

## The relation between the type of microorganisms and some hematological parameters in neonatal septicemia.

By: Dr. Zalnab Sulaiman Erzalque, Dr.Noorgan Abdullah, Dr. Ahmed H. Alanee, Dr. Sami Azeez.

### Abstract

Neonatal sepsis is a clinical syndrome characterized by many signs and symptoms which are non specific for diagnosis. Blood culture is standard measure but needs time to give it's results. Monocyte count is now used for early detection and follow up of patients of neonatal sepsis. The aim of the study is to evaluate the relation between the type of microorganism and some hematological parameters in neonatal sepsis. The number of studied cases were 46 neonates diagnosed as a cases of neonatal sepsis after positive blood culture. Each one was assessed clinically by prepared questionnaire including history and clinical assessment. Laboratory parameters includes WBC count, ESR, and monocyte count were done for all included cases. Very early neonatal sepsis was the commonest clinical type of sepsis 30(65,2%) with poor feeding is the common presentation 40(87%). Group B. streptococcus was the commonest bacteria isolated in 17 cases (37%). At time of diagnosis monocyte, ESR, and WBC count were high in 31(67,4%), 26(56,5%) and 28(60,9%) respectively. Most of the bacteria show nearly similar presentation of normal and high W.B.C. count except for staph aureus which shows all W.B.C. count is high 6(100%). All types of bacteria show nearly similar normal and high E.S.R. except for staph aureus which shows most of cases have high E.S.R. The high percentage of high monocyte count was in Coagulase negative staph, E.coli and staph aureus 10(76.9%), 8(80%) and 4 (66.7%) respectively, while the normal monocyte count was nearly similar to the high monocyte in Group B. streptococcus. It is concluded that there is no significant relation between the type of microorganism and the hematological parameters in neonatal sepsis.

### Introduction

Sepsis is a clinical syndrome that complicates severe infection and is characterized by systemic inflammation and widespread tissue injury. In this syndrome, tissue is removed from the original insult that displayed the signs of inflammation, such as vasodilatation, increased microvascular permeability, and leukocyte accumulation. Multiple organ dysfunction is a continuum, with incremental degrees of physiological derangements in individual organs; it is a process rather than an event. (1).

The infectious agents associated with neonatal sepsis have changed over the past 50 years. *Staphylococcus aureus* and *Escherichia coli* were the most common bacterial infectious hazards for neonates during the 1950s in the United States. Additional organisms, such as *L. monocytogenes*, *Chlamydia pneumoniae*, *H. influenzae*, *Enterobacter aerogenes*, and species of *Bacteroides* and *Clostridium* have also been identified in neonatal sepsis. In today's neonatal intensive care units (NICUs), infants with lower birth weight and infants who are less mature have an increased susceptibility to these organisms(2).

*Staphylococcus epidermidis*, a coagulase-negative *Staphylococcus*, is increasingly seen as a cause of nosocomial or late-onset sepsis, especially in the premature infant, in whom it is considered the leading cause of late-onset infections. Its prevalence is likely related to several intrinsic properties of the organism that allow it to readily adhere to the plastic mediums found in intravascular catheters and intraventricular shunts. The bacterial capsule polysaccharide adheres well to the plastic polymers of the catheters. Also, proteins found in the organism enhance attachment to the surface of the catheter. The adherence creates a capsule between microbe and catheter, preventing C3 deposition and phagocytosis(3).

The most common risk factors associated with early onset neonatal sepsis include maternal GBS colonization (especially if untreated during labor), premature rupture of membranes (PROM), and prematurity. Risk factors also associated with early-onset neonatal sepsis include low Apgar score (<6 at 1 or 5 min), maternal fever, poor prenatal care, poor maternal nutrition, low socioeconomic status, low birth weight, difficult delivery, meconium staining, and congenital anomalies. The clinical signs of neonatal sepsis are nonspecific and are associated with characteristics of the causative organism and the body's response to the invasion. These nonspecific clinical signs of early sepsis syndrome are also associated with other neonatal diseases, such as **respiratory distress syndrome** (RDS), metabolic disorders, intracranial hemorrhage, and a traumatic delivery. Given the nonspecific nature of these signs, providing treatment for suspected neonatal sepsis while excluding other disease processes is prudent(4,5).

