

# PREVALENCE OF HYPERGLYCEMIA AND ASSOCIATED RISK FACTORS IN NEONATES WITH SEPSIS AT KISII LEVEL FIVE HOSPITAL

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A dissertation submitted in partial fulfillment of the requirement for the degree of Masters in  
Medicine (MMED) in Pediatrics and Child Health, University of Nairobi.

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## DECLARATION

This dissertation is my original work and has not been presented for the award of a degree in any other university.

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## **DEDICATION**

To my husband

*Fred Chumo*

for his unwavering support and encouragement

and

My parents

*James and Lucy Njihia,*

for their unconditional love , support and

for been my constant source of inspiration.

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## **LIST OF ABBREVIATIONS**

|      |   |                                    |
|------|---|------------------------------------|
| CAMP | - | Cyclic Adenosine Monophosphate     |
| ELBW | - | Extremely Low Birth Weight         |
| GLUT | - | Glucose Transporter                |
| IL   | - | Interleukin                        |
| KDHS | - | Kenya Demographic Health survey    |
| TNF  | - | Tissue Necrosis Factor             |
| PICU | - | Pediatric Intensive Care Unit      |
| MCH  | - | Maternal Child Health              |
| I.T  | - | Immature to total neutrophil count |

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## **ABSTRACT**

### **Background**

The highest proportion of under five mortality occurs in the neonatal period with a global estimation of 4 million infants dying annually in the first four weeks of life .The main causes of death are prematurity- 28%, neonatal infections- 26% and asphyxia- 23%. The neonatal mortality rate in Kenya is 31/1000 live births with neonatal sepsis contributing significantly to the high neonatal mortality rate. Neonatal sepsis results in metabolic derangements. These include hyperglycemia which is associated with high mortality rates. Other deleterious effects include impaired immunologic function, osmotic diuresis with electrolyte imbalances, intracranial hemorrhage and prolonged hospital stay.

### **Objectives**

#### **Primary Objectives**

To determine the prevalence of hyperglycemia in neonates with sepsis admitted at Kisii Level 5 Hospital.

#### **Secondary Objective**

To determine the risk factors associated with hyperglycemia in neonates with sepsis admitted at Kisii Level 5 Hospital.

To determine the mortality of neonates with hyperglycemia in sepsis at Kisii Level 5 Hospital.

## **Methodology**

A cross sectional study was conducted at Kisii Level 5 hospital newborn unit and pediatric ward. All neonates aged 0-28 days with suspected neonatal sepsis were recruited after informed parental consent was obtained. Neonatal sepsis was suspected in patients presenting with any one of the following 7 signs -difficulty in feeding , convulsions ,temperature greater than 38 degrees or less than 35.5 degrees , respiratory rate greater than 60 breaths per min ,lower chest wall indrawing and reduced activity .Neonatal data was recorded in a questionnaire that was also used to collect maternal data. Glucose levels were assayed at admission and levels above 8.3mmol/l were considered as hyperglycemia. Blood culture and I.T ratio samples were collected at admission.

## **Results**

In total, 68 neonates admitted to Kisii Level V Hospital with neonatal sepsis were recruited into the study. Following exclusion of 16 neonates who were on dextrose infusion before the first glucose reading, a total of 52 neonates were used in the analysis. Hyperglycemia was present in 12/52 with a prevalence of 23%. Six neonates had positive blood cultures. In the multivariable logistic regression, use of herbal medication ( $p=0.05$ ) and I.T ratio $>0.2$  ( $p=0.038$ ) were significantly associated with hyperglycemia .Length of hospital stay and mortality did not have a significant association with hyperglycemia.

## **Conclusion**

The prevalence of hyperglycemia was found to be 23% in neonates with sepsis admitted to Kisii Level 5 hospital with peak glucose levels being 10.7mmol/l .Use of herbal medication and an elevated I.T ratio were significantly associated with hyperglycemia. Mortality and length of hospital stay were not significantly associated with mortality.

## INTRODUCTION

The highest proportion of under-five mortality occurs during the neonatal period with a global estimation of 4 million infants dying annually in the first 4 weeks of life. Three quarters of these neonatal deaths happen in the first week of life with 99% being from the developing countries with sub-Saharan Africa having high rates (5). Globally, the main causes of neonatal deaths are prematurity-28%, neonatal infections-26% and birth asphyxia-23% (5).

In Kenya, the neonatal mortality rate is 31/1000 live births as per the KDHS while the infant mortality rate is 52/1000 live births with 60% of infant deaths occurring during the first month of life (7).

Metabolic derangements associated with increased mortality in neonatal sepsis include hyperglycemia, hypoglycemia, metabolic acidosis (1) and elevated lactate levels (1,11). Hyperglycemia is common in the critically ill children and indicates severity of the disease (13, 20, 22). It has been associated with increased mortality and prolonged hospital stay (20). Hyperglycemia may occur without any clinical manifestation or may present with glycosuria and osmotic diuresis (3,30). Its other effects include impaired immune function (2) and intracranial hemorrhage (3). Hyperglycemia is easily detected and management can be instituted early to avoid these deleterious effects.

There is no established definition of hyperglycemia in neonates, various researches have suggested whole blood level  $>6.9\text{mmol/l}$  and plasma glucose levels  $>8.3\text{mmol/l}$  based on renal threshold for infants (3,10).

## LITERATURE REVIEW

Majority of studies on neonatal hyperglycemia focus on preterm and low birth weight neonates and most studies on hyperglycemia in sepsis involve older children .This has resulted in paucity in data regarding hyperglycemia in neonates with sepsis. Mburu et al (24) illustrated that the prevalence of hyperglycemia in neonates admitted at Kenyatta National Hospital is forty six percent [46.2%] with intravenous dextrose infusion and other factors such as sepsis contributing to the development of hyperglycemia .She however, did not find a significant association between hyperglycemia and sepsis[p<0.276].

Bhutta et al (1) carried out a retrospective study at Aga khan University Medical Centre in Pakistan involving 292 neonates with confirmed sepsis to analyze the factors determining outcome and mortality in neonatal sepsis. A total of 63 [21%] neonates had hyperglycemia. The overall mortality was 65 [22.2%] and hyperglycemia was present in 25 [39%] of the non-survivors [p<0.05].

Ahmad et al (11) conducted an analytical study at the neonatal intensive care unit of Fazle Omar Hospital in Pakistan to determine blood glucose levels of neonates with proven and probable sepsis. Among 502 neonates, the prevalence of hyperglycemia was found to be 6.9%.Mortality in this group of neonates was significantly high (p<0.05).

Hall et al (13) conducted a study that concluded that hyperglycemia is common in neonates with necrotizing enterocolitis and is associated with increased mortality and longer stay in the intensive care unit. The study included 95 neonates with confirmed necrotizing enterocolitis admitted to the intensive care unit .Glucose levels ranged from 0.5 to 35 mmol/l and 69% of the neonates became hyperglycemic (glucose >8 mmol /l) during the admission period. The

mortality rate was higher in neonates with a maximum glucose level of  $>11.9\text{mmol/l}$  and late mortality ( $>10$  days of admission) was also higher in these neonates [  $p=0.009$ ].

Branco et al (21) conducted a prospective cohort study on the relationship between serum glucose levels and mortality in children older than 1 month with septic shock. Fifty seven children were enrolled. The peak glucose level in those with septic shock was  $11.8\text{ mmol/l} \pm 5.4\text{ mmol/l}$  and the mortality rate was 49.1% (28/57). In non survivors, the peak glucose level was  $14.5\text{mmol/l} \pm 6.1\text{mmol/l}$  which was higher ( $p <0.01$ ) than that found in survivors  $9.2 \pm 3.0\text{ mmol/l}$ . The relative risk of death in patients with peak glucose levels of  $>9.9\text{ mmol/l}$  was 2.59 (range 1.37- 4.88).

