PROFILE OF NEONATAL SEPSIS IN A TERTIARY CARE CENTRE, CHENNAI, TAMIL NADU

Dissertation Submitted for

MD DEGREE EXAMINATION
BRANCH VII - PAEDIATRIC MEDICINE

INSTITUTE OF CHILD HEALTH AND HOSPITAL FOR CHILDREN
MADRAS MEDICAL COLLEGE
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SEPTEMBER 2006

CERTIFICATE

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DECLARATION

I declare that this dissertation entitled **"PROFILE OF NEONATAL SEPSIS IN A TERTIARY CARE CENTRE, CHENNAI, TAMIL NADU"** has been conducted by me at the Institute of Child Health and Hospital for Children. It is submitted in part of fulfillment of the award of the degree of M.D (Paediatrics) for the September 2006 examination to be held under the Tamil Nadu Dr.M.G.R Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

(Dr.D.VELMURUGAN)

SPECIAL ACKNOWLEDGEMENT

My sincere thanks to **Prof. Dr. Kalavathi Ponniraivan, Bsc., M.D.** the Dean of Madras Medical College for allowing to do my dissertation and to utilize the facilities of the institution.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to **Prof. Mangayarkarasi Senguttuvan M.D.D.C.H.**, Professor and Head of the department of Paediatrics and Director and Superintendent of Institute of Child Health and Hospital for Children for permitting me to undertake this study.

I am extremely thankful to my unit Chief **Prof.Dr.Saradha Suresh, M.D., D.C.H., Ph.D.,** for her invaluable help, guidance, encouragement and support throughout the study.

I am greatly indebted to **Prof. Dr. Meer Mustafa Hussain. MD. D.C.H. Ph.D.,** for the unstinted guidance given by him throughout my study.

I thank the assistant professors of my unit **Dr.Luke Ravi Chellaiah, M.D.,(Paediatrics), Dr Guna Singh M.D., D.C.H., Dr. C. Subbulakshmi, M.D., D.C.H.,** and former assistant Professor **Dr. R. Kandaswamy., M.D., D.C.H.,** for their guidance and support.

I thank the assistant professors of new born unit **Dr.A.Paramanandam, M.D. D.C.H., Dr J.Kumudha, M.D., D.C.H., Dr. V. Vijayakumar, M.D., D.C.H.,** for their guidance and support.

I express my sincere thanks to **Prof.Mohamed Meeran, M.D., (Microbiology) M.D., (Venerology) D.V.,** Head of Department of Microbiology and **Dr.U.Umadevi, M.D., (Microbiology)** Assistant Professor, Department of Microbiology for their valuable guidance, supervision and constant support.

I extend my sincere thanks to registrars, **Dr.Kothai Nayaki**, **M.D., D.C.H.**, and **Dr. P. Ramachandran**, **M.D., D.C.H.**, for their valuable suggestions in doing this work.

I sincerely thank all the **neonates and their parents** who had submitted themselves for this study without whom this study would not have been possible.

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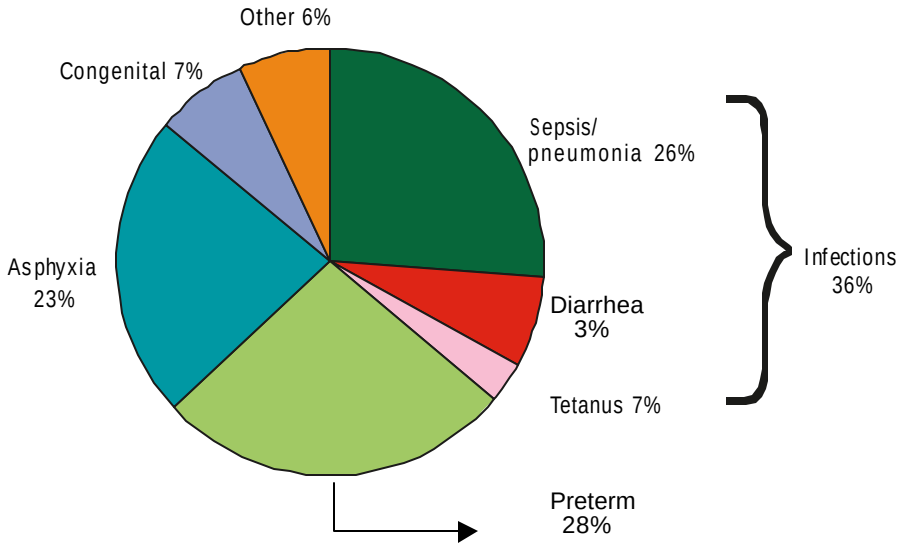
INTRODUCTION

1. INTRODUCTION

Of the 130 million babies born every year, about 4million die in the rst 4 weeks of life, the neonatal period[1]. Most neonatal deaths (99%) arise in low-income and middle- income countries, and about half occur at home. In poor communities, many babies who die are unnamed and unrecorded, indicating the perceived inevitability of their deaths. The three major causes of neonatal deaths worldwide are infections, including sepsis, pneumonia, tetanus, and diarrhea (36 per- cent); prematurity (28 percent); and birth asphyxia or problems related to childbirth complications[1].

(Figure 1)

Figure 1



Child survival programmes in the developing countries like India have tended to focus on pneumonia, diarrhea, malaria, and vaccine-preventable conditions, which are important causes of death after the rst month of life. Between 1980 and 2000, child mortality after the rst month of life i.e., from month 2 to age 5 years fell by a third, whereas the neonatal mortality rate (NMR) was reduced by only about a quarter. Hence, an increasing proportion of deaths are now in the neonatal period.

Infections are the major cause of death after the first week of life. Most of these infection-related deaths could be prevented if all mothers and their babies had access to simple preventive measures and treatments. A quarter of a million babies continue to die each year from neonatal tetanus a condition that can be prevented by giving a pregnant woman two injections of tetanus toxoid.

In developing countries like India great majority of people live in rural areas where access to health care facilities are not possible. Majority of women do not undergo proper ante-natal follow ups and majorities of deliveries takes place at home usually conducted by traditional birth attendants in unhealthy conditions and unsterile manner. So the new born is subjected to risks for complications like neonatal sepsis, birth asphyxia etc.

In the Institute of Child Health and Hospital for Children, which is a tertiary care centre, attached to Madras Medical College, admits approximately 4000 neonates for various causes in its extramural new born ward. The common causes of admissions were preterm care, septicemia, jaundice, birth asphyxia etc.

Table 1: INSTITUTE OF CHILD HEALTH NEW BORN STATISTICS

	2003		2004		2005	
Disease	Admitted %	Mortality %	Admitted %	Mortality %	Admitted %	Mortality %
Preterm care	19.5	39.7	34.2	39.2	26.5	43.7
Septicemia	16.5	41.6	11.7	29.6	12.2	25.6
Jaundice	16.4	10.5	16.3	8.9	17.2	7.6
Birth asphyxia	12.8	33.2	20.3	27.1	15.4	32.4
Respiratory infections	7.4	29.4	7.6	30.6	6.9	30.0
Birth trauma	4.7	38.4	1.4	22.0	2.5	11.2
Diarrhea	3.3	13.4	2.9	13.4	2.7	12.9
Meconium aspiration syndrome	1.6	46.8	1.8	66.7	1.7	62.5
Meningitis	0.8	61	0.9	56.7	0.8	58.3
Total	N=4720	30.1	N=4151	32.9	N=4588	29.8

EPIDEMIOLOGY AND PATHOGENESIS

2. EPIDEMIOLOGY AND PATHOGENESIS

The uniqueness of neonatal infections is a result of a number of factors. There are diverse modes of transmission of infectious agents from mother to fetus or newborn infant [2].