The neonatal neutrophil or polymorphonuclear (PMN) cell, which is vital for effective killing of bacteria, is deficient in chemotaxis and killing capacity. Decreased adherence to the endothelial lining of blood vessels reduces their ability to marginate and leave the intravascular space to migrate into the tissues. Once in the tissues, they may fail to degranulate in response to chemotactic

factors. Also, neonatal PMNs are less deformable; therefore, they are less able to move through the extracellular matrix of tissues to reach the site of inflammation and infection. The limited ability of neonatal PMNs for phagocytosis and killing of bacteria is further impaired when the infant is clinically ill. (2)

The ESR is a popular constituent of the screening tests undertaken to detect neonatal sepsis and has for long been recognized as a valid investigative tool(6). A normal ESR had been considered as 'day of life plus 3 mm/hr to maximum of 15 mm/hr. Observations made by us, had not supported these recommended values (7, 8)

Monocytes are responsible for phagocytosis (ingestion) of foreign substances in the body. Monocytes can perform phagocytosis using intermediary (opsonising) proteins such as antibodies or complement that coat the pathogen, as well as by binding to the microbe directly via pattern-recognition receptors that recognize pathogens. Monocytes are also capable of killing infected host cells via antibody, termed antibody-mediated cellular cytotoxicity. Vacuolization may be present in a cell that has recently phagocytized foreign matter(9,10).

### **Aim**

The aim of the study is to decrease the morbidity of neonates by early detection of the type of microorganism causing sepsis and its relation with some hematological parameters .

### **Patients and Methods**

A prospective study was done on 46 cases of patients with neonatal sepsis admitted at the Kirkuk Pediatrics General Hospital during the period from 1st of December 2014 to last of March 2015 to identify the relation between the type of microorganism and some hematological parameters in neonatal sepsis. The diagnosis of neonatal sepsis is done by clinical features of sepsis with positive blood culture which

was done for all included cases. Each patient was evaluated clinically and by laboratory investigations by prepared questionnaire that include name, age, sex, onset of disease, maturity, weight, risk factors of neonatal sepsis and clinical presentation. Monocyte count, ESR, and WBC count at time of diagnosis were done to all the study cases.

Patients inclusion criteria :

1. Patients less than 28 days of age .
2. Signs and symptoms of sepsis .
3. presence of 2 or more of the following:(2)
  - a. Temperature greater than 38°C or less than 35°C.
  - b. Heart rate greater than 160 beats per minute.
  - c. Respiratory rate greater than 60 breaths per minute .
  - d. WBC count greater than 20,000 cells/ $\mu$ L, less than 5000 cells/ $\mu$ L.
4. positive blood culture .
5. No previous treatment with antibiotics .

A sample of at least 2ml of blood per set was taken from peripheral vein from 2 separate sites after adequate skin disinfection using iodine solution that left to dry and then whipped off with (70%) alcohol, both samples were taken before antibiotic administration, samples were cultured aerobically. One to three milliliter of blood from 46 neonate were aspirated .The blood sample was inoculated in bottle containing 25 ml of brain heart infusion broth (Oxoid),this media contain Sodium Polyanthol Sulfonate (SPS) in a final concentration of 0.05%.This bottle then incubated for 18-24hr at 37Co(2).

Macroscopic changes were observed in the next day. Gram stain was performed irrespective of macroscopic evidence of growth. And blind subculture on blood and chocolate agar plate were carried out, the first was incubated aerobically for 48 hr at 37Co.

If gram negative bacilli were detected by Gram stain or colony characteristics other samples from the bottle were subcultured on the third and seventh day before discarding the specimen as negative(2).

Identification of isolated microorganism was done according to direct smear ,cultural characteristics, motility and biochemical tests.

Streptococci were identified mainly on blood agar plate, type of haemolysis,optochin sensitivity ,Bacitracin sensitivity and direct smear. Staphylococci were identified by direct smear colony morphology, catalase, and mannitol fermentation. Gram negative bacteria were identified by MacConKey agar to show either lactose or non lactose fermenter. Further identification depend on motility and biochemical reaction, Urease reaction and swarming phenomenon on blood agar are characteristics of proteus species(2).