Several case reports have been published on hyperglycemia in neonates with sepsis. Mittal et al (33) published a case report on a term neonate who presented to hospital aged 9 days with features of sepsis. Further examination revealed the patient was in septic shock with glucose levels  $>40\text{mmol/l}$ , insulin infusion was required to normalize glucose levels. Blood culture grew staphylococci aureus, confirming sepsis.

Obasa et al (34) at the Ilorin teaching hospital in Nigeria also reported of a 13 day neonate who presented to hospital with a 12 hour history of refusal to breastfeed and convulsions. The blood glucose level at the time of admission was  $20\text{mmol/l}$ . Post-mortem Lumbar puncture revealed elevated white cell count confirming sepsis.

Louaib et al (35) also reported of 6 day old neonate who presented to hospital with vomiting. The glucose level was elevated at  $9.7\text{mmol/l}$ . Blood cultures revealed group B streptococci and blood glucose levels normalized after antibacterial treatment.



## **Glucose Homeostasis**

At birth, the neonate switches from having a continuous supply of glucose from the mother through the placenta to maintaining its own glucose supply during the intermittent feeds(18).Glucose homeostasis requires a balance between utilization and production from the liver .This balance is controlled by insulin and counter regulatory hormones namely glucagon, growth hormone, cortisol and catecholamines (8, 18).

### **Functions of Insulin**

1. It promotes muscle glucose uptake and metabolism- the resting muscle membrane is impermeable to glucose except when stimulated by insulin (2 , 23 ).
2. It promotes uptake, storage and utilization of glucose by the liver (2, 23).
3. It also promotes conversion of excess glucose into fatty acids and inhibits gluconeogenesis in the liver (2, 23).

### **Functions of Glucagon**

Glucagon causes glycogenolysis in the liver leading to increased plasma glucose levels (2-3, 9, 17, 23) and it also causes an increase in gluconeogenesis by increasing the rate of amino acids uptake into liver cells and conversion of these amino acids into glucose (3,16, 17, 23).

Other counter regulatory hormones include growth hormone, cortisol and catecholamines. They cause further release of glucose by the liver (9,16, 23) and also decrease glucose utilization by most cells of the body, increasing the total plasma glucose concentration. Other metabolic pathways include lipolysis and ketogenesis (23).Glucose is transported across cells by protein carriers called glucose transporters (GLUTS) that are tissue specific (3, 23).

**Table 1: Glucose Transporters (3)**

| Glucose transporter | Primary tissue                        | Characteristic function            | Relative affinity for glucose |
|---------------------|---------------------------------------|------------------------------------|-------------------------------|
| Glut 1              | All tissues<br>Important in the brain | Basal glucose uptake               | +++                           |
| Glut 2              | Liver and pancrease                   | Hepatic glucose uptake and release | +                             |
| Glut 3              | Most tissues; CNS                     | Basal glucose uptake               | ++++                          |
| Glut 4              | Muscle and fat                        | Insulin sensitive transporter      | ++                            |
| Glut 5              | Intestine and liver                   | Fructose uptake                    | +                             |

In preterms , hyperglycemia may be more common due to inadequate development of GLUT 4 which is insulin sensitive .GLUT 4 develops progressively during gestation and coincides with the growth of insulin sensitive tissue like skeletal muscle .Decreased skeletal muscle expression of GLUT 4 contributes to insulin resistance in low birth weights and extremely low birth weights (3,8). Enzymes important in glucose metabolism increase in activity with increasing gestational age and in preterm neonates the immature biochemical pathways may lead to hyperglycemia (3).

### **Stress Hyperglycemia in Sepsis**

The ability to control blood glucose levels is known to be impaired in patients subjected to the stress of major surgery, sepsis and other illnesses resulting in hyperglycemia (9).It can also be attributed to different factors including insulin insensitivity common in preterms, drugs like aminophylline , dexamethasone and lipid component of parenteral nutrition (2-3).

Hyperglycemia is associated with prolonged hospital stay and high mortality rates (11-13). It is a marker of severity of illness, a predictor of poor outcome and early sign of sepsis. Hyperglycemia is defined as whole blood glucose concentration of greater than 6.9mmol/l (125mg/dl) or plasma glucose concentration of greater than 8.3mmol/l (150mg/dl) (3, 10) .

### **Pathophysiology of Stress Hyperglycemia**

Stress hyperglycemia is defined as hyperglycemia resolving spontaneously after dissipation of an acute illness .It refers to patients without known diabetes .Stress as measured by increased cortisol levels (3) is an important risk factor for development of neonatal hyperglycemia.

Stress associated with sepsis is characterized by activation of the hypothalamic-pituitary-adrenal axis with release of cortisol from the adrenal gland (9). This is an essential component of the general adaptation to illness and stress .The stress response is also characterized by increased production of catecholamines, growth hormone and glucagon (3,9,17). The underlying illness may affect the scale of hormonal derangements (9).

High hepatic output of glucose especially through gluconeogenesis is the most important contributor to stress hyperglycemia (9,16,17). Excess glucagon is the primary mediator of gluconeogenesis .Cytokines and catecholamines independently and synergistically promote hepatic glucose production .Cytokines also promotes gluconeogenesis by stimulating glucagon production (2).

Insulin levels are normal or decreased despite insulin resistance .Insulin resistance during illness is characterized by an inability to suppress central hepatic glucose production(9). In the peripheral tissues decreased insulin-mediated glucose uptake results from defects in post receptor

insulin signaling (impaired tyrosine kinase activation of insulin receptor substrate 1) and down regulation of glucose transporter 4 (9). Excess cortisol and epinephrine also reduce insulin mediated glucose uptake. Cytokines that is TNF alpha and interleukin 1 inhibit post receptor insulin signaling (2, 9, 10 )The severity of illness is associated with proportional rise in serum cytokines and insulin resistance .In vitro studies demonstrate that hyperglycemia dose dependently stimulates TNF alpha and IL-6 production .These properties aggravate inflammation in sepsis.

Growth hormone, glucocorticoids and catecholamines cause insulin resistance by causing impairment in the post receptor insulin signaling and inhibiting GLUT 4 translocation from its internal membrane stores to the plasma membrane.

Insulin resistance promotes catabolic state in which lipolysis takes place ,excessive free fatty acids exacerbates insulin resistance by disrupting end organ insulin signaling and glycogen synthase (23). All the above lead to high glucose levels in sepsis.

Some interventions performed during in-hospital management and are also risk factors for hyperglycemia include,

#### 1. Drugs

Catecholamines increase glucose production. Aminophylline by inhibiting phosphodiesterase causes a raise in cyclic AMP that inhibits glycogen synthesis and promotes glycogenolysis.

Dexamethasone also increases blood glucose levels.

## 2. Parenteral nutrition

In severe illness, parenteral nutrition is sometimes necessary. The lipid component of parenteral nutrition is associated with increase in glucose levels. Lipids competitively limit glucose oxidation and promote fatty acid carbon oxidation leading to hyperglycemia (3-4,8,12).

## 3. Intravenous dextrose infusions

In preterm neonates started on glucose infusion rates greater than 6mg/kg/minute, the incidence of hyperglycemia is high. Anusha et al demonstrated that over 50% of neonates receiving dextrose infusion at a rate greater than 11mg/kg/min had hyperglycemia (4, 8, 29).