1). Transplacental hematogenous spread may occur at different times during gestation. Vertical transmission of infection may take place in utero, just prior to delivery, or during the process of delivery. After birth, the newborn infant may be exposed to infectious diseases in the nursery or in the community. With the increasing complexity of neonatal intensive care, gestationally younger and lower birth weight newborns are surviving and remaining for a longer time with a high risk of infection.

2) The newborn infant may be less capable of responding to infection owing to one or more immunologic deficiencies involving the reticuloendothelial system, complement, polymorph nuclear leukocytes, cytokines, antibody, or cell-mediated immunity.

3) Coexisting diseases of the newborn often complicate the diagnosis and management of neonatal infections. Respiratory disorders such as

hyaline membrane disease may coexist with bacterial pneumonia. Acidosis impairs functions of polymorph nuclear leukocytes.

4) The manifestations of infectious diseases in the newborn infant are extremely variable.

In addition, the comparative immunodeficiency of the neonate not only predisposes him to infection, but also means that when infection occurs it may disseminate very rapidly, with septicemia shock and death occurring within 12 hours of the first signs of illness. This dissemination which is particularly rapid has two major implications:

1. Early diagnosis is essential. Even very trivial clinical findings that suggest infection demand full laboratory evaluation.
2. Initial therapy must be started on the basis of clinical suspicion. There is no time to wait for the laboratory results like blood culture to come back after 48 – 72 hours later.

In both term and preterm infants, early warning signs and symptoms are often minimal, subtle, non-specific, and can easily be misinterpreted as being due to non-infective causes such as transient tachypnoea of the newborn, environmentally induced fluctuation of body temperature, apnea of prematurity and acute exacerbations of bronchopulmonary dysplasia.

Although the onset of illness is often inconspicuous, the clinical course may be alarmingly fulminant, leading to septicemic shock, disseminated intravascular coagulation, and death within hours of the onset of clinical manifestations. Infected infants must therefore be promptly identified and differentiated from non-infected patients, and antibiotics started without delay. However, as microbiological culture results and antimicrobial susceptibility data are not usually available until at least 48 hours after the specimen reaches the laboratory, early identification of genuine sepsis is a major diagnostic problem. In addition, antimicrobial treatment based solely on risk factors and clinical grounds is likely to result in over treatment. Continuation of antibiotics for presumptive bacterial infection often leads to unnecessary and prolonged treatment.

The most important neonatal factor predisposing to infection is prematurity or low birth weight; there is a 3- to 10-fold higher incidence of infection and sepsis in these infants than in full-term normal-birth weight infants. Males have an approximately two-fold higher incidence of sepsis than females, suggesting the possibility of a sex-linked factor in host susceptibility. Resuscitation at birth, particularly if it involves endotracheal intubations, insertion of an umbilical vessel catheter, or both, is associated

with an increased risk of bacterial infection, possibly due to prematurity or the presence of infection at the time of birth.

Infection in the newborn infant may be limited to a single organ or may involve multiple organs (focal or systemic); it may be mild, moderate, or severe; acute, sub acute, or chronic; or it may be asymptomatic. Asymptomatic bacteremia has been demonstrated in infants born to women with risk factors. Infections with different microorganisms may have overlapping patterns; it is usually not possible to make a definitive diagnosis of a specific etiologic agent from the clinical features alone. Early manifestations of infection may be subtle and nonspecific such as inability to tolerate feeding, irritability, or lethargy. Signs consistent with infection in the newborn may also be caused by a variety of noninfectious disease processes involving different organs

Only about 50% of infected newborn infants have a temperature greater than 37.8º C (axillary), and fever in newborn infants does not always signify infection. Fever may be caused by increased ambient temperature, dehydration, central nervous system disorders, hyperthyroidism, familial dysautonomia, or ectodermal dysplasia. A single temperature elevation is infrequently associated with infection. Most febrile infected infants have additional signs compatible with infection,

although a focus of infection may not be apparent. In premature infants, hypothermia or temperature instability is more likely to be associated with infection, but some degree of temperature instability is not unusual in low-birth weight infants.

Cutaneous manifestations of infection provide useful clues. Impetigo, cellulitis, mastitis, omphalitis, and subcutaneous abscesses should be recognizable. Ecthyma gangrenosum is indicative of pseudomonal infection. The presence of small salmon-pink papules suggests Listeria monocytogenes infection. A vesicular rash is consistent with herpesvirus infection. The mucocutaneous lesions of Candida albicans are covered later. Petechiae and purpura may have an infectious cause.

Neonatal pneumonia may be difficult to differentiate in premature infants with respiratory distress syndrome or bronchopulmonary dysplasia. Pneumonia should be considered in ventilated infants who have progression of their respiratory failure. Pneumonia is likely in full-term infants with respiratory distress who are not at risk for hyaline membrane disease.

Neonatal infections are unique for the following reasons:

(1) There are diverse modes of transmission of infectious agents from mother to fetus or newborn infant [2].

(2) The newborn infant may be less capable of responding to infection owing to one or more immunologic deficiencies involving the reticuloendothelial system, complement, polymorphonuclear leukocytes, cytokines, antibody, or cell-mediated immunity.

(3) Coexisting conditions of the newborn often complicate the diagnosis and management of neonatal infections. Respiratory disorders such as hyaline membrane disease may coexist with bacterial pneumonia. Acidosis impairs functions of polymorphonuclear leukocytes.

(4) The clinical manifestations of infectious diseases in the newborn infant are extremely variable. There may be subclinical infection, congenital malformations, focal disease, and poorly localized systemic infection. The timing of exposure, inoculum size, immune status, and virulence of the etiologic agent influence the expression of disease in the fetus or newborn infant.

(5) Maternal infection that is the source of transplacental fetal infection is often undiagnosed during pregnancy because the mother is either

asymptomatic or had nonspecific signs and symptoms at the time of presentation.

(6) A variety of etiologic agents infect the newborn, including bacteria, viruses, fungi, protozoa, and mycoplasma.

(7) Finally, with the advances in the neonatal care, increasingly immature, very low birth weight (VLBW) newborns are surviving and remain in the hospital for a longer time, an environment that puts them at ongoing high risk of infection[2].

PATHOGENESIS OF ASCENDING BACTERIAL INFECTION

In most cases the fetus or the neonate is not exposed to potentially pathogenic bacteria until the membrane rupture and the infant passes through the birth canal and /or enters the extra uterine environment. Chorioamnionitis results from microbial invasion of amniotic fluid, usually as a result of prolonged rupture of membranes >18 hours. Previously longer than 24 hours was considered prolonged rupture of membranes because microscopic evidence of inflammation of membranes is present when the duration of the rupture of membranes is uniformly present when the duration of rupture exceeds 24 hours. However, at 18 hours the incidence of early-onset disease with group B streptococcus (GBS) increases significantly. Therefore, longer than 18 hours is the current cutoff for

increased risk of infection. In most cases bacterial colonization does not result in disease. Factors influencing which colonized infant will develop disease are not well understood but include prematurity, underlying illness, invasive procedures, inoculum size, virulence of the organism, and transplacental maternal antibodies.