Blood samples were taken from neonates using Ethylene diamine tetra acetic acid (EDTA K3) anticoagulants. Impedance method(Sysmex NE 8000 cell counter,Toa Medical Electronic 'USA'Inc) which is fully automated hematology analyzer for the diagnostic testing of total WBCs count were used. Then blood film was done and stained by Wright's stain for differential leukocytes count. Erythrocyte sedimentation rate was carried out by heparinized capillary tube, and cut off >10 mm first hour considered abnormal, the normal ranges for WBC count and monocyte count are given in the reference values. (5)

## Results

The total number of cases was 46 neonates diagnosed as sepsis. Eight of them died during the first week of admission and 38 case were followed up after 1wk. Most of the cases were males 28 (60.9 %)and 18 (39.1%) of cases were females with male :female ratio was 1: 0.56 at presentation.

Table(1) Shows the distribution of cases according to the gender in regard to the age of onset of disease. Most of male and female cases presented in the very early onset (less than 12hr) of age 30(65.2%), then late onset 13(28.3%), and 3 (6.5%) in the early onset. And in all these onsets of disease the male cases were more than female cases.

Figure 1. Shows the distribution of study cases according to the maturity. Most of cases of neonatal sepsis occur in preterm patients 32( 69.6%) and 14(30.4%) occur in full term neonates.

Figure 2. Shows the distribution of study cases according to the weight. Most of neonatal sepsis cases occur in low birth weight patients 23(50%), in very low birth weight 13 (28.3%) and 10(21.7%) occur in normal birth weight patients.

Figure (3). Shows the distribution of cases according to the type of labour. Most neonatal sepsis cases occur in normal vaginal delivery 28(60.9%) and 18(39.1%) occur in C.S

Table (2)Shows the most common risk factors of neonatal sepsis. Neonates with preterm delivery represents the most common risk factor of neonatal sepsis 32(69.6%), followed by male gender 28(60.9%).

Figure 4.Shows the most common signs and symptoms of neonatal sepsis. These were poor feeding 40 (87%), followed by RD 34 (73.9%), poormoro reflex 23 (50%), pallor 20 (43.5%),hypothermia 13 (28.3%),Lethargy 9 (19.6%), and 8 (17.4%) with cyanosis.

Figure 5.Shows the distribution of cases according to blood culture results. As observed the most common bacteria that cause neonatal sepsis was group B. streptococcus 17(37%) followed by coagulase negative staph 13 (28.3%),then E.coli 10(21.7%),and 6(13%) staph aureus.

Table (3) Shows the distribution of study cases according to the W.B.C count in regard to the type of bacteria .Most of the bacteria show nearly similar presentation of normal and high W.B.C. count except for staph aureus which shows all W.B.C. count is high 6(100%).

Table 4.shows the distribution of E.S.R. in regard to the type of bacteria. All types of bacteria show nearly similar normal and high E.S.R. except for staph aureus which shows most of cases have high E.S.R.

Table(5) Shows the distribution of study cases according to the monocyte count in regard to the type of bacteria. The high percentage of high monocyte count was in Coagulase negative staph , E.coli and staph aureus 10(76.9%),8(80%)and 4 (66.7%) respectively, while the normal monocyte count was nearly similar to the high monocyte in Group B. streptococcus.

Table(5) Distribution of study cases according to the monocyte count in regard to the type of bacteria.

## Discussion

Sepsis is a challenging problem in the neonatal period. Regarding the age of onset, the study shows that the higher incidence of neonatal sepsis is in the very early onset followed by the late onset and early onset ,this goes with Wilson(11) and Greenough(12) studies which shows that the high incidence of very early onset sepsis is 1 to 10 cases per 1000 live birth with amortality rate of 15 to 50%).This is may be due to presence of many risk factors for very early onset sepsis like preterm and LBW among the study cases.

The initial event of neonatal early-onset sepsis is supposed to occur prior to birth, since the majority of infected newborns present clinically as sepsis syndrome within the first 12h. of life. As a rule, early-onset sepsis results from an ascending infection of bacteria from the maternal recto vaginal flora invading the amniotic fluid and coming into contact primarily with mucosal cells of the fetal gastrointestinal and respiratory tract(13).