## **Clinical Presentation and Complications of Hyperglycemia**

Hyperglycemia causes a rise in serum osmolality, each increment of 1mmol/l of blood glucose concentration causes a rise of 1 mosm/l in serum osmolality (3,24). A rise of serum osmolality to 300mosm/l ( glucose-22 .2mmol/l) causes a rapid shift in intracellular fluid from the extravascular space to the intravascular space leading to shrinkage of brain cells ,capillary dilation and cerebral hemorrhage. In preterm neonates already at risk of hemorrhage due to immature blood vessels in the germinal matrix , hyperglycemia causes large damaged areas with reduced metabolism ,increased glucose levels and worsening hyperglycemia (18). Hyperosmolality also leads to osmotic diuresis and dehydration (3,17) .All the above can manifest as decreased consciousness and seizures. Hyperglycemia impairs the ability of the host to combat infection as it reduces neutrophil activity, It leads to formation of reactive oxygen species and causes decreased phagocytosis despite accelerated diapedesis of leucocytes into peripheral tissue (2,9,19,15).

Hyperglycemia also impairs complement activity through complement glycation and has potential to compete with micro-organism for attachment of complement, inhibiting opsonization (15). Hyperglycemia causes increased concentration of pro-inflammatory cytokines which are implicated in the development of insulin resistance (2,15). The overall effect being sustained hyperglycemia with aggravated inflammation, worsening of sepsis and increased chance of mortality.

In extremely low birth weight infants, hyperglycemia is associated with retinopathy of prematurity .The exact pathophysiology needs to be elucidated but it is postulated to be due to free oxygen radicals formation (12).

Acute hyperglycemia is also associated with delayed gastric emptying .Gastric emptying is a coordinated process of motor events. Hyperglycemia reduces proximal gastric tone, an effect that may contribute to delayed gastric emptying which leads to malabsorption of nutrients, poor glycemic control and may influence absorption of drugs (14).

Hyperglycemia is associated with increased and early mortality and prolonged length of hospital stay (4,11,12) .

## **STUDY JUSTIFICATION**

The neonatal mortality rate in Kenya remains high at 31/1000 live births as per the KDHS 2008 (7). Approximately 60 % of infant mortality is attributed to neonatal mortality (7). The leading causes of the neonatal mortality are complications due to prematurity [28%] and neonatal sepsis [26%] (6). In neonatal sepsis, the mortality rate is high due to associated metabolic derangements (1). These metabolic derangements include hyperglycemia (10). Studies done in children with severe illness and infections have demonstrated that stress hyperglycemia is independently associated with increased morbidity and mortality (4,12,14).

Kisii Level 5 Hospital has a high neonatal admission rate of 60-150 neonates per month. The neonatal mortality rate is approximately 15-20% with sepsis contributing significantly to this mortality. Blood sugar is not routinely measured in these neonates and occurrence of hyperglycemia is unknown. Hyperglycemia is easily detected and managed and its negative effects can be avoided with early intervention. It is important to determine the burden of hyperglycemia, its risk factors and outcomes so as to sensitize health workers on the importance of frequent monitoring of blood glucose levels.

### **Study Objectives**

#### **Primary Objectives**

To determine the prevalence of hyperglycemia in neonates with sepsis admitted at Kisii Level 5 Hospital.

#### **Secondary Objectives**

To determine the risk factors associated with hyperglycemia in neonates with sepsis admitted at Kisii Level 5 hospital

To determine the mortality of neonates with hyperglycemia in sepsis at Kisii Level 5 Hospital.

## **STUDY METHODOLOGY**

### **Study Design**

A cross sectional study carried out at Kisii Level 5 Hospital.

### **Study area**

The study was carried out at Kisii Level 5 Hospital .It is a regional referral hospital covering south nyanza ,south rift and the entire South Gusii region .Neonatal admissions to the newborn unit and the general ward at the hospital ranges between 50-100 neonates per month with 15-20% been managed for neonatal sepsis.

### **Study population**

Neonates aged 0-28 days admitted to the newborn unit and the paediatric ward with suspected neonatal sepsis. Clinical signs of suspected neonatal sepsis are as indicated in Table 2 below.

### **Case definitions**

Proven neonatal sepsis - clinical syndrome of bacteremia with systemic signs and symptoms of infection with isolation of organism from blood cultures .

Suspected neonatal sepsis –Clinical syndrome with systemic signs and symptoms of infection with no growth of organism from blood cultures .

Hyperglycemia- Whole blood glucose level  $>6.9\text{mmol/l}$  or plasma glucose levels  $>8.3\text{mmol/l}$  based on renal threshold (3,10) .



### **Inclusion criteria**

1. Informed parental consent
2. The presence of any 1 or more of the 7 clinical signs during presentation to the hospital was considered as suspected neonatal sepsis [Table 2] and the neonates were eligible for entry into the study. These signs and symptoms are derived from a large multicentre study done by the Young Infant Clinical Signs Study Group which identified 7 clinical signs in children under 2 months that are predictive of severe illness. The study included 6 countries and 8889 children. The seven signs had a sensitivity of 85% with a specificity of 75% for children aged 0-6 days and a sensitivity of 74% with a specificity of 79% for children aged 7-59 days (30).

**Table 2: Clinical signs that predict sepsis in children under 2 months, a multicentre study.**

|                    |                           |
|--------------------|---------------------------|
| Difficulty feeding | Respiratory rate >60b/min |
| Reduced Activity   | Severe chest indrawing    |
| Temperature >37.5  | Convulsions               |
| Temperature <35.5  |                           |

Source: The Lancet 2008, Vol 371 [30]

### **Exclusion criteria**

Neonates with major congenital malformations .

### **Sample size determination**

$$N = \frac{Z^2 P (1-P)}{d^2}$$

N=sample size

Z=95% confidence interval of 1.96

P=estimated prevalence of hyperglycemia in neonatal sepsis

d=precision of 0.06

Prevalence of 6.9% derived from Sultan Ahmad and Riffat Khalid; blood glucose levels in neonatal sepsis and probable sepsis and its association with mortality. (11)

Sample size=68

### **Data Collection**

The principal researcher had 1 research assistant. The principal researcher trained the assistant on the identification of the signs of sepsis and how to ensure sterility when drawing samples.

All eligible neonates were recruited into the study after informed parental consent was obtained. Questionnaires were filled with neonatal and maternal data(see appendix 1). Neonates were considered to have probable sepsis if 1 or more of the clinical characteristics listed in Table 2 were present .Blood samples were collected for blood cultures, I.T ratio and plasma glucose levels at admission.

### **Clinical procedure**

**Blood glucose measurements**-A free flowing heel prick sample after sterilization with 70% alcohol was collected into the micro-cuvette and fed into the glucometer for reading. Hemostasis was achieved by placing a cotton swab and applying pressure. Only 5 microlitre of blood was required.

**Blood culture and I.T ratio** –Samples for blood cultures and I.T ratio were collected from a peripheral vein after sterilizing with 70% alcohol .Sterility was ensured to avoid specimen contamination. 2.5mls of blood was drawn for the blood culture and 2mls for I.T ratio. A dry cotton swab was then placed at the venous site with pressure to stop the blood flow and strapped in place. The blood and broth was mixed by shaking the bottle gently. The specimens were then transported to the laboratory within 1 hour while in a cool box.

### **Laboratory procedure**

All laboratory procedures were carried out at the Aga Khan University Hospital laboratory in Kisii town. The culture bottle used was biphasic. In the laboratory, broth and agar tilts were done twice a day until turbidity of the broth was noted. Subcultures were done on blood agar and chocolate agar plates after which the plates were incubated at 37 degree centigrade. The plates were checked daily for colony formation. On identification of a colony, organisms were identified by microscopy and biochemical tests. Sensitivity testing was also done. The wire loops used during subculture to collect the colonies were sterilized with a flame continuously during the procedure. Incubation of blank media and agar was done as a quality control measure.