Difficult or traumatic delivery and premature delivery are also associated with increased frequency of neonatal infection. Resuscitation at birth, particularly if it involves endotracheal intubation, insertion of an umbilical vassel catheter, or both, is associated with increased risk of bacterial infection.

The physical and chemical barriers to infection in the human body are present in the newborn but are functionally deficient. Skin and mucus membranes are broken down easily in the premature infant. Neonates who are ill and/or premature are additionally at risk because of the invasive procedures that breach their physical barriers to infection. Because of the interdependence of the immune response, these individual deficiencies of the various components of immune activity in the neonate conspire to create a hazardous situation for the neonate exposed to infectious threats.

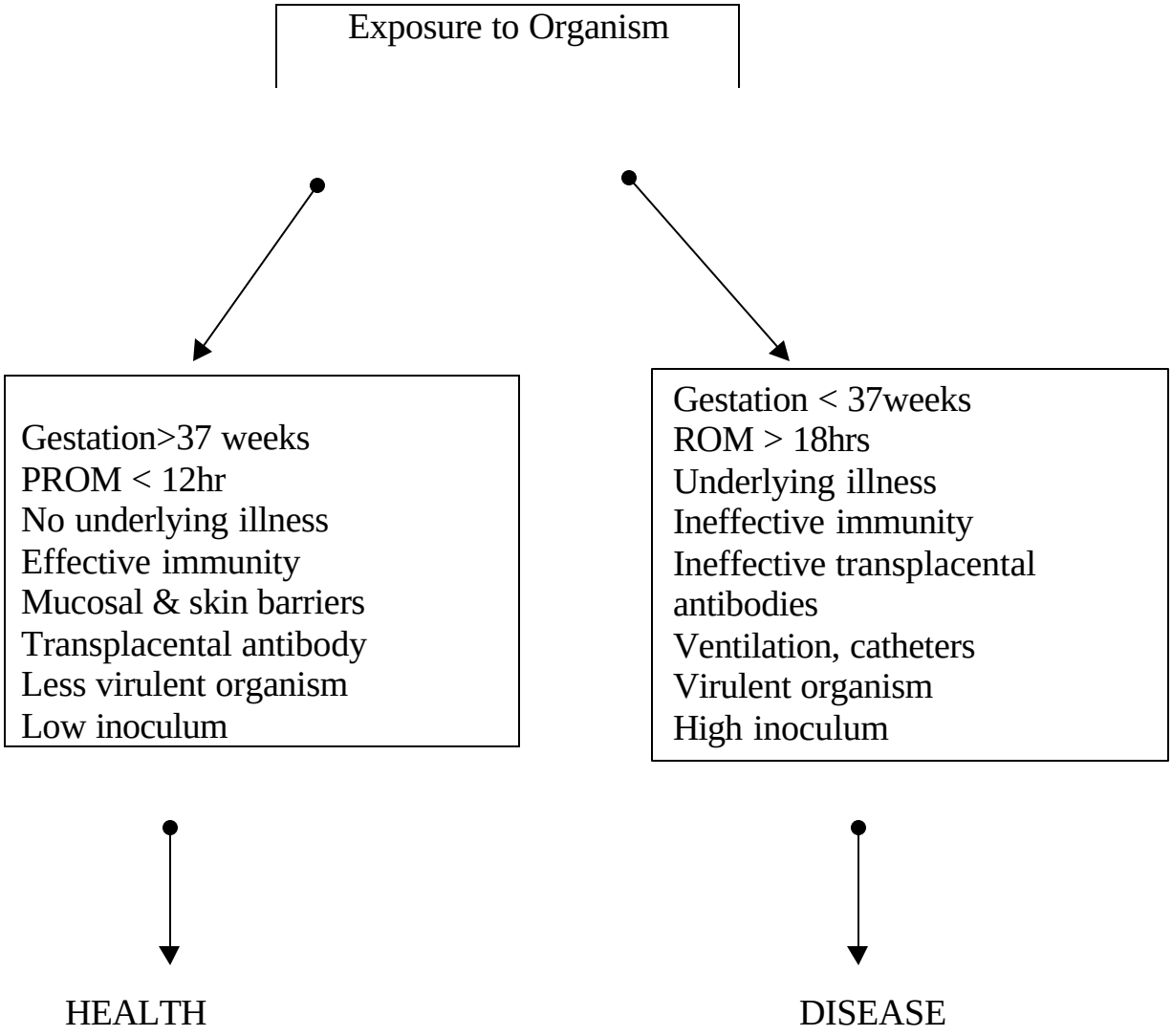
Aspiration or ingestion of bacteria in amniotic fluid may lead to congenital pneumonia or systemic infection, with manifestations becoming

apparent before delivery, at delivery, or after a latent period of few hours. Aspiration or ingestion of bacteria during the birth process may lead to infection after a period of 1-2 days

PATHOGENESIS OF LATE ONSET POSTNATAL INFECTIONS

Here the neonates are exposed to infectious agents in the community or in the nursery. Postnatal infections may be transmitted by direct contact with the hospital personnel, the mother or other family members; from inanimate sources like contaminated clothes or equipments. The most common source of post natal infections in hospitalized newborns is hand contamination of health care personnel.

Factors influencing the balance between health and disease in neonates exposed to potential pathogens



IMMUNOLOGICAL STATUS OF A NEONATE

There have been many studies that compare immunologic function of newborn infants to that in adults. Diminished concentrations of immunologic factors and decreased function are often demonstrated. Despite these defects in immunity in premature and full-term infants, the rate of invasive infectious diseases is low in the absence of obstetric and neonatal risk factors. It is important to maintain this perspective when evaluating immunologic prophylactic measures such as the use of intravenous immunoglobulin in the newborn.

Immunoglobulins.

There is active transport of immunoglobulin G (IgG) across the placenta with concentrations in the full-term infant comparable to those of the mother. Other classes of Igs are not transferred, although the fetus can synthesize IgA and IgM in response to intrauterine infection. The presence of specific IgG antibody in adequate concentrations provides protection to the newborn against those infections in which protection is mediated by antibody (e.g., encapsulated bacteria such as GBS). Specific bactericidal and opsonic antibodies against enteric bacilli are predominantly in the IgM class; the newborn infant lacks protection against Escherichia coli and other Enterobacteriaceae.

Complement.

Complement mediates bactericidal activity against certain organisms such as E. coli and functions as an opsonin with antibody in optimal phagocytosis of bacteria such as GBS. There is essentially no transfer of complement from the maternal circulation. The fetus synthesizes complement components as early as the first trimester. Full-term newborn infants have slightly diminished classic pathway complement activity and moderately diminished alternative pathway activity. There is considerable variability in both concentration of complement components and activity. The alternative pathway components (B and P) are usually 35%–60% of normal. Premature infants have lower levels of complement components and less complement activity than full-term newborns. These deficiencies contribute to diminished complement-derived chemotactic activity and to diminished ability to opsonize certain organisms in the absence of antibody. In general, opsonization of Staphylococcus aureus is normal in neonatal sera, but varying degrees of impairment have been noted with GBS and E. coli.