Males were predominantly affected by neonatal sepsis than females. This highly significant distribution is approved by Remington and Klien(13) who mentioned that male have approximately 2 fold higher incidence of sepsis than females, suggesting the possibility of sex-linked factor in host susceptibility to infection(13).

In this study neonatal sepsis cases were reported more frequently in premature than mature patients. Similar results was observed in Eisenfeld and Usmaniet studies who found that in preterm infants, chemotactic maturation begins after 2 to 3 weeks of life, proceeding slowly. In term infants, normal chemotactic function is established by the age of 2 weeks, whereas in preterm infants, chemotactic motility remains impaired for at least 3 weeks(14).Total neutrophil mass and the capacity to increase progenitor proliferation in preterm infants are even lower (14).

This is may be due to the fact that phagocytosis and microbicidal activity of phagocytes of healthy term newborn infants

appear to be mature (86,87,88) although in preterm infants and in septic or stressed infants, the neutrophil respiratory burst activity, phagocytosing capacity, or killing capacity are significantly depressed(15).

Low birth weight and very low birth weight are more prone to neonatal sepsis than normal birth weight this, goes with Stoll study which shows the incidence is increased ten fold in very low birth weight babies(16).

The incidence of sepsis is significantly higher in infants with very low birth weight (<1000 g), at 26 per 1000 live births, than in infants with a birth weight of 1000-2000 g, at 8-9 per 1000 live births. The risk for death or meningitis from sepsis is higher in infants with low birth weight than in full-term neonates. This is due to that LBW babies have depressed immunity system due to that most of LBW babies are either pre term or SGA or both(16).

The higher number of cases were born by normal vaginal delivery. This explain why most of study cases were occur in the very early onset sepsis because during the fetal life the fetal environment is normally sterile until the onset of labor and delivery. After rupture of the membranes, the infant becomes colonized with micro-organisms from the maternal genital tract(17). This leads to ascending infection from the genital tract and neonatal colonization with bacteria.

This study shows the most common signs and symptoms of neonatal sepsis is poor feeding followed by RDS ,poor Moro reflex, pallor, hypothermia, lethargy, and cyanosis. This results nearly similar to Rodriguez study which show among the clinical signs and symptoms: poor feeding, lethargy, coffee ground vomiting, respiratory distress, signs of dehydration, hypothermia, pallor, cyanosis, apnea, mottled skin, sclerema & prolonged capillary refilling time, reported significant association with outcome of death in neonatal sepsis. This wide range of presentation may be due to that the sign and symptoms of neonatal sepsis are non specific and differ from patient to another. (18)

This study shows that group B. streptococci is the most common bacteria isolated from neonatal sepsis patients followed by coagulase negative staph, E.coli and staph aureus. This goes with Kaftan study which shows that the micro-organisms recognized to have significant association with neonatal infections are group B. streptococci, coagulase negative staphylococci, group A streptococci, Hemophilus influenzae, and E. coli.(19).This may be due to presence of many risk factors for GBS neonatal sepsis among the study cases such as maternal intrapartum fever, preterm delivery, and preterm rupture of the membranes which enhance colonization of baby by GBS. In Cordero study Gram negative microorganisms were the most common microorganisms isolated from those neonates with sepsis; especially Klebsiella pp. while low incidence of gp. B.hemolytic Streptococci was reported(20).Other study by VanAmerfoorts shows that (52,1%) gram-positive, (37.5%) gram-negative, (4,7%) polymicrobial, (4,6%) fungal, and (1,0%) anaerobic bacteria. Remarkably, gram-positive infections increased during the study period. This increase is attributed to increased nosocomial infections from such sources as catheterization and is particularly alarming considering that reported rates of methicillin-resistant Staphylococcus aureus isolates range from 29% to 45% and demonstrate an increasing trend (21).