After growth was obtained, it was reported to the principal investigator who notified the clinician in-charge of the neonates to facilitate treatment.

### **Hemocue beta-glucose analyzer.(25-27)**

Hemocue beta-glucose analyzer manufactured by Hemocue limited was used to measure blood glucose levels. It measures glucose in hemolysed whole blood after a modified glucose dehydrogenase reaction via absorbance of reaction products at unique wavelengths. Glucose measurements can be displayed as whole blood or the plasma equivalent. The plasma equivalent is based on the 2001 recommendation of the international federation of chemistry that glucose levels be reported as plasma glucose levels. The conversion factor is the constant 1.11 based on the relationship between plasma and whole blood glucose at normal hematocrit (0.43).

It is portable and requires minimal maintenance. The accuracy and precision of hemocue systems is compatible with those of laboratory instrumentation. Only 5 micro/l of blood is required and therefore cannot cause anemia. Analyzers are factory calibrated and no calibration was needed

between micro-cuvette batches. Internal quality control was done randomly during the study by an independent party to avoid bias.

## **DATA MANAGEMENT AND ANALYSIS**

Data obtained from questionnaires was coded and entered into preformed Access spread sheets and analyzed using the statistical package for social science [SPSS] version 17.0. Descriptive statistics such as mean, standard deviation and median were used for continuous variables. Categorical data was summarized using proportions and tabulated using frequency tables. The chi square test was used to assess association between categorical variables. The threshold for statistical significance was set at 0.05.

## **ETHICAL CONSIDERATIONS**

The study was conducted after getting approval from the Kenyatta National Hospital/University Of Nairobi ethics and research committee and the Kisii level 5 Hospital ethics committee.

### **Autonomy**

Written informed consent was obtained from the parents and guardians before recruitment into the study. There was no additional cost for participation in the study and the participants were free to withdraw from the study without any penalties.

### **Informed consent**

The parents/guardians was given detailed information before recruitment into the study. Participants were only recruited through signing of the informed consent form (appendix 11).

**Confidentiality**

The questionnaires were number coded. Only the principal researcher and research assistants knew the numbers of the participants and did not disclose information about the participants to anyone except to the primary clinician in charge of the patient when it was necessary. Questionnaires were kept under lock and key.

**Benefits**

The result of the blood glucose levels were discussed with the parent/ guardian. The clinician in charge of the patient was only informed if any intervention was required. This was beneficial to the patient.

**Risks and Compensation**

The participants were pricked several times to get the samples required and this induced pain. There was no monetary compensation for participating in the research

## RESULTS

In total 68 neonates admitted to Kisii Level V Hospital with neonatal sepsis were recruited into the study. Following exclusion of 16 neonates who were on dextrose infusion before the first glucose reading, a total of 52 neonates were used in this analysis. The results begin with the characteristics of recruited neonates, the prevalence of hyperglycemia and finally analysis of association between neonatal sepsis and hyperglycemia.

Most admissions sought initial care at Kisii Level V but 6 (11.5%) had been treated at another health facility prior to admission at the hospital. The characteristics of the sample are presented in Table 3. The median age (IQR) of admissions was 3 days (IQR 2 to 6.5) and three-quarters (75%) of admissions were in the first week of life (1 to 6 days). There were 26 males (50%), male-to-female ratio 1: 1. Preterms (<37 weeks) accounted for 12 (23.5%) out of the 52 participants and 12 (23.5%) newborns were underweight (<2500g). The duration of present illness ranged from 1 to 5 days with a median duration (IQR) of 2 days (1 to 5). The current weight was comparable to birth weights with a median of 3.0 (IQR 2.5 to 3.5) versus a median of 3.0 (IQR 2.5 to 3.6), for birth weights.

**Table 3: Characteristics of neonates admitted to Kisii Level V hospital with sepsis**

| Characteristic                              | Number<br>N=52 | Percent |
|---|----------------|---------|
| Age in days                                 |                |         |
| 1-6   | 39             | 75.0    |
| 7-28  | 13             | 25.0    |
| Sex   |                |         |
| Male  | 26             | 50.0    |
| Female                                      | 26             | 50.0    |
| Gestational age in weeks                    |                |         |
| <37 weeks                                   | 16             | 30.7    |
| 37 weeks                                    | 36             | 69.3    |
| Birth weight                                |                |         |
| < 2500 gms                                  | 13             | 25      |
| 2500 gms                                    | 39             | 75      |
| Treatment in another facility               | 6              | 11.5    |
|   | Median         | IQR     |
| Median body weight in kgs (n = 52)          | 3.0            | 2.5-3.7 |
| Median duration of illness in days (n = 52) | 2              | 1-3     |

## Maternal characteristics

Table 4 summarizes maternal attributes of the neonates with sepsis. Most mothers were married (69.2%), unemployed (52%), had SVD births (59.6%) conducted in hospital (69.2%).

**Table 4: Maternal characteristics**

| <b>Maternal characteristic</b> | <b>Number</b> | <b>Percent</b> |
|--------------------------------|---------------|----------------|
| <b>Employment</b>              |               |                |
| Permanent                      | 9             | 17.3           |
| Casual                         | 16            | 30.7           |
| Unemployed                     | 27            | 52             |
| <b>Marital status</b>          |               |                |
| Single                         | 14            | 26.9           |
| Married                        | 36            | 69.2           |
| Widowed                        | 2             | 3.9            |
| <b>Mode of delivery</b>        |               |                |
| C/S                            | 17            | 32.7           |
| SVD                            | 31            | 59.6           |
| Breech                         | 4             | 7.7            |
| <b>Place of delivery</b>       |               |                |
| Home                           | 6             | 11.5           |
| Hospital                       | 36            | 69.2           |
| on Transit to hospital         | 10            | 19.3           |

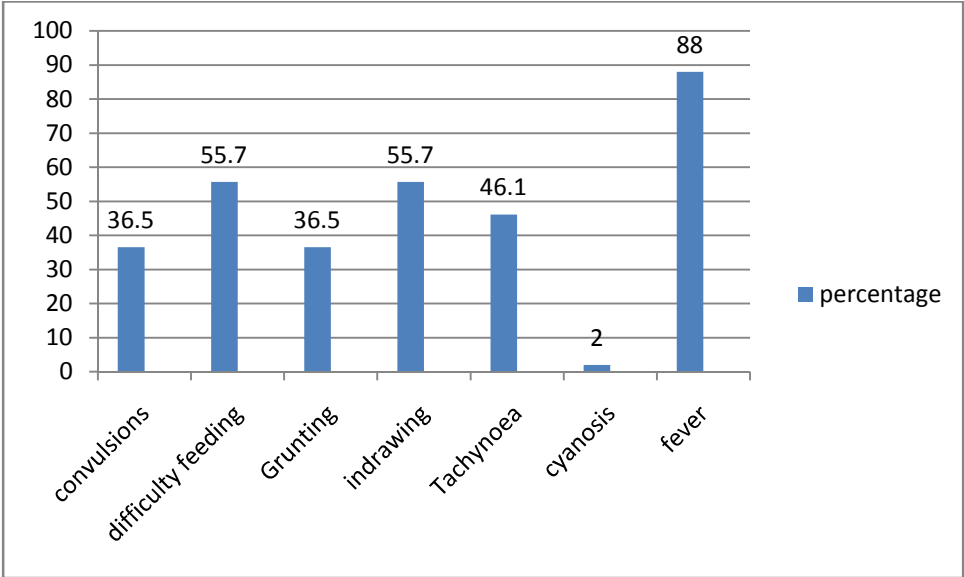


|                             |    |      |
|-----------------------------|----|------|
| <b>Level of education</b>   |    |      |
| Primary                     | 18 | 34.6 |
| Secondary                   | 18 | 34.6 |
| Post secondary              | 14 | 26.9 |
| None                        | 2  | 3.9  |
| <b>Gestational diabetes</b> |    |      |
| Yes                         | 1  | 2.1  |
| No                          | 30 | 57.6 |
| Not known                   | 21 | 40.3 |