Neutrophils.

Quantitative and qualitative deficiencies of the phagocytic system are important factors contributing to newborns' increased susceptibility to infection. Chemotaxis is abnormal at birth both in term and in preterm infants. In addition, neonatal neutrophils have decreased adhesion, aggregation, and deformability, all of which may delay the response to infection.

The number of circulating neutrophils is elevated after birth in both full-term and premature infants, with a peak at 12 hr, returning to normal by 22 hr. Band neutrophils constitute less than 15% in the normal newborn and may increase in newborns with infection and other stress responses such as asphyxia.

Neutropenia is frequently observed in preterm infants and intrauterine growth restriction, and it increases the risk of sepsis. The neutrophil storage pool in newborn infants is 20—30% of that of adults and is more likely to be depleted in the face of infection.

Monocyte-Macrophage system.

The number of circulating monocytes in neonatal blood is normal, but the mass or function of the macrophages in the reticuloendothelial system apparently is diminished in the newborn and particularly in the

premature infant. In both term and premature infants, chemotaxis of monocytes is impaired, which affects the inflammatory response in tissues.

Clinical features:

Early signs

Lethargy, tachypnea, refusal to suck hypotonia, listlessness, irritability, pallor, mottled skin, are often the first, mild, non-specific signs that a neonate is unwell[2].

Temperature change. A body temperature below 36°C or above 37.5°C sustained for more than an hour or two is due to infection until proved otherwise.

Vomiting, abdominal distention and constipation are features of sepsis particularly when there is an intra abdominal infection.

Late signs

These are usually specific to one organ system

Respiratory: Chest retractions, grunting and cyanosis.

Abdominal: Bilious vomiting, gross abdominal distention, absent bowel sounds.

CNS: High pitched cry, bulging fontanelle and convulsion.

Hemorrhagic diathesis: Petechiae, ecchymoses.

Sclerema: especially in preterm neonates.

Investigations:

1. Blood culture

   At least 0.5ml (preferably 1mL) of blood should be taken in pediatric blood culture bottles containing 9 ml of brain heart infusion agar broth.

2. WBC count

   A total WBC <5000, >15000 and IT Ratio >0.2 have all been correlated with presence of bacterial infection. IT Ratio is 0.16 at birth and declines to peak value of 0.12 after 72hrs of age. IT Ratio of >0.2 is suggestive of infection.

3. C-reactive protein

   It is an acute-phase reactant, synthesized in the liver that increases the most in the presence of inflammation caused by infection or tissue injury. After the onset of inflammation CRP synthesis increases within 4-6hrs, doubling every 8 hours and peaks at about 36-50 hours. Levels remain elevated with ongoing inflammation, but with resolution they decline rapidly due to short half life of 4-7hrs.

4. Chest X-Ray

   It should be done for all the cases unless there is an obvious extrapulmonary focus of infection.

5. Lumbar Puncture

   Normal CSF WBC counts in term, noninfected infants are variable, with a mean of less that 30 cells/mm^3 with ranges of up to 90 cells, and widely varying levels of polymorpho- nuclear cells on the differential. The normal CSF protein concentration is 0.6gms/L(range 0.4-1.0gms/L)in term and preterm neonates, with an upper limit of 1.5-2.0gms/L. The CSF should be gram-stained and cultured.(nrc Robert 246)

TREATMENT

Any neonate in whom it is remotely possible that an infection is responsible for the abnormal clinical and laboratory findings should be given antibiotics. In virtually all cases the antibiotic should be given intravenously and can be stopped in 5 days or less if the neonate's condition rapidly improves and cultures are negatives.

Proven infections should be treated for 14 days in most babies with septicemia and at least 21 days in meningitis.

Empirical antibiotic therapy[2] includes broad spectrum antibiotic usually beta-lactum antibiotic (ampicillin) and an aminoglycoside (gentamycin).A third generation cephalosporin (cefotaxime or ceftazidime) is added to the empirical treatment based of the blood culture results.

Supportive treatments[2] for sepsis include the use of mechanical ventilation; exogenous surfactant therapy for respiratory distress syndrome; volume and pressor support for hypotension and poor perfusion; sodium bicarbonate for metabolic acidosis; and anticonvulsants for seizures.

REVIEW OF LITERATURE

3. REVIEW OF LITERATURE

Literature review was done to understand the current status of the clinical profile, causative organisms and their sensitivity pattern, laboratory findings, neonatal and maternal risk factors of neonatal sepsis in similar hospitals in India and abroad.

CLINICAL PROFILE

Hajiehe Borna, M.D. et al [6] has shown that clinical signs such as tachypnea, apnea, cyanosis, tachycardia, abdominal distension and skin presentations were more common

R.S.Jaswal et al [8] have shown that the most common symptoms, by which 66% of these patients presented were refusal for feed, followed by lethargy and jaundice.

BLOOD CULTURE

Roy I et al [4] ., have shown that 47.5% had positive on blood culture.

Jain NK et al., [5] have shown that, in their study 28.3 % were culture positive

Hajiehe Borna, M.D. et al [6] have shown in their study the rate of proven sepsis was 9.5%.

D.K.LChan, L Y Ho et al [7] have shown that in his study 20% of suspected sepsis had positive cultures.

R.S.Jaswal et al [8] has shown that the incidence of blood culture positivity was 42% in his study.

Mathur M et al [11] have shown that blood culture was positive in 24.88%.

A.S.M. Nawshad Uddin Ahmed et al [20] , have shown that the 34.9% had positive blood culture.

Das PK et al [23] have shown that in his 48.38% had positive blood culture.

Chacko Betty et al [24] have shown that culture proven EOS occurred in 41.6%.

CAUSATIVE ORGANISMS AND SENSITIVITY PATTERN

Roy I et al., [4] have shown that in his study the most frequent offender was Klebsiella (24.5%) followed by Enterobacter (22.8%). There was an overall predominance of gram negative organisms.

Jain NK et al., [5] in their study have shown an increased prevalence of gram negative septicemia, E-coli and Klebsiella were the common organisms.

Hajiehe Borna, M.D. et al [6] Klebsiella , staph aureus and coagulase negative staph were the common causal organisms.

Mathur M et al [11] have shown that gram negative septicemia was encountered in 87.1% of these neonates. Klebsiella and Enterobacter species were the predominant pathogens amongst Gram negative organisms. Of Gram positive isolates, Staphylococcus aureus was the predominant isolate (79.0%). Salmonella species was isolated in 2.4% of these cases.

Greenberg et al [14] have shown that out of the 229 cases studied, 57 of all isolates were Gram-negative organisms (mainly Klebsiella pneumoniae (20%) and Escherichia coli (16%)). Gram-positive organisms were isolated in 41% of cases.

A.S.M. Nawshad Uddin Ahmed et al [20], have shown that majority (70%) of the cultures isolated gram negative bacilli, most commonly E.coli and Klebsiella. These isolates were most often sensitive to gentamicin, ciprofloxacin, and third generation cephalosporins.

Kurien Anil Kuruvilla et al [21] have shown that E. coli and E. fecalis were the predominant organisms causing E0S, while Klebsiella and E. fecalis were the predominant organisms in LOS.