On the other hand Savey study(22) shows the major species involved in neonatal infection is *S. epidermidis*, which accounts for approximately 50 to 80% of CoNS colonization (23,24), and (60) to (93%) of CoNS bloodstream infection (25). *S. epidermidis* colonization rates of 86 to 100% have been reported among NICU patients(26).The majority of CoNS colonization is acquired nosocomially, predominantly from the hands of health care workers. In a survey using multiple molecular typing techniques, (62%) of NICU nurses were colonized with methicillin resistant CoNS, with similar species distribution to that of bacteremic strains in the unit (27).

This study shows that from total of 46 cases, the high W.B.C. count is found in 28 (60.9%)and this is goes with Crain(28) and Dagan(29) studies

which shows that (50%) of infants had high WBC count ,and none had low count(29).This high percentage of high WBC count due to fact that in any newborn infant, PMN accumulate poorly at the sites of infection as a result of chemotactic deficiencies (28),and this lead to increase its count in the peripheral blood.

During sepsis, however, newborn infants frequently become neutropenic . Because of their limited neutrophil storage pools in the bone marrow and their inability to increase stem cell proliferation (30). In addition newborn infants born to mothers with hypertension have abnormally low blood neutrophil concentrations due to decreased neutrophil production(28 ).

Also this study goes with Munroe and Rod well study which showed impaired sensitivity of a single WBC count assay in neonatal sepsis as shows from 61cases 48(10%) with abnormal WBC count and 13(23%) with normal WBC count (31).White blood cell count, band form count and related ratios have served as diagnostic tools for neonatal infections. The specificity and sensitivity of these tests, however, are insufficient to serve as the only markers for sepsis(28).

In this study no significant effect of bacteria on WBC count except for staph aureus which shows all cases have high WBC count. This may be due to the fact that higher concentrations of IL-18 observed in gram-positive compared with gram-negative infections (32)have been corroborated by in vitro stimulation; whole blood stimulation with gram-negative LPS indicated a slight increase after 24h,whereas gram-positive S.aureus stimulation induced a significant increase after 4 h, peaking at 24 h . The usefulness of this marker has been reported in several studies, including differentiation of sepsis severity(32).

Erythrocyte sedimentation rate increased in 26(56.7%) of the study cases with no significant effect of certain bacteria on ESR . This is in agreement with previous observations by Sinph(33) and Nandeo(34). However therapeutic decision-making based on ESR may be difficult because of its low specificity .This is similar to other study by Adler SM, which shows that 32 infants with culture proven sepsis, only 12 would be elevated if the analysis was based on the

traditional values for ESR .This study also shows the high effect of staph aureus on ESR in which (83.3%) of cases have high ESR .This may be due to higher concentration of inflammatory mediator IL-18 in gram positive S.aureus compared with gram negative infections(32) as mentioned above.

This study shows that the higher number of cases have high monocyte count 31(67.4%),which is Similar to Martin study which shows the high count of CD14,CD16 monocyte in sepsis. This fact may be due to in newborn infants, monocyte influx into inflammatory sites is impaired most likely due to the delayed and attenuated monocyte chemotactic activity. Also expression of monocyte HLA-DR is lower in healthy neonates and is further decreased in neonates with sepsis(35).

There is no significant association with type of bacteria.This is similar to Cuzzola(36). and Mancuso(37). study which shows no correlation between monocyte , sex and type of microorganism. It has been reported recently that purified group or type specific carbohydrates or lipoteichoic acids of S. agalactiae activate cells of the innate immune system primarily via CD14 and complement receptors (CR) (36). Other investigators have shown that CR3 but not CR4 seems to be involved in activation of human monocytes by streptococci, whereas CR4 is involved in activation by Staph.aureus(37).

## **Conclusions**

The higher number of neonatal sepsis cases were presented in the very early onset period (less than 12 hr. of age) 30(65.2%). Males were more frequently affected by neonatal sepsis than females 28 (60.9%). The most common bacteria caused neonatal sepsis in this study was Group B. strep.17(37%) followed by Coagulase negative Staph,E coli and Staph. aureus. There is no significant relation between the type of bacteria and the hematological parameters in neonatal sepsis.

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The relation between the type of microorganisms and some hematological parameters in neonatal septicemia.