**Clinical characteristics of Neonates**

The clinical assessment of neonates presenting with sepsis is presented in Figure 1. The clinical characteristic reported most frequently was fever 45(88%) and cyanosis was rarely identified in sepsis 1 (2%)

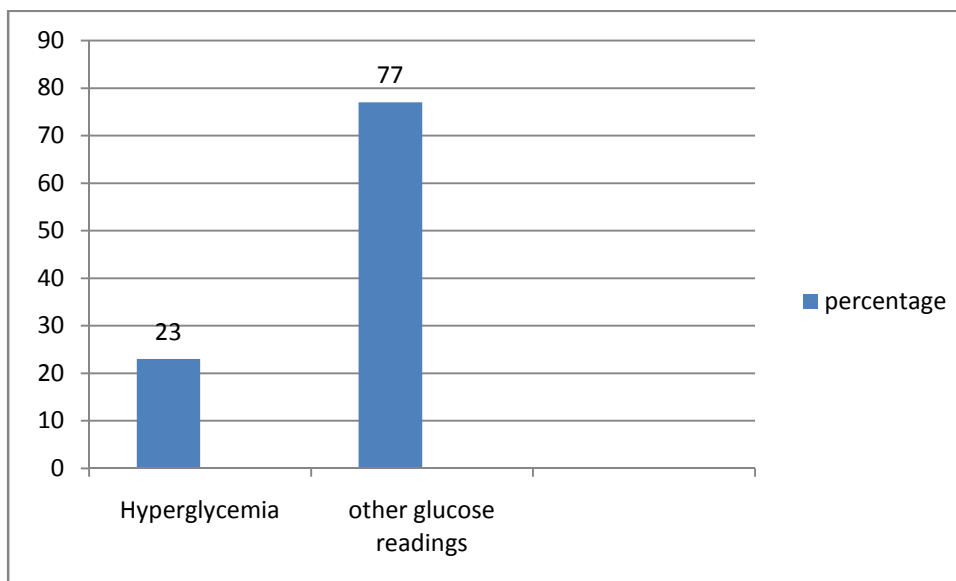
**Figure 1: Clinical characteristics of neonates with sepsis.**



## Hyperglycemia

The prevalence of hyperglycemia in the neonates with sepsis was found to be 23% [12/52] as indicated in Figure 2 . The range of blood glucose levels among the neonates with sepsis was 1.4 to 10.7 mmol/l. Hypoglycemia (glucose level <3mmol/l ) was found in 15.4% (8/52) of the neonates with sepsis.

**Figure 2: Prevalence of Hyperglycemia in neonates with sepsis admitted at Kisii level 5 hospital**



## Hyperglycemia in neonates with sepsis in relation to neonatal characteristic

Neonatal characteristics did not have significant associations with hyperglycemia in neonates with sepsis as presented in Table 5.

**Table 5: Hyperglycemia in relation to neonatal characteristics**

| Variable                    |            | Hyperglycemia |          | OR (95% CI)    | P value |
|-----------------------------|------------|---------------|----------|----------------|---------|
|                             |            | Yes           | No       |                |         |
| Age in days                 | 1 - 6      | 4(10.3)       | 35(89.7) | 1.0            |         |
|                             | 7 - 28     | 6(46.1)       | 7(53.9)  | 5.8(0.7-46)    | 0.09    |
| Gender                      | Male       | 5(19.2)       | 21(80.8) | 1              |         |
|                             | Female     | 3(11.5)       | 23(88.5) | 0.55(0.122.58) | 0.45    |
| Birth weight                | < 2500     | 2(16.7)       | 10(83.3) | 1.0            |         |
|                             | > 2500     | 6(15.4)       | 34(85.0) | 0.9(0.2-5.2)   | 0.92    |
| Gestational age             | <37 weeks  | 3(20.0)       | 12(80.0) | 1.0            |         |
|                             | 37 weeks + | 5(14.7)       | 32(86.0) | 0.7(0.1-3.4)   | 0.65    |
| Birth order                 | 1st        | 2(11.8)       | 15(88.2) | 1.0            |         |
|                             | >2nd       | 6(17.1)       | 29(82.9) | 1.6(0.3-8.6)   | 0.616   |
| Convulsions                 | Present    | 1(5.3)        | 18(94.7) | 1.0            |         |
|                             | Absent     | 7(21.2)       | 26(78.8) | 4.8(0.5-42.9)  | 0.16    |
| Inability to breastfeed     | Present    | 3(10.3)       | 26(89.7) | 1.0            |         |
|                             | Absent     | 5(21.7)       | 18(78.3) | 2.4(0.5-11.4)  | 0.27    |
| Herbal medications          | Yes        | 2(25.0)       | 6(75.0)  | 1.0            |         |
|                             | No         | 6(13.6)       | 38(86.4) | 0.5(0.1-2.9)   | 0.42    |
| Treatment in other facility | Yes        | 2(33.3)       | 4(66.7)  | 1.0            |         |
|                             | No         | 6(13.0)       | 40(87.0) | 0.3(0.04-2.0)  | 0.22    |

|                            |         |         |          |               |      |
|----------------------------|---------|---------|----------|---------------|------|
| Grunting                   | Present | 2(10.5) | 17(89.5) | 1.0           |      |
|                            | Absent  | 6(18.2) | 27(81.8) | 1.9(0.3-10.5) | 0.46 |
| Lower chest wall indrawing | Present | 2(6.9)  | 27(93.1) | 1.0           |      |
|                            | Absent  | 6(26.1) | 17(73.9) | 4.8(0.9-26.3) | 0.07 |
| Respiratory rate           | <60     | 6(21.4) | 22(78.6) | 1.0           |      |
|                            | 60+     | 2(8.3)  | 22(91.7) | 0.3(0.1-1.8)  | 0.21 |
| Phenytoin                  | Yes     | 1(11.1) | 8(88.9)  | 1.0           |      |
|                            | No      | 7(17.1) | 36(83.7) | 1.6(0.2-15.4) | 0.66 |

**Hyperglycemia in neonates with sepsis in relation to Laboratory Evaluation .**

The odds of presenting with hyperglycemia during admission were higher in neonates with elevated I.T ratio than in neonates with normal I.T ratio (OR = 10.2, 95% CI 1.4-76.9, p = 0.02).

Blood culture findings did not have significant association with hyperglycemia.