Das PK et al [23] have shown that Klebsiella was the most frequent offender, followed by Staph aureus and Staph epidermidis.

Chacko Betty et al [24] have shown that in his study pseudomonas was the commonest (60%) isolate.

MORTALITY

Jain NK et al [5] ., in their study have shown that the incidence of neonatal deaths due to sepsis was 11.32%.

A.S.M. Naushad Uddin Ahmed et al [20] ., has shown that in his study, the incidence of neonatal deaths due to sepsis was 40%.

Das PK et al [23] has shown a overall case fatality was 17.1% in his study

Kurien Anil Kuruvilla et al [21] has shown in his study the case fatality rate was 14.4%.

RISK FACTORS

Jain NK et al [5]., in their study have shown that majority of study population was poor, didn't have proper ante-natal check ups, delivered at home and untrained birth attendants conducted most of the deliveries, which was associated with an increased risk of serious neonatal infection and respiratory distress syndrome was found to be the most common clinical presentation.

Abdul Hakeem Jokhio et al [12] has shown that training traditional birth attendants and integrating them into an improved health care system were achievable and effective in reducing perinatal mortality improving the perinatal and maternal health in developing countries.

Schuchat A, et al [19]. have shown that an obstetric risk factor - preterm delivery, intrapartum fever, or membrane rupture > 18 hours - was found in 49% of GBS cases and 79% of other sepsis.

Kurien Anil Kuruvilla et al [21] have shown in his study that maternal factors significantly associated with EOS were meconium staining of liquor and multiple vaginal examinations.

Chacko Betty et al [24] has concluded in his study that screening for sepsis in an asymptomatic neonate is warranted only in the presence of a maternal risk factor even if the neonate is at high risk of developing sepsis due to associated problems of prematurity, low birth weight or asphyxia.

LABORATORY TESTS

Hajiehe Borna, M.D. et al [6] have shown in their study that initial CRP had a high NPV (97%) but low PPV (36%) with the sensitivity and specificity of 79% and 85% respectively.

D K L Chan, L Y Ho et al [7] have shown that the sensitivity, specificity, positive and negative predictive values of CRP M0.7 mg/dL were 56%, 72%, 71% and 57% respectively. Only abnormal platelet counts had similar efficiency as CRP. Abnormal WCC had the lowest sensitivity and positive predictive value while abnormal ANC had the lowest specificity and negative predictive value among them.

R.S.Jaswal et al [8] have shown that the negative predictive value of serial serum CRP is 100% in deciding duration of antibiotics therapy in neonatal septicemia up to7 days. Newborn with suspected septicemia having raised CRP levels and positive blood culture need longer duration of antibiotics therapy (more than 7 days).

AG Philip, JR Hewitt et al [9] have shown that for the early diagnosis of neonatal sepsis the 5 most important tests were: band/total neutrophils (greater than or equal to 0.2); leukocyte count (less than 5,000/cu mm); latex-C-reactive protein (positive greater than 0.8 mg/100 ml); ESR (greater than or equal to 15 mm for the

first hour); and latex haptoglobin (positive greater than 25 mg/100 ml). When applied early 93% of cases subsequently proven to have infection had two or more abnormal tests. When less than two tests were positive, the probability that sepsis was not present was 99%.

Bomela et al [13] have found in their study that serial CRP estimation correctly identified 99 of 100 infants in the study as not requiring further antibiotic therapy (negative predictive value, 99%; 95% confidence intervals, 95.6 to 99.97%) and they conclude that the use of serial CRP measurements to guide antibiotic therapy is a safe and practical approach in neonates with suspected sepsis in a developing country.

A Narang et al [22] have done a prospective study on one hundred babies to evaluate a sepsis screening consisting of micro ESR, gastric aspirate for polymorphs, absolute neutrophil count (ANC), band-neutrophil count ratio and CRP to show the relative efficacy of these tests. CRP was found to be the most sensitive (80 percent) and specific (91 percent) test. The combination of any two or more positive tests was found sensitive in 86 percent of cases and specific in 89.6 percent. Even if CRP was excluded from the sepsis screen the sensitivity of two or more positive tests in diagnosing infection was 83 percent and can be recommended as a satisfactory screening procedure where CRP is not available.

Nuntnarumit P et al [25] have reported a sensitivity of 100% ,specificity of 94% ,PPV and NPV of 91.6% and 100% respectively ,of CRP for detecting proven sepsis and localized infection at cut off point >or =5mg/l.

Manucha et al [26].A CRP level measured at the beginning of septic work-up has a sensitivity of 76% and negative predictive value (NPV) of 96%.

Garland SM et al [27] have shown that a CRP level measured at the beginning of septic work-up has a sensitivity of 67% and negative predictive value (NPV) of 87%.

The gold standard for the diagnosis of neonatal sepsis is positive blood culture. The rate of positive blood culture in various studies range from 10-40%. It is higher in early onset sepsis where maternal risk factor play a major role than in late onset sepsis which is community acquired. So it is also important to understand the role of other investigations in community acquired sepsis.

RATIONALE

4. RATIONALE

- Neonatal mortality remains high in our country in spite of the decline in the infant mortality rate.

- In ICH, in the year 2003, of the 4720 admissions in the new born ward, 781 (16.5%) were neonatal sepsis with a mortality of 325 (41.6%) compared to the total mortality in the unit which is 1421 (30.1%) deaths.

- One third of the neonatal mortality is reported to be due to sepsis and related illness
- Hence this study was planned to understand the clinical parameters, role of investigations and the outcome in community acquired neonatal sepsis.

OBJECTIVES

5. OBJECTIVES

- To describe the clinical presentation of community acquired sepsis in neonates admitted in the extramural ward of our hospital.
- To analyze the causative organisms and their sensitivity pattern.
- To identify the neonatal and the maternal risk factors in the causation and outcome of neonatal sepsis.
- To identify modifiable risk factors in order to develop appropriate strategies to address them.
- To identify laboratory investigations for early diagnosis of sepsis.

METHODOLOGY

6. METHODOLOGY

This descriptive study was done during the period of Feb 2005-Feb 2006 in the extramural ward, department of neonatology, Institute of Child Health and hospital for children. This hospital is a tertiary care centre which services predominantly low income community. The study population constituted all neonates admitted with history and clinical features suggestive of neonatal sepsis. With the expected culture positivity of 20% and 95% confidence interval for the point estimate, the sample size of 112 neonates with suspected sepsis need to be studied.

INCLUSION CRITERIA: All neonates with symptoms and clinical signs suggestive of sepsis with or without maternal and/or neonatal risk factors.