**Table(1) Distribution of cases according to the gender in regard to the age of onset of disease.**

Onset	Male	Female	Total
<12 hr.very early onset	18(39.1%)	12 (26.1%)	30(65.2%)
12-72hr.early onset	2(4.3%)	1(2.2%)	3(6.5%)
>72hr.late onset	8(17.4%)	5(10.9%)	13(28.3%)
Total	28(60.9%)	18(39.1%)	46(100%)

**Table(2) The most common risk factors of neonatal sepsis.**

Risk factors	N0.	%
Preterm	32	69.6
Male gender	28	60.9
Maternal fever	28	60.9
Poor hand washing practice	27	58.7
Bottle feeding	20	43.5
Interference*	30	
Meconium aspiration	19	41.3
Prolonged rupture of membrane	15	32.6
Previous admission to incubator	12	26.1
Superficial skin infection	7	15.2

Interference\*:vaccum, forceps, episiotomy delivery, umbilical catheterization.  
Endotrachial intubation, I.V. fluid users , suction.

The relation between the type of microorganisms and some hematological parameters in neonatal septicemia.

**Table (3) Distribution of study cases according to the W.B.C count in regard to the type of bacteria .**

Bacteria	W.B.C		Total
	Normal	High	
Group B.streptococcus	8 (47.1%)	9 (52.9%)	17(100% )
Coagulase -ve staph.	5(38.5%)	8(61.5% )	13(100%)
E.coli	5(50%)	5(50%)	10(100%)
Staph aureus	0 (0%)	6(100%)	6(100%)
Total	18(39.1%)	28 (60.9%)	46(100%)

Chi-Square =4.78 DF =3 P Value at 0.05 = 7.84 not significant

**Table (4) Distribution of study cases according to the E.S.R in regard to the type of bacteria.**

Bacteria	E.S.R		Total
	Normal	High	
Group B.streptococcus	7( 41.2%)	10(58.8%)	17(100% )
Coagulase -ve staph.	7(53.8%)	6(46.2%)	13(100%)
E.coli	5(50%)	5(50%)	10(100%)
Staph aureus	1(16.7%)	5(83.3%)	6(100%)
Total	20 (43.5%)	26(56.5%)	46(100%).

Chi-Square =2.19 DF =3 P Value at 0.05 =7.81 not significant

**Table(5) Shows the distribution of study cases according to the monocyte count in regard to the type of bacteria.**

Bacteria	Monocyte		Total
	Normal	High	
Group B.Strept.	8(47.1%)	9 (52.9%)	17(100%)
Coagulase -ve staph.	3(23.1%)	10 (76.9%)	13(100%)
E.coli	2(20%)	8(80%)	10(100%)
Staph aureus	2(33.3%)	4(66.7%)	6 (100%)
Total	15(32.6%)	31(67.4%)	46(100%)

Chi-Square =5.64 DF =3 P Value at 0.05 =7.81 not significant

The relation between the type of microorganisms and some hematological parameters in neonatal septicemia.