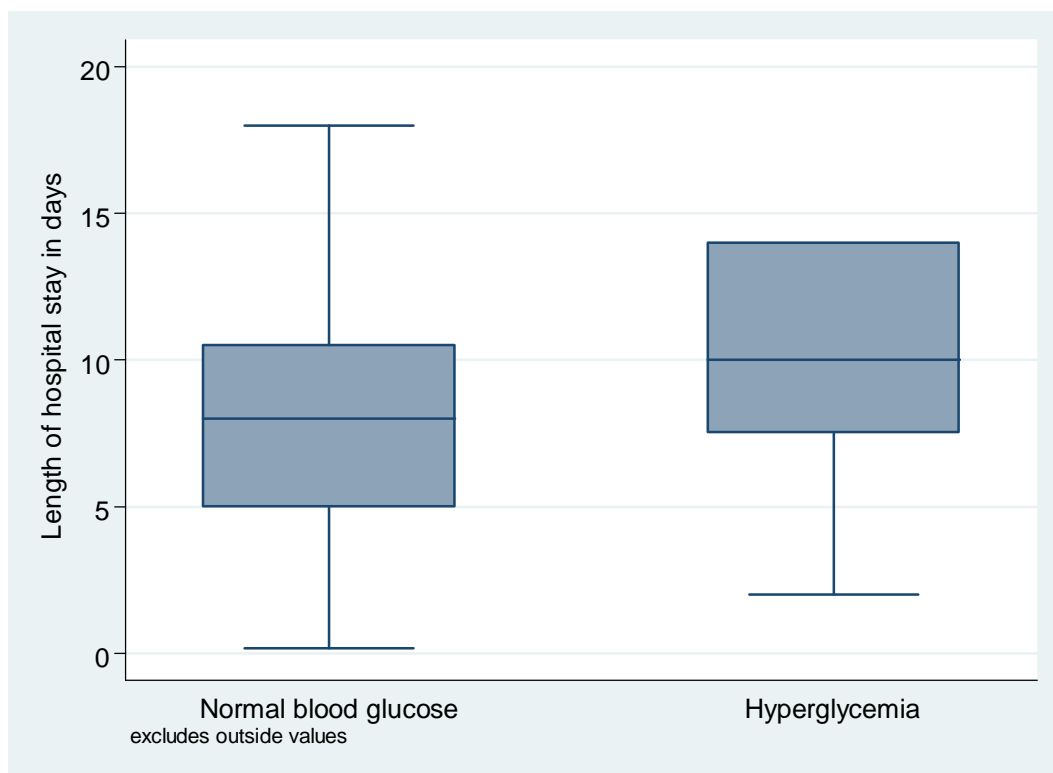
**Table 6: Hyperglycemia in relation to laboratory evaluation .**

| Investigations |          | Hyperglycemia |          | OR (95% CI)    | P value |
|----------------|----------|---------------|----------|----------------|---------|
|                |          | Yes           | No       |                |         |
| ITR            | <0.2     | 5(12.8)       | 34(87.2) | 1.0            |         |
|                | 0.2+     | 3(60.0)       | 2(40.0)  | 10.2(1.4-76.9) | 0.02    |
| Blood cultures | positive | 0(0)          | 6(100)   | 1              |         |
|                | negative | 8(20.5)       | 38(82)   | 1              | N/A     |

### Hyperglycemia in neonates with sepsis in relation to Outcome and length of hospital stay .

The median length of stay for all admissions was 9.5 days (IQR 5 – 12.5). Figure 4 compares median length of hospital stay for normal blood glucose and hyperglycemic neonates. There was no statistically significant difference in duration of hospital stay for the two groups (median [IQR] for hyperglycemia 10 [7.5-14] versus 8 [5-10.5] for normal blood glucose, Mann-Whitney p value=0.45

**Figure 3: Hyperglycemia in relation to length of hospital stay.**



**P=0.45**

### Outcome of Patient

There were six (11.5%) deaths among 52 neonates assessed for hyperglycemia. Inpatient mortality was not significantly associated with hyperglycemia (OR = 1.4, 95% CI 0.1-14.7, p=0.76)

**Table 7: Hyperglycemia in relation to mortality**

|                    |       | Hyperglycemia |          | OR (95% CI)   | P value |
|--------------------|-------|---------------|----------|---------------|---------|
|                    |       | Yes           | No       |               |         |
| Outcome of Patient | Alive | 7(14.9)       | 39(85.1) | 1             |         |
|                    | Dead  | 2(33)         | 4(67)    | 1.4(0.1-14.7) | 0.765   |

### Hyperglycemia in neonates with sepsis in relation to Maternal Characteristics

None of the maternal characteristics were significantly associated with hyperglycemia.

**Table 8: Hyperglycemia in relation to maternal characteristics**

| Variable             |           | Hyperglycemia |          | OR (95% CI)   | P value |
|----------------------|-----------|---------------|----------|---------------|---------|
|                      |           | Yes           | No       |               |         |
| Delivery mode        | C/S       | 3(18.8)       | 14(81.3) | 1.0           |         |
|                      | SVD       | 4(13.3)       | 27(86.7) | 0.7(0.1-3.4)  | 0.63    |
|                      | Breech    | 1(33.3)       | 3(66.7)  | 2.2(0.1-35.2) | 0.58    |
| Gestational diabetes | Yes       | 0(0.0)        | 1(100.0) | NA            | NA      |
|                      | No        | 5(17.2)       | 25(82.8) | NA            | NA      |
|                      | Not known | 4(15.8)       | 17(84.2) | NA            | NA      |

|                    |                   |         |          |               |      |
|--------------------|-------------------|---------|----------|---------------|------|
| Liquor             | Normal            | 6(14)   | 38(86)   | 1.0           |      |
|                    | Foul              | 0(0.0)  | 5(100.0) | NA            |      |
|                    | Meconium          | 2(66.7) | 1(33.3)  | 12(0.9-153.9) | 0.06 |
| Maternal fever     | Yes               | 1(14.3) | 6(85.7)  | 1.0           |      |
|                    | No                | 5(16.7) | 26(83.3) | 1.2(0.1-12.3) | 0.88 |
|                    | Not known         | 3(22)   | 11(78)   | 1.2(0.1-16.2) | 0.89 |
| Delivery place     | Home              | 0(0)    | 6(100)   | 1.0           |      |
|                    | Hospital          | 7(20)   | 29(80)   | 2.0(0.2-18.7) | 0.54 |
|                    | In transit        | 1(11.1) | 9(88)    | 1.0           |      |
| Diabetes in family | Yes               | 2(16)   | 11(84)   | 1.0           |      |
|                    | No                | 5(25)   | 16(75)   | 1.7(0.4-10.3) | 0.6  |
|                    | Not known         | 1(5.9)  | 17(94.1) | 0.3(0.02-3.9) | 0.4  |
| Education level    | Primary           | 2(11.8) | 16(88.2) | 1.0           |      |
|                    | Secondary         | 4(25)   | 13(75)   | 2.5(0.4-16)   | 0.33 |
|                    | Post<br>secondary | 2(15.4) | 12(84.6) | 1.4(0.2-11.2) | 0.78 |
|                    | None              | 0       | 1(100)   | 1.0           |      |
| Employment         | Permanent         | 0       | 9(100)   | 1.0           |      |
|                    | Casual            | 3(20)   | 13(80)   | 1.05(0.2-5.2) | 0.95 |
|                    | Unemployed        | 5(19.2) | 22(80)   | 1.0           |      |
| Marital status     | Single            | 2(15.4) | 12(84.6) | 1.0           |      |
|                    | Married           | 6(17.1) | 30(82.9) | 1.14(0.2-6.5) | 0.89 |
|                    | Widowed           | 0       | 2(100)   | 1.0           |      |

### Multivariable Logistic Regression Analysis

As shown in Table 9, multivariable logistic regression analysis identified use of herbal medication and elevated I.T ratio as factors that independently predicted hyperglycemia in neonatal sepsis.

