered by a nurse. Analysis shows statistical significance difference on admission temperature between the two groups in relation to birth attendant. Only three neonates were delivered by TBA (two normothermic and one hypothermic) in this study.

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Table 12: Characteristics of newborn babies in the study.

CHARACTERISTIC	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	Test	P-Value
1.Sex: Male	211 (51.3%)	200 (54.6%)	X^2=0.49	0.48
Female	155 (48.3%)	166 (45.4%)		
2.Birthweight:				
< 2500 gm	122 (59.2%)	84 (23%)		
≥ 2500 gm	244 (46.4%)	282 (77%)	X^2=9.75	0.002
3.GA: < 36 wks	94 (61.8%)	58 (15.8%)	X^2=10.76	0.001
≥ 36 wks	272 (46.9%)	308 (84.2%)		
4.Breastfed:				
Yes	7 (41.2%)	10 (2.7%)		
No	359 (50.2%)	356 (97.3%)	X^2 =0.54	0.462
5.Transfer- time [Minutes] (Mean ± SD)	88.14± 72.05	52.55 ±37.82	t =8.4	0.000

Table 12 shows characteristics of neonates in relation to sex, birth weight, gestational age, time before transfer to the neonatal unit and breast-feeding status prior to admission. X^2 was used in the comparison of percentages while means were compared by student t-test. Hypothermia on admission was significantly associated with low birth weight, prematurity and longer duration of time before transfer to the neonatal care unit. There was statistically no difference between the two groups of

neonates in terms of sex and breast-feeding status prior to admission. Very few neonates (1.9%) in hypothermic and 2.7% in the normothermic group) were breastfed before they were brought to the neonatal unit.

Table 13 compared body temperature on admission in relation to the way the baby was clothed when brought to the neonatal unit.

Table 13: Admission temperature in relation to baby_clothing.

CLOTHING	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	TOTAL
Inadequate clothing	121 (86.4%)	19 (13.6%)	140
Adequate clothing	245 (41.4%)	347 (58.6%)	592

$X^2 = 91.89$ (DF = 1) P = 0.00

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Analysis shows statistical significance assosiation between inadequate clothing and hypothermia on admission to the neonatal unit.

Table 14 shows various causes of morbidity on the neonates according to the body temperature on admission to the neonatal unit. Some neonates had more than one cause of morbidity.

Table 14: Causes of morbidity.

DISEASES	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES	X^2	P-Value
Low birth weight	108 (59%)	75 (41%)	11.9	0.000
Birth asphyxia	104 (60.8%)	67 (39.2%)	16.01	0.000
Prematurity	82 (60.7%)	53 (39.3%)	12.46	0.000
Infected liquor	41 (46.1%)	48 (53.9%)	1.1	0.294
RDS	44 (86.3%)	7 (13.7%)	53.69	0.000
Cord sepsis	28 (53.8%)	24 (46.2%)	0.62	0.62
Septicaemia	20 (57.1%)	15 (49.2%)	0.52	0.473
Haemorrhage	20 (66.7%)	10 (33.3%)	6.67	0.009
Pneumonia	18 (66.7%)	9 (33.3%)	6.00	0.014
Total responses	465(100%)	308(100%)		

Causes of morbidity significantly associated with hypothermia were LBW , RDS, prematurity, birth asphyxia, haemorrhage, and pneumonia.

Table 15 outlines the outcome in terms of weight loss and duration of stay in the Neonatal Unit in relation to the admission body temperature.

Table 15: Outcome in terms of weight loss and duration of hospital stay.

OUTCOME	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES		P-Value
Postnatal weight loss (gm) (Mean±SD)	51.26±27.93	23.89±15.53	[1]t=16.39	0.00
Duration of stay (days) (Mean±SD)	4 ± 2	2 ± 1	[2]H=125.31	0.00

[1] **t** = Students t - test. [2] **H** = Kruskal - Wallis test for two groups.

The mean body weight loss was greater in the hypothermic compared to the normothermic neonates and the difference was statistically significant (P = 0.00). Hypothermic neonates stayed longer in the neonatal unit compared to the normothermic neonates (P = 0.00).

The outcome in terms of mortality in the two groups of neonates in the study is shown on Table 16.

Table 16: Mortality in relation to admission temperature.

OUTCOME	DIED	SURVIVED	RR	95% CI	P - Value
HYPOTHERMIC	33 (9%)	333 (91%)			
			3.30	1.65 - 6.60	0.00
NORMOTHERMIC	10 (2.7%)	356 (97.3%)			
	366	366			

RR = Relative risk; CI = Confidence interval

Mortality was significantly associated with hypothermia on admission. The relative risk as seen in Table 16 above is 3.30 with 95% confidence interval of 1.65 - 6.60.

Table 17 summarises the causes of death in all 43 neonates who died.

Table 17: Causes of death among 43 neonates, according to admission temperature.