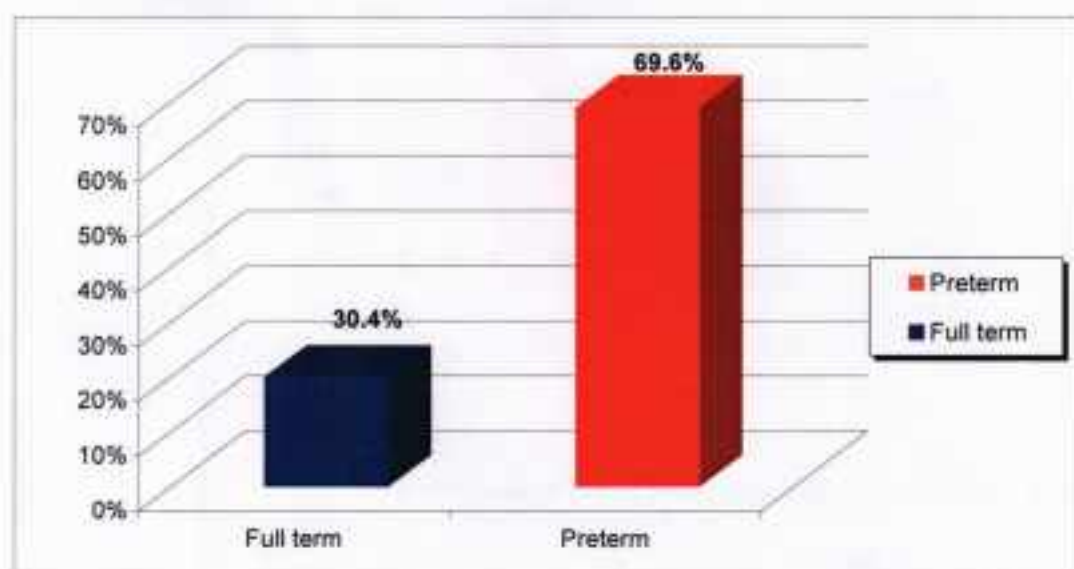
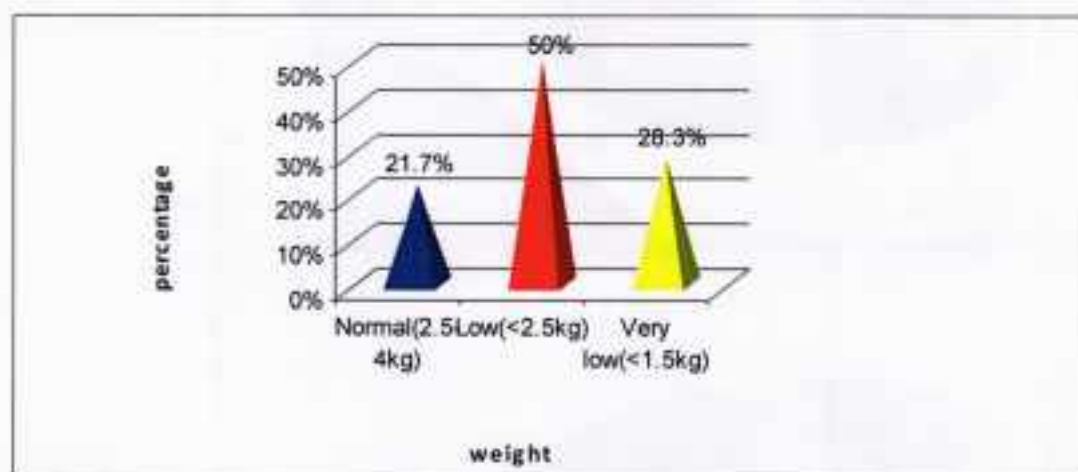
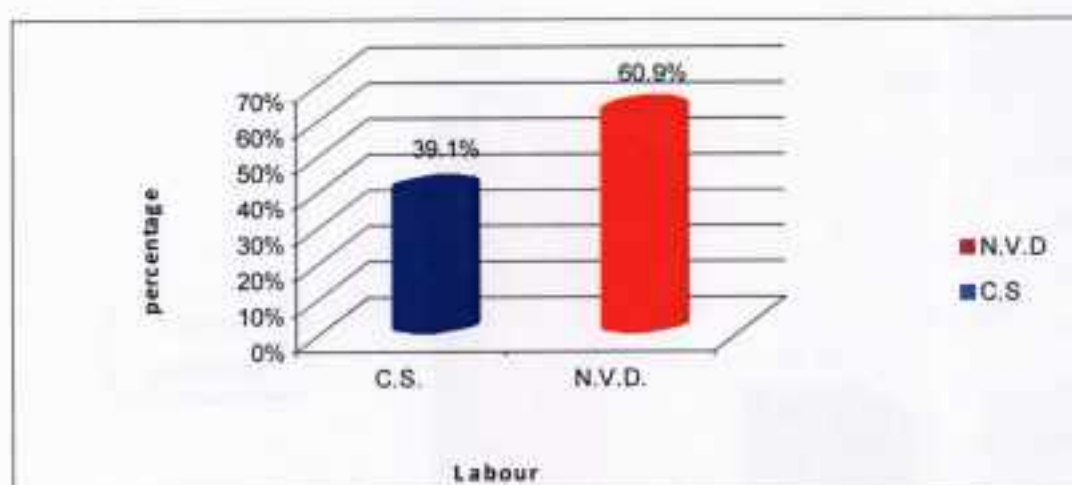


Figure (1) Distribution of cases according to the maturity .