**Table 9: Multivariable logistic regression of independent predictors of hyperglycemia in neonatal sepsis**

|                         | Odds Ratio | Std. Err. | z     | P>z   | 95% CI |         |
|-------------------------|------------|-----------|-------|-------|--------|---------|
| Gestational age         | 0.28       | 0.41      | -0.86 | 0.388 | 0.02   | 4.95    |
| Birth weight            | 0.50       | 0.78      | -0.45 | 0.656 | 0.02   | 10.66   |
| Herbal medication       | 0.02       | 0.04      | -1.94 | 0.05  | 0.0003 | 1.04    |
| Birth order             | 3.66       | 7.86      | 0.6   | 0.547 | 0.05   | 247.14  |
| IT ratio                | 84.98      | 164.86    | 2.29  | 0.038 | 1.90   | 3807.24 |
| Length of hospital stay | 0.72       | 0.14      | -1.69 | 0.09  | 0.50   | 1.05    |
| Marital status          | 0.10       | 0.20      | -1.17 | 0.244 | 0.00   | 4.66    |
| Secondary education     | 2.86       | 4.11      | 0.73  | 0.465 | 0.17   | 48.00   |
| Tertiary education      | 0.94       | 1.80      | -0.03 | 0.974 | 0.02   | 39.84   |



## DISCUSSION

Neonatal sepsis is a common cause of admission in Kenyan hospitals. During the four-month period (October 2013 to January 2014), 68 neonates with neonatal sepsis at Kisii level V hospital were recruited into the study but following exclusion of 16 who were on dextrose infusion at time of first glucose reading, 52 were used in this analysis. The median age of all admissions was 3 days (IQR 2 to 7) and approximately three-quarter (73.5%) of admissions were in the first week of life (1 to 6 days). The majority of the neonates were term (71.9%) with weights above 2.5kg (76.1%), median weight was 3.0 kg (IQR 2.5 to 3.7). Duration of current illness ranged from 1 to 6 days with a median duration (IQR) of 2 days (1 to 3).

This study was conducted in order to determine the prevalence of hyperglycemia in neonates admitted with suspected neonatal sepsis at Kisii Level 5 Hospital. The study also aimed to establish the association between hyperglycemia and length of hospital stay and mortality. Hyperglycemia, defined as plasma glucose levels of above 8.3 mmol/l had a prevalence of 23% (12 / 52). Most studies on neonatal hyperglycemia mainly assess preterms and very low birth weight neonates while studies on hyperglycemia in sepsis involve older children. This has resulted in paucity in data regarding hyperglycemia in neonates with sepsis. A study by Ahmad et al(11) conducted at Fazle Omar hospital in Pakistan found a prevalence of 6.9% using a glucose cut off point of 11.1mmol/l among 502 neonates with confirmed and probable neonatal sepsis. This is lower than the findings in this study possibly due to the high glucose cut off point. Hall et al (13) found a prevalence of 69% [n=95] among neonates with necrotizing enterocolitis at the intensive care unit at Great Ormond hospital in the London. Hyperglycemia was considered as blood glucose levels >8 mmol/l. This high prevalence could be explained by intravenous dextrose infusions and may also reflect greater adrenergic activity and stress

response. Bhutta et al(1) found a prevalence of 21.5% among neonates with sepsis at Aga Khan University Medical centre in his study of factors determining outcome in neonatal sepsis , this is comparable to the findings in the current study of 23%. Hyperglycemia in critically ill or in sepsis is as a result of the stress response that leads to elevated cortisol, growth hormone and catecholamine.

There was no significant association between hyperglycemia and mortality in the current study ( $p=0.76$ ). The highest reading of blood glucose recorded was 10.7mmol/l. The majority of studies done indicate that mortality is associated with higher glucose levels. Ahmad et al (11), in a study to determine blood glucose levels in neonatal sepsis and its association with mortality found significantly higher mortality in neonates with blood glucose levels above 11.1mmol/l ( $p<0.05$ ). Hall et al (13) similarly found glucose levels above 11.9mmol/l were associated with increased mortality. In common with the current study, Bhutia et al (31) also found that glucose levels  $>7$  mmol/l but below 10mmol/l had no association with mortality or length of stay in hospital .Cerebral hemorrhage is common when blood glucose levels are above 22.2 mmol/l due to Hyperosmolality. (3) This is a possible explanation for the lower mortality with lower glucose levels.

Hyperglycemic neonates had a median length of hospital stay of 10 days while those without hyperglycemia had a median of 8 days however this was not statistically significant ( $p=0.45$ ).This is comparable to other studies .Bhutia et al [31] found that glucose levels above 7 mmol/l but below 10mmol/l had no association with prolonged length of hospital stay. Higher glucose levels occurring in critically ill children subsequently results in longer periods of treatment and therefore prolonged hospital stay. The maternal characteristics selected in this study had no significant associations with development of hyperglycemia.

Use of herbal medication was significantly associated with hyperglycemia ( $p=0.05$ ). This can be due to toxicities of herbal medication and also as a result of worsening of sepsis due delayed treatment. No studies have been done yet to compare herbal medication and hyperglycemia.

Elevated I.T ratio was found to have significant association with hyperglycemia ( $p=0.038$ ) and this can be explained by the fact that it is a marker of sepsis in neonates. Hyperglycemia due to sepsis is attributed to stress response with elevation of counter regulatory hormones.

Majority of other studies done on hyperglycemia in neonates involve premature and very low birth weight neonates who have disordered glucose metabolism. This study involved term neonates (71%) with weights above 2.5kg (76%). Only 6 of the neonates had culture proven sepsis and notably, they did not have hyperglycemia. Majority of studies indicate otherwise, Bhutta et al included neonates with culture proven sepsis only and is not comparable to this study. Several case reports have shown neonates with gram negative sepsis having hyperglycemia (33-35). A larger study is required to make conclusions on this aspect.

## **STUDY LIMITATIONS**

1. We were not able to recruit patients during night hours and during the weekends because of increased laboratory costs at those times leading to missed opportunity for recruitment.
2. The exclusion of 16 neonates (23%) from analysis means that our sample size provided a lower precision (7%) in estimating hyperglycemia prevalence compared to the initially anticipated precision of 5%.
3. Language barrier as most parents and guardians spoke in Kisii and the principle investigator spoke English and Kiswahili. To overcome this, an interpreter was used.

## **CONCLUSIONS**

The prevalence of hyperglycemia was found to be 23% in neonates with sepsis admitted to Kisii Level 5 hospital. Use of herbal medication and elevated I.T ratio were significantly associated with hyperglycemia. Hyperglycemia was not associated with mortality or statistically significant length of hospital stay.

## **RECOMMENDATIONS**

The prevalence of hyperglycemia was high at 23% and all neonates admitted with neonatal sepsis should have blood glucose measurements at admission.

Use of herbal medication should be discouraged and mothers should be educated on complications of herbal medication such as hyperglycemia

A study with a larger sample size is needed to provide further evidence on risk factors associated with hyperglycemia in neonatal sepsis.

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## APPENDIX 1: QUESTIONNAIRE

### NEONATAL DATA

1. Study number.....
2. Name of Baby.....
3. Hospital IP number.....
4. Age of the neonate    days..... hours.....
5. Sex                    Male.....                    Female.....
6. Gestational age (weeks)    weeks.....
7. Birth weight (kg).....
8. Current weight (kg).....
9. Length of illness    days.....                    Hours .....
10. Inability to breastfeed    present..... Absent .....
11. Convulsions    present..... Absent.....
12. Weak or no cry    present..... Absent .....
13. Reduced activity    present..... Absent .....
14. Treatment in another facility before KDH  
    yes..... No.....  
    a) If yes was dextrose given    yes..... No.....

15. Did the child receive any herbal medication before being brought to KDH

o yes ..... No.....

16. Any other complaints.....

17. Birth order of the child (actual birth order).....

**EXAMINATION**

18. Temperature at admission (in Degree Celsius) .....

19. Is the child lethargic? Yes..... No.....

20. Cyanosis present..... Absent.....

21. Other colors pink..... Dusky gray..... Blue.....

22. Capillary refill time (in seconds).....

23. Temperature of extremities cold..... Warm.....

24. Ability of the child to breastfeed (ask the mother to breastfeed)

Breastfeeding well.....