EXCLUSION CRITERIA:

1) Birth Asphyxia
2) MAS
3) Physiological jaundice
4) Nosocomial infections (infants who were admitted for causes other than sepsis but develop features of sepsis there after)

MANEUVER:

This study was approved by the Ethical Committee of our institute. Neonates with suspected sepsis whose parents gave consent were enrolled for the study. After selection, a complete history with importance given to maternal risk factors (pre-maturity, intrapartum fever, PROM >18 hours, per vaginal examination >3 during delivery, etc.) and neonatal risk factors (feeding pattern, administration of native medicines, etc.) was taken for all newborns who were admitted with features of sepsis from the parent or care taker and a thorough physical examination was done. The findings were recorded in a predesigned proforma. All suspected septic newborns were investigated at the time of admission with chest x-ray, blood culture, C-reactive protein, lumbar puncture (if necessary) and peripheral smear studies for total WBC count, IT Ratio and toxic granules. The patients were treated with empirical antibiotics and modified based on these investigations. With all these data the risk factors, clinical presentation, etiology of sepsis, outcome of sepsis with the management will be analyzed. Based on clinical features and results of investigations, diagnosis of cases is categorized in to 3 groups as

1) Clinical sepsis

2) Probable sepsis

3) Proven sepsis

Case definitions

Clinical sepsis: Neonates in whom only clinical features are consistent with sepsis, without laboratory abnormalities or growth of organism in body fluid cultures.

Probable sepsis: Neonates in whom clinical and laboratory findings are consistent with sepsis but culture negative. They can be either CRP positive neonates or neonates who were positive for two hematological parameters.

Proven sepsis: Neonates with positive blood culture or positive cerebrospinal fluid culture or positive culture of other body fluids.

All the statistical analysis in this study was performed by using SPSS software version 10.0 package. Statistical tools such as chi-square test, independent t-test and one way analysis of variance (ANOVA) were used in the analysis. P-value of <0.05 is considered statistically significant.

RESULTS

7. RESULTS

In this study 120 neonates with suspected sepsis admitted in the new born ward were enrolled. Sepsis workup was done for all the neonates, including blood culture, CSF culture(wherever required), tests for indirect evidence of infection like C-reactive protein (CRP), and hematological indicators such as peripheral smear studies for abnormal WBC counts, immature to mature leukocytes ratio (IT ratio) and the presence of toxic granules in neutrophils. Based on the sepsis screen results, the diagnosis was categorized into 3 groups.

Classification of neonatal sepsis:

Table 2: Categories of Neonatal Sepsis
N = 120

	n	%
Clinical Sepsis	52	43.3
Probable Sepsis	43	35.8
Proven Sepsis	25	20.8

Table 2 shows that among the 120 neonates admitted, 52 neonates were clinical sepsis, 43 were probable sepsis and 25 were proven sepsis. In this study, the male female ratio was 1.4: 1.

Figure 2: Classification of neonatal sepsis

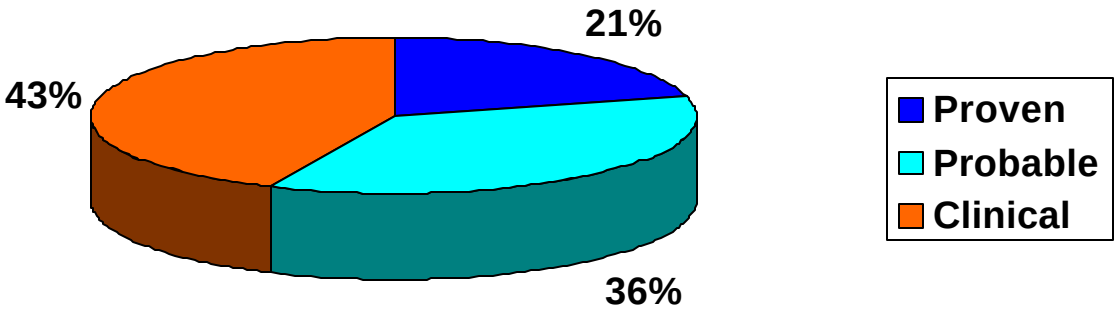


Figure 2 shows that out of the 120 neonates with suspected sepsis 25(20.8%) are proven sepsis, 43(35.8) are probable sepsis and 52(43.3%) are clinical sepsis.

Based on the age at the time of clinical presentation neonates were classified as **Early Onset Sepsis** (EOS) when the age is less than or equal to 7days and as L**ate Onset Sepsis** (LOS) when the age is equal to or greater than 8days. Table 3 shows that of the 120 neonates, 37.5% were early onset sepsis and 62.5% were late onset sepsis.

Table 3: Early onset vs. Late onset Sepsis
N=120

Age at clinical presentation	Proven Sepsis n (%)	Probable Sepsis n (%)	Clinical Sepsis n (%)	Total n
Early Onset Sepsis	8 (17.8)	16 (35.5)	21 (46.7)	45
Late Onset Sepsis	17 (22.6)	27 (36.0)	31 (41.4)	75

Clinical features

The most common clinical presentations in this study were tachypnea, lethargy, refusal to suck and fever. The frequency and percentage of occurrence of clinical signs are shown in the following table (Table 4). The distribution of these clinical signs among the 3 sepsis groups, namely clinical, probable and proven sepsis is shown in (Table 5). It is evident from this table that the percentages of nonspecific clinical signs like tachypnea, lethargy, refusal to suck, poor weight gain and fever are almost equally distributed among the three groups of sepsis so that the

presence of these signs were of no significance. Chest x-ray showed bronchopneumonia in 8 neonates and pneumonitic changes in 14 neonates.

Table 4: Frequency of Clinical signs

Clinical Signs	n	%
Tachypnea (RR>60)	118	98.3
Lethargy	79	65.8
Refusal to suck	79	65.8
Fever	70	58.3
Chest Retractions	43	35.8
Poor weight gain	34	28.3
Incessant cry	28	23.3
Weak cry	23	19.2
Abdominal distension	23	19.2
Grunt	19	15.8
Seizure	13	10.8
Shock	12	10
Bulging fontanelle	5	4.2
Hypothermia	5	4.2
Apnea	3	2.5

Signs like chest retractions, grunt and abdominal distension were associated with infections like pneumonia and necrotizing enterocolitis in most clinical situations. These signs are found in higher percentage in probable and proven sepsis group than in clinical sepsis group. It is also

observed that the occurrence of signs like seizures, shock and bulging fontanelle were not found in the clinical sepsis group.

Table 5: Clinical Symptoms and Signs
N=120

Symptoms and signs	Proven (n-25)	Probable (n-43)	Clinical (n-52)	Total
	n (%)	n (%)	n (%)	
Tachypnea	25(21.2)	42(35.6)	51(43.2)	118
Lethargy	20 (25.3)	32 (40.5)	27 (34.2)	79
Refusal to suck	22 (27.8)	30 (38.0)	27 (34.2)	79
Fever	19 (24.1)	32 (40.5)	28 (35.4)	79
Chest retractions	**15 (34.9)**	**21 (48.8)**	**7 (16.3)**	**43**
Poor weight gain	7 (20.6)	12 (35.3)	15 (44.1)	34
Incessant cry	**3 (10.7)**	**5 (17.9)**	**20 (71.4)**	**28**
Weak cry	8 (34.8)	6 (26.1)	9 (39.1)	23
Abdominal distension	6 (26.1)	11 (47.8)	6 (26.1)	23
Grunt	**5 (26.3)**	**12 (63.2)**	**2 (10.5)**	**19**
Seizure	5 (38.5)	7 (53.8)	1 (7.7)	13
Shock	5 (41.7)	7 (58.3)	0	12
Bulging fontanelle	4 (80.0)	1 (20.0)	0	5
Hypothermia	2 (40.0)	2 (40.0)	1 (20.0)	5
Apnea	2 (66.7)	0	1 (33.3)	3

Outcome in neonatal sepsis

At the time of admission, sepsis screen was done for all the neonates enrolled and empirical antibiotic therapy with Ampicillin and gentamycin were administered intravenously. The neonates were periodically reviewed clinically and with laboratory results. Based on the organism grown in culture the antibiotic regimen was changed according to the sensitivity pattern. Figure 3 shows that, 21(17.5%) neonates expired and 99(82.5%) neonates recovered. Among the expired group 71.4% were in the proven sepsis group. In the probable sepsis group 6(14%) out of the 43 neonates expired and none expired in the clinical sepsis group (table 6).