CAUSES	HYPOTHERMIC NEONATES	NORMOTHERMIC NEONATES
Birth Asphyxia	13 (39.4)	4 (40)
Septicaemia	9 (27.3)	3 (30)
RDS	6 (18.2)	1(10)
Pneumonia	3 (9.1)	1(10)
Haemorrhage	2 (6.1)	1(10)
Total	23 (100%)	10 (100%)

The common associated causes of death among forty three neonates who died in this study were birth asphyxia, septicaemia and pneumonia.

Results of logistic regression analysis for the risk factors of hypothermia are shown in Table 18.

Table 18: Results of logistic regression analysis.

VARIABLE	[1]β	[2]SE	[3]DF	P-VALUE
Intrapartum medications	0.3994	0.1732	1	0.021
Delivery by LSCS	1.3601	0.5049	1	0.007
Delivery by LCVE	1.1556	0.3059	1	0.000
Delivery at OBS Theatre	2.0394	0.3229	1	0.000
Delivery by Doctor	1.5185	0.2186	1	0.000
Birth weight	-0.0685	0.0070	1	0.000
Clothing	-1.9316	0.3059	1	0.000

[1]β = Correlation coefficient. [2]SE= Standard error of β. [3]DF= Degrees of freedom.

When β is positive, for a unit increase in the variable, the log odds that the infant will develop hypothermia increases by the value of β. When β is negative, for a unit increase in the variable, the log odds that the infant will develop hypothermia decreases by β. (If the log odds decreases, the probability of developing hypothermia decreases and vise versa).

DISCUSSION:

The prevalence of hypothermia on admission to the Neonatal Care Unit is 22.4%, this prevalence is higher than 6.7% which was reported by Ji-xiao Cheng et al in China.[27] This difference can be explained by the fact that in their study they studied newborn babies with sclerema which is a manifestation of severe form of neonatal hypothermia. However, prevalence in the current study is lower than that reported in other studies.[19, 23,43,47,48,49] This can partly be explained by differences in the altitude, environmental temperature and humidity between Dar es Salaam and places where these other studies were conducted. For instance the Ethiopian study was done in Addis Ababa, a City situated at high altitude with cold environmental temperature (it ranged between 9.8°C and 11.4°C when the study was conducted).[19] The temperature of Dar es Salaam during this study ranged between 23°C - 30°C. Despite the differences in reported prevalence, the study does confirm earlier reports that neonatal hypothermia is a problem even in the tropics.

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Hypothermia was not recorded or reported as reason for admission in any of the newborn babies in this study although some had severe hypothermia at the time of admission (13.1% of the hypothermic neonates had severe hypothermia). Similar observation was reported in Zambian study,[43] this may suggest that hypothermia is not considered as a problem in tropical climates and is given little attention by health care providers. This attitude may be influenced by the fact that slight fall in body temperature is often regarded as clinically unimportant. Second possible explanation

for the little attention given to hypothermia is unavailability of low reading thermometers for routine use in the care of newborns as a result severe neonatal hypothermia may go unnoticed.

Hypothermia on admission was significantly associated with maternal intrapartum medication. It is known that some of medications given to mother during labour, especially those with sedative effect predispose newborn baby to hypothermia by interfering with thermoregulatory centre and with reflexes responsible for heat production soon after delivery. This effect can indirectly be observed from the finding that neonates delivered by LSCS had increased risk of being hypothermic on admission probably due to anaesthetic drugs given to mother during operation. Therefore it should be anticipated that the baby of a mother who has been given medications during labour is at risk of developing hypothermia. As observed in the study the common medications given to the mother were Diazepam, Pethedine, and Phenobarbitone.

Neonates delivered by low cavity vacuum extraction were observed to have increased risk of hypothermia on admission, possibly because mothers delivered by this method had EPHG or prolonged labour of more than 18 hours hence their babies were prone to asphyxia neonatorum and this is known to predispose newborn babies to hypothermia. Another possible explanation for this observation is the fact that delivery by LCVE is associated with trauma to the baby hence adding to the risk of hypothermia. For instance out of twenty one babies delivered by LCVE in this

study, seven had scalp bruising and three had subaponeurotic bleeding. Bruising of the skin is associated with increased transepidermal heat loss.[8,9,10]

Hypothermia on admission was significantly associated with delivery by LSCS. This could be multifactorial; firstly as reported earlier, it is possible that anaesthetic drugs given to mother during operation predispose the newborn baby to hypothermia.[1] Secondly, the environment in the operating theatre predisposes the neonate to hypothermia despite precautions taken to switch off the air-condition machine before the baby is delivered to the time when it has been transferred out of the theatre. The temperature of the operation theatre ranged between 20 - 24°C during the study period. Thirdly, the indications for LSCS such as poor progress of labour, prolonged labour, fatal distress and cord complications may have contributed to an element of birth asphyxia and hence hypothermia.

Neonates delivered in other hospitals were found to have increased risk of being hypothermic on admission to the neonatal unit, a study is needed to evaluate the environmental conditions of delivery rooms in these hospitals and to see if there are factors which might have contributed to this observation. Moreover, it may also be related to duration of transfer from one hospital to another, especially at night.