Breastfeeding poorly.....

Unable to breastfeed .....

N/B . Not applicable in ELBW

**Respiratory system**

25. Respiratory rate (breaths per min).....

26. Grunting present..... Absent.....

27. Lower chest wall indrawing present..... Absent.....

**Central Nervous System**

28. Consciousness normal..... Drowsy/lethargic.....  
Unconscious.....

29. Bulging anterior fontanelle yes..... No.....

30. Convulsing now /convulsed yes..... No.....

a) if yes - number of times in past 12hrs.....

31. Full hemogram result-White blood cell count

..... \* 10 cells/l

32. Hemoglobin level .....g/dl

33. Platelet count .....\*10/l

34. Blood cultures

Positive..... if yes organism grown.....

Negative.....

Not done.....

35. Mode of nutrition

a). Parenteral dextrose . Specify concentration 5%..... 10%.....

o <6mg/kg/min

o 6-11mg/kg/min

o >8mg/kg/min

b). Enteral (breastfeeding or naso-gastric feeds)

Breast milk ..... Formula.....

Cow milk.....

Volume in 24hrs Total ..... ml/kg/24hrs.....

36. Drugs a) Dexamethasone a) yes b) no

b) Theophylline a) yes b) no

c) Phenytoin a) yes b) no

37. Blood Glucose levels in mmol/l

|       | 1 <sup>st</sup> reading/age in hrs | 2 <sup>nd</sup> reading/age in hrs | 3 <sup>rd</sup> reading/age in hrs |
|-------|------------------------------------|------------------------------------|------------------------------------|
| Day 1 |                                    |                                    |                                    |
| Day 2 |                                    |                                    |                                    |
| Day 3 |                                    |                                    |                                    |

38. Length of hospital stay in hours.....  
Days.....

39. Outcome of Patient Alive..... Not  
Alive.....

**MATERNAL DATA**

40. Age of mother in years.....

41. Employment . Permanent..... Casual.....  
Un-employed.....

42. Marital status .Single..... Married.....  
Divorced/separated..... widowed .....

43. Parity.....

44. Mode of delivery

a) C/S                      b) SVD                      c) breech

45. Place of delivery

a) Home .....              b) Hospital .....              c) In transit to hospital.....

46. Level of education    a) Primary.....              b) Secondary.....

c) Post secondary (certificate, diploma, degree) .....

d) none.....

47. History of gestational diabetes during the pregnancy

a) Yes..... b) No ..... c) Not known.....

48. Presence of maternal fever during the last week before delivery or during labour >38

a) Yes b) No c) not known

49. Duration of rupture of membrane in hours .....

50. Describe liquor

a) normal b) foul smell c) meconium stained

51. Presence of diabetes in the family

a) Yes b) No c) Not known

## **APPENDIX II: INFORMED CONSENT FORM**

**Title:** Prevalence of Hyperglycemia and Associated Risk Factors in Neonates with Septicemia Admitted at Kisii District Hospital.

Study ID number:

**Investigator:** Dr Njihia Gladys

**Supervisors:** Prof E. Wafula, Dr F. Murila and Dr R. Kumar

**Investigators statement:** Thank you for reading this form. It will offer you information about the above named study that is been carried at Kisii District Hospital. The information offered will allow you to make an informed decision on whether or to participate in the study.

**Introduction:** High blood glucose is a condition that can occur in sick children. It is not easily detected and has to be measured from the blood of the baby. It can cause many problems to the baby including bleeding into the brain, dehydration and electrolyte imbalance and cause inability to fight infections by the baby's immune system. This can lead to death of the baby.

This study will help us know how often high blood glucose levels occur and some of the risk factors associated with it.

**Procedure:** On receiving informed consent, information will be obtained from the mother regarding the baby's illness including symptoms, length of illness, previous treatment etc. Information regarding the baby's weight and treatment will be obtained from the child's records. Information regarding labour, birth process and drugs used will be obtained from the mother. The blood glucose levels will be obtained from a heel prick, minimal blood will be required for this and in total the child will be pricked 7 times over 3 days. Blood will also be obtained from a large vein to do blood cultures and a complete blood count. This will help us ascertain infection.

Extreme care will be taken while sampling to ensure cleanliness and avoid contamination.

**Benefits:** The results of the study on your child will be discussed with you and the clinician in charge of the baby. Abnormalities in the blood glucose will be managed appropriately. The results will help us know the burden of the condition and allow for regular monitoring of blood glucose levels.

**Risks and Compensation:** Risks in the study include induction of pain to participants during sampling. There is no monetary compensation for participating in this research. You will not incur any financial costs for participating in the study.

**Confidentiality:** Participation in this study is completely voluntary .The information obtained about you and your child will be kept strictly confidential and will not be shared with anyone outside the research team. Any information about you will have a number on it instead of you or your child's name. Only the researchers will know what your number is and the information will be kept under lock and key.We will make every effort to ensure information obtained is confidential and not easily accessed by other people.To indicate that you understand the conditions of this study and that you consent to participate in it ,you and your child, please sign or put your thumbprint in the space provided below.

I, \_\_\_\_\_ confirm that the study has been fully explained to me and I give full consent to participate in it.

Signature/thumbprint \_\_\_\_\_

Investigator's signature \_\_\_\_\_

Date \_\_\_\_\_



## **FOMU YA KUPATA KIBALI CHA WAZAZI/WALEZI WA WASHIRIKI**

**Kifunguo:** Hii fomu ya kupata idhini ni kwa ajili ya watoto waliolazwa katika hospitali ya Kisii district, ambao tunawakaribisha kushiriki kataika utafiti. Jina la mradi wa utafiti wetu ni “Ufanisi wa kiwango cha sukari kwa watoto wachanga walio wagonjwa”.

Mimi ni Dk. Gladys Njihia, mwanafunzi katika Chui Kikuu cha Nairobi kutafuta masomo ya utaalamu katika afya ya watoto. Mimi ninafanya utafiti juu ya kiwango cha sukari kwa watoto wachanga walio wagonjwa na kulazwa katika hospitali ya Kisii district. Nitakupa taarifa na kukukaribisha kwa utafiti huu. Kunaweza kuwa na baadhi ya maneno ambayo huelewi, tafadhali uliza na mimi nitachukua muda kukueleza.

**Sababu ya utafiti:** Sukari inaweza kupanda juu sana kwa watoto walio wagonjwa na kusababisha madhara mengi ni pia maafa. Ni muhimu kiwango cha sukari kuangaliwa mapema na kutibiwa.

**Maandalizi ya utafiti:** Utafiti huu utahusu kupima damu ya mtoto wako ili kuweza kujua kiwango cha sukari mwilini na pia mahojiano ya moja kwa moja. Kushiriki katika utafiti huu ni kwa hiari. Usipochagua kushiriki bado utapokea huduma zote katika hospitali hii. Unaweza kujiondoa kwa utafiti huu wakati wowote. Utafiti utafanyika katika kipindi cha siku tatu baada ya mtoto kulazwa hospitalini.

**Madhara:** Utafiti wetu hautamthuru mtoto wako. Habari ambayo tutakusanya kutoka kwa mradi wa utafiti huu itakuwa siri.

**Mawasiliano:** Kama una maswali yoyote unaweza kuuliza hivi sasa au baadaye. Unaweza kuwasiliana nami kupitia nambari 0721280710.

Nimesoma maelezo haya na nimepewa nafasi ya kuuliza maswali kuhusu hayo maelezo.Nimeidhini kwa hiari kushiriki katika utafiti huu

Jina .....

Sahihi.....

Tarehe.....

Sahihi la

mtafiti.....Tarehe.....