Figure 3: Outcome

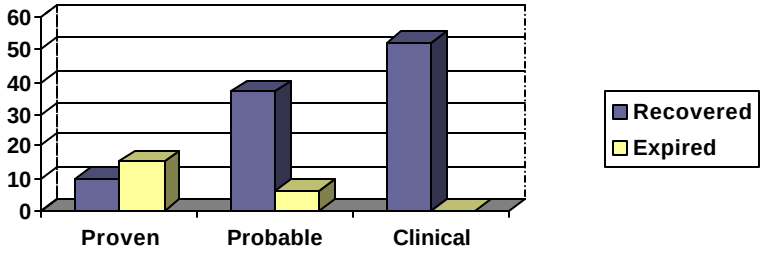


Table 6: Mortality in 3 types of sepsis
N=120

Outcome	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n
Expired	15(71.4)	6(28.6)	0

The results were further analyzed in the following order:

1. Causative organisms and their sensitivity pattern
2. Indicators of probable sepsis
3. Neonatal risk factors
4. Maternal risk factors
5. Laboratory investigations in early identification

Causative organisms and their sensitivity pattern

In this study, of the 120 neonates, blood culture was positive in 25 neonates. CSF culture was done in 18 neonates who had features of meningitis. Among them 7 neonates had positive CSF culture but these neonates were also blood culture positive and hence this did not add to the diagnosis. Majority of infections were caused by gram negative organisms. About 76% of infections were caused by gram negative organisms (Table 7) and E coli was the commonest organism (52%) of all (Table 8).

Table 7: Organisms causing sepsis
N =25

Proven sepsis	n	%
Gram positives	6	24
Gram negatives	19	76

Table 8: Organisms and frequency
N =25

Specific organism	n	%
E Coli	13	52
Klebsiella	6	24
Staphylococcus aureus	6	24

Among the early onset sepsis, 87.5% were gram negative organisms and 12.5% were gram positive organisms. Table 9 shows that E coli was the most common organism (62.5%) followed by klebsiella (25%). Staph aureus was the only organism found in gram positive group (12.5%).

Table 9: Organisms in early and late onset sepsis (N=25)

	E coli n (%)	Klebsiella n (%)	Staph aureus n (%)	Total n (%)
Early onset sepsis	5 (62.5)	2 (25)	1 (12.5)	8
Late onset sepsis	8 (47.1)	4 (23.5)	5 (29.4)	17

Among the late onset sepsis group also, gram negative organisms (70.6%) predominate. E.coli was the most common organism (47.1%) followed by Staph aureus (29.4%).

In this study the sensitivity pattern of various organisms to antibiotics are described as follows.

E coli was sensitive to amikacin in 76.9% neonates, and resistant to ampicillin and cefotaxime in 53.8% and 23.1% neonates respectively.

Klebsiella was sensitive to amikacin in 88.89% and ciprofloxacin in 83.3%. It was resistant to ampicillin in 33.3% and cefotaxime in 23.1%.

Table 10: Organisms and their sensitivity pattern

Organism	S	Ampicillin n (%)	Gentamycin n (%)	Amikacin n (%)	Ciprofloxacin n (%)	Cloxacillin n (%)	Erythromycin n (%)	Cotrimoxazole n (%)	Cefotaxime n (%)	Ceftriaxone n (%)	Ceftazidime n (%)
E.coli n=13	H	3 (23.1)	5 (38.5)	10 (76.9)	7 (53.8)	-	-	-	5 (38.5)	6 (46.2)	4 (30.8)
	M	3 (23.1)	4 (30.8)	3 (23.1)	4 (30.8)	6 (46.2)	-	3 (23.1)	5 (38.5)	6 (46.2)	7 (53.8)
	R	7 (53.8)	4 (30.8)	-	2 (15.4)	7 (53.8)	-	10 (76.9)	3 (23.1)	1 (7.7)	2 (15.4)
Klebsiella n=6	H	1 (16.7)	1 (16.7)	4 (66.7)	5 (83.3)	-	1 (16.7)	-	2 (33.3)	3 (50)	5 (83.3)
	M	3 (50)	2 (33.3)	2 (33.3)	1 (16.7)	1 (16.7)	1 (16.7)	-	2 (33.3)	1 (16.7)	1 (16.7)
	R	2 (33.3)	3 (50)	-	-	5 (83.3)	4 (66.7)	6 (100)	2 (33.3)	2 (33.3)	-
Staph. aureus n=6	H	1 (16.7)	2 (33.3)	4 (66.7)	-	4 (66.7)	3 (50)	1 (16.7)	2 (33.3)	3 (50)	1 (16.7)
	M	2 (33.3)	-	1 (16.7)	2 (33.3)	2 (33.3)	2 (33.3)	2 (33.3)	1 (16.7)	1 (16.7)	1 (16.7)
	R	3 (50)	4 (66.7)	1 (16.7)	4 (66.7)	-	1 (16.7)	3 (50)	3 (50)	2 (33.3)	4 (66.7)

S - Sensitivity; H - Highly Sensitive; M - Moderately Sensitive; R – Resistant

Staph. aureus was sensitive to amikacin and cloxacillin in 66.7% neonates and to ceftriaxone in 58.33% neonates. It was resistant to ampicillin in 50% and ciprofloxacin in 66.7% neonates.

Indicators of probable sepsis

In this study neonates who were CRP positive or positive for 2 hematological parameters were classified as probable sepsis.

C-reactive protein (CRP):

The table below shows among the 43 probable sepsis neonates 37 were CRP positive of whom 5 neonates expired and 6 were CRP negative but classified as probable sepsis based on the hematological parameters of whom 1 neonate expired (Table 11) .

Table 11: C-reactive protein
N = 68

CRP	Proven sepsis n	Probable sepsis n
(>0.6 mg/dL)	22	37
(<0.6 mg/dL)	3	6

Chi-square = 0.02
p-value = 0.887

In this study C-reactive protein was qualitatively estimated and they were positive (>0.6mg/dL) in 59 neonates, 22 in proven sepsis, 37 in probable sepsis (Table 11).

Hematological parameters:

Table 12: WBC counts(N =120)

WBC Count	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
<5000	1 (6.3)	1 (6.3)	14 (87.5)	16
5000-15000	12 (18.8)	19 (29.7)	33 (51.6)	64
>15000	12 (30.0)	23 (57.5)	5 (12.5)	40

Chi-square = 30.181
p-value = 0.000

WBC Counts <5000 was found in 6.3% in both proven and probable sepsis. Counts >15000 was found in 30% and 53.5% in proven and probable sepsis respectively (Table 12). This was found to be statistically significant ($p<0.05$).