Newborn babies delivered by a doctor were found to have increased risk of hypothermia, this finding can be explained by the fact that most (91.3%) of the deliveries conducted by a doctor were LSCS and as it has been discussed earlier it predisposes a neonate to hypothermia. There were only three neonates delivered by

TBA in this study hence meaningful analysis on the effect of being delivered byTBA on the body temperature of the newborn baby could not be done.

Inadequate clothing of the newborn baby is another factor which was demonstrated to be associated with increased risk of hypothermia on admission, similar observation was reported by Johanson et al. in Kathmandu.[46] In their study cold environmental temperature and not being well wrapped were important risk factors for hypothermia in neonates. In the literature it is documented that heat loss is nearly five times as great in wet infants exposed to room air compared to those who were both dried and warmed.[16] It is therefore important to note that drying the baby and clothing it adequately can decrease the risk of becoming hypothermic.

Time taken to transfer the infant from place of delivery to the neonatal unit was found to be associated with increased risk of hypothermia on admission, a similar observation was reported by Isleta in Manilla.[25] It is possible that during the process of transfer, the neonate is exposed to a cold environment which predisposes it to the heat loss and hence hypothermia. This is more so if the initial rewarming procedure was not done and the baby is inadequately clothed.

Increased risk of hypothermia in low birth weight and premature babies have also been reported in other studies.[27, 34,40,46] In one of these studies for instance high risks for hypothermia were prematurity, low birth weight and birth asphyxia.[34] Brown fat which is the main source of energy during non-shivering thermogenesis is of reduced quantity in preterm and low birth weight neonates hence increased risk of

hypothermia. In addition if a neonate is premature thermoregulatory mechanisms are less developed, and they have large body surface area in proportion to the body weight. All these factors contribute to the increased risk of hypothermia in this group of neonates.

It is known that early initiation of breastfeeding decreases the incidence of hypothermia in newborn babies because of close body contact hence direct transfer of heat from the mother to the baby and through the physical exertion inherent in suckling.[2,3,42] In this study breast-feeding status prior to admission did not differ significantly between the two groups of neonates. However, only 2.3% of neonates were breastfed prior to admission, this low rate of breastfeeding may be due to the sickness of the child or mother for which the neonate was admitted to the unit. However, it could have contributed to the development of hypothermia while in the ward in 3.9% of the neonates who had normal temperature on admission.

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Hypothermic neonates had significantly more weight loss compared to those with normal temperature on admission, this can be a result of diversion of calories to heat production so as to regulate body temperature towards normal instead of growth.[50,51,52] Although weight loss is common in the first week of life but the difference in weight loss in the two groups may explain the influence of hypothermia on rate of growth.

This study found a statistically significant association between hypothermia and mortality, similar findings were reported in other studies.[14,19,22,26,32,37] Although

this study did not establish a direct relationship between admission hypothermia and mortality, but a 3.5 times higher risk of death among hypothermic neonates cannot be neglected. A study done in Ethiopia showed a relative risk of 2.2 in mortality among hypothermic compared to normothermic infants.[34] It is therefore possible to reduce neonatal mortality by preventing hypothermia.

Hypothermic neonates stayed longer in the hospital than normothermic neonates, this can possibly be due to increased morbidity, poor weight gain and prematurity in this group. The increased duration of stay in the hospital affects maternal-child bonding and is an additional economic burden to the hospital and the family. All these problems can be minimised by preventing hypothermia.

CONCLUSIONS:

1. The prevalence of hypothermia on admission to the Neonatal Care Unit, MMC is 22.4%.

2. Factors significantly associated with hypothermia at the time of admission to the neonatal unit include, maternal intrapartum medications, delivery in other hospitals, delivery in MMC Obstetrics Theatre, delivery by LSCS or LCVE, low birth weight, longer duration of transfer from place of delivery to the neonatal Unit and inadequate clothing of the baby after delivery.

3. Hypothermia on admission was associated with poor neonatal outcome in terms of morbidity, increased weight loss, longer duration of stay in the neonatal unit and mortality.

4. Despite 22.4% of infants having hypothermia at time of admission, none had hypothermia recorded as reason for admission. Therefore one can conclude that hypothermia is a neglected problem.

RECOMMENDATIONS

1. There is need to study the degree of awareness on neonatal hypothermia among health providers and the community. Where this will be found to be low, measures to increase the awareness should be taken; by seminars, case presentation, and role play.

2. Hypothermia can be prevented by simple measures like wiping the baby dry soon after delivery, adequate clothing of the baby, provision of warm environment during and after delivery, avoiding prolonged naked exposure of the baby and early initiation of breast-feeding. This should therefore be emphasised.

3. Where medications such as Diazepam, Pethedine and Phenobarbitone are given to the mother during labour, extra caution should be taken because a neonate is at risk of becoming hypothermic after delivery.

4. During transfer of the baby from place of delivery to the neonatal unit the baby should be held close to the chest of the mother, (or any other responsible person in case the mother is sick), and adequately clothed to minimise heat

loss. It is also important to make sure that the transfer time is as short as possible by using the fastest means of transport available.

5. It is recommended that low reading mercury thermometers be used in daily clinical practice so as to detect severe hypothermia which requires more aggressive management.

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