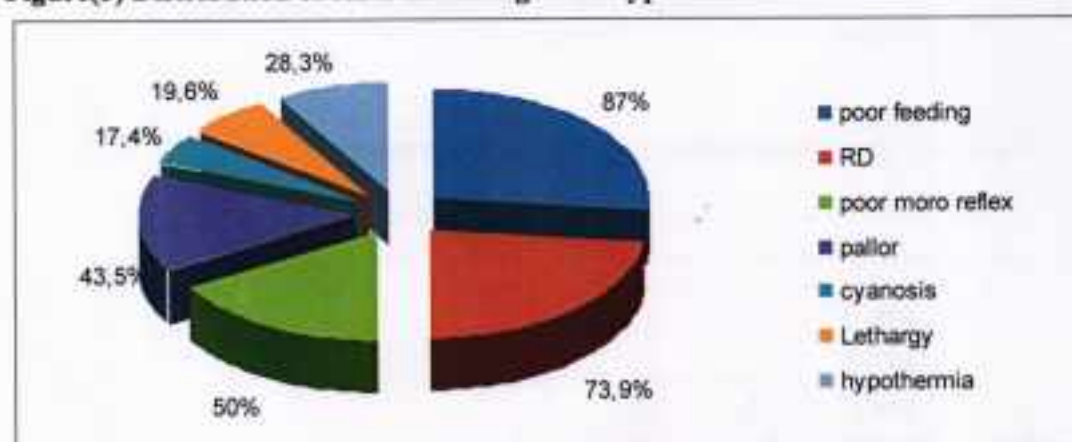


Figure(2) Distribution of cases according to the weight .

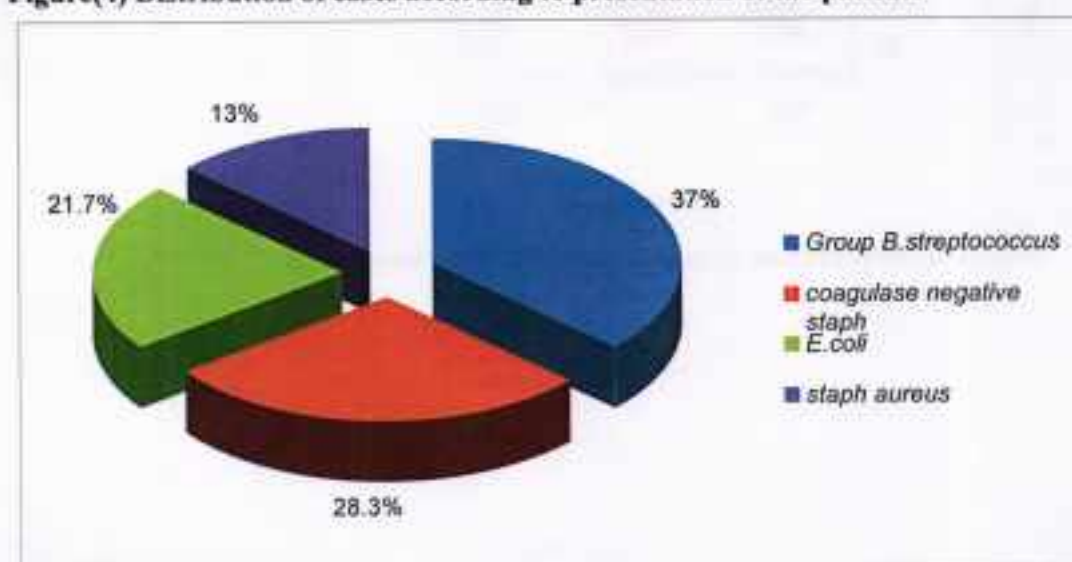
The relation between the type of microorganisms and some hematological parameters in neonatal septicemia.



Figure(3) Distribution of cases according to the type of labor .



Figure(4) Distribution of cases according to presentation of the patients



Figure(5) Distribution of cases according to blood culture results .