Table 13: IT Ratio (N =120)

IT Ratio	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
>0.2	16 (41.0)	22 (56.4)	1 (2.6)	39
< 0.2	9 (11.1)	21 (25.9)	51 (63.0)	81

Chi-square = 40.297 p-value = 0.000

Among the 120 neonates IT Ratio > 0.2 was found in 39 neonates, 41.0% in proven sepsis, 56.4% in probable sepsis and 1% in clinical sepsis. IT Ratio <0.2 was found in 11.1% in proven sepsis group, 25.9% in probable sepsis group and 63% in clinical sepsis group (Table 13). This was found to be statistically significant ($p < 0.05$).

Table 14: Toxic granules
N =120

Toxic granules	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
Presence	15 (32.6)	24 (52.2)	7 (15.2)	46
Absence	10 (13.5)	19 (25.7)	45 (60.8)	74

Chi-square = 24.131
p-value = 0.000

Among the 120 neonates, toxic granules were positive in 46 neonates, 32.6% in proven sepsis, 52.2% in probable sepsis and 15.2% in clinical sepsis. Toxic granules were negative in 13.5% in proven sepsis group, 25.7% in probable sepsis group and 60.8% in clinical sepsis group (Table 14). This was found to be statistically significant ($p < 0.05$).

Other Neonatal Risk Factors

Of the 120 neonates who had undergone sepsis work-up during study period, the mean (±SD) age was 12.05 days (± 8.34) and range 1 to 30 days. The mean (±SD) of gestational age was 37.52 week (±1.0) with the range of 34-39 weeks. These parameters were 2534.83 (±189.87) gram (range: 1950-3580) respectively for their birth weight .The mean (±SD) duration of stay was 6.41(±2.91).

Table 15: Neonatal risk factors

	Proven Sepsis (± 1 SD)	Probable Sepsis (± 1 SD)	Clinical Sepsis (± 1 SD)
Age (days)	12.92 ± 8.6	11.95 ± 8.35	11.75 ± 8.34
Gestational Age (weeks)	37.72 ± 0.84	37.56 ± 0.83	37.38 ± 1.17
Weight on Admission	2506.4± 112.47	2583.72± 236.16	2508.08± 170.58
Duration of stay (days)	7.96 ± 3.71	7.12 ± 2.80	5.08 ± 1.83

The characteristics of the sepsis groups are compared with the risk factors in table 15. With respect to age, gestational age and birth weight there were no differences. The mean of duration of hospitalization in proven sepsis group was significantly ($p<0.000$) longer than other two groups (7.96 days in proven sepsis, 7.12 in probable sepsis and 5.08 days in clinical

sepsis). The sex distribution was similar with respect to gestational age, weight on admission and duration of stay, but the mean age of admission was significantly ($p=0.02$) longer among female neonates.

Table 16 shows that the occurrence of sepsis in exclusively breast fed neonates and in neonates who were not breast fed was 37 (30.8%) and 83 (69.2%) respectively. The percentage of neonates in proven and probable sepsis group was significantly low among exclusively breast fed infants. This is found to be statistically significant ($p<0.05$). It also shows that 56 neonates were given home remedies. The percentage of occurrence of sepsis is significant in proven and probable sepsis group. This is found to be statistically significant ($p<0.05$). Vasambu ingestion, nose blowing and oil bath were among the commonly found bad child rearing practices.

Table 16: Feeding pattern

	Proven Sepsis n (%)	Probable sepsis n (%)	Clinical Sepsis n (%)	Total n
Exclusive breast fed	6 (16.2)	10 (27.0)	21 (56.8)	37
Other types of feeds	19 (22.9)	33 (39.7)	31 (37.4)	83
Home remedies	16 (28.6)	27 (48.2)	13 (23.2)	56

It was also found that the occurrence of sepsis was high in those neonates who were given prelacteal feeds but it is not statistically significant ($p>0.05$).

Maternal Risk Factors

In this study maternal risk factors were analyzed for early onset sepsis only. Among the 45 deliveries in the EOS group, 39 were vaginal deliveries, 1 assisted and 5 were caesarian deliveries. The percentage of occurrence of sepsis was low (31.1%) in mothers who had a complete course of iron and folic acid tablets in the ante-natal period than in those who had not taken the complete course of iron and folic acid tablets. But it is not statistically significant ($p>0.05$). Among the neonates whose mothers had complete tetanus toxoid immunization in the ante-natal period, the percentage of sepsis was higher in the clinical sepsis group whereas in the proven and probable sepsis groups, the percentage of occurrence of sepsis was low. This is not statistically significant ($p>0.05$). Among the 13 home deliveries, 8 deliveries were conducted by untrained dais and 5 deliveries by trained dais (Table 17). Although the percentage of proven and probable sepsis was higher in deliveries conducted by untrained dais, it is not statistically significant ($p>0.05$).

Table 17: Home deliveries (N=13)

Home deliveries	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
By untrained Dai	2 (25.0)	5 (62.5)	1 (12.5)	8
By trained Dai	0	2 (40.0)	3 (60.0)	5

p-value = 0.149

Intrapartum fever was present in 2 neonates of suspected sepsis of which one was in the probable sepsis group and other in the clinical sepsis group.

Table 18: PROM (N=45)

PROM	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
>18hrs	3 (33.3)	3 (33.3)	3 (33.3)	9
<18hrs	5 (13.9)	13 (36.1)	18 (50.0)	36

Chi-square = 0.499
p-value = 0.778

The above table (Table 18) shows that in 9 neonates, the risk of premature rupture of membranes for >18 hours was present, in which a higher percentage was found in the proven sepsis group, but it is not statistically significant ($p>0.05$).

A significant percentage of sepsis occurred in all the three groups of sepsis when more than three vaginal examinations were done during delivery (Table 19). It was statistically significant ($p<0.05$).

Table 19: Vaginal examinations during labour (N=36)

>3 vaginal examination	Proven sepsis n (%)	Probable sepsis n (%)	Clinical sepsis n (%)	Total n
Yes	5 (17.2)	13 (44.8)	11 (37.9)	29
No	0	0	7 (100)	7

Chi-square = 8.69
p-value = 0.013

In this study, urinary tract infection in the last trimester was found in one neonate in the proven sepsis group.

The most common maternal illness complicating pregnancy was anemia (19 neonates) followed by pregnancy induced hypertension (2 neonates). There is no significant difference in the occurrence of sepsis in neonates born for mothers who had antenatal illnesses.

MODIFIABLE RISK FACTORS

Based on the above analysis, it is found that all the maternal risk factors like, home deliveries, PROM and unnecessary vaginal examinations and neonatal risk factors like feeds other than breast feeds, home remedies, are modifiable.

Table 20: Validity of individual laboratory tests against blood culture as gold standard test

Lab tests	Sensitivity	Specificity	PPV	NPV
CRP	88	61	37	95
WBC >15000	48	70.5	30	83.8
IT Ratio >0.2	64	75.8	41	88.9
Toxic Granules	60	67.4	32.6	86.5

The sensitivity, specificity, positive predictive value and negative predictive value were studied for CRP and hematological parameters like WBC count, IT Ratio and toxic granules against the gold standard (Table 20). The sensitivity and negative predictive value of C-reactive protein were more when compared to the other tests. The specificity and positive predictive value of IT Ratio >0.2 were more when compared to the other tests.

Table 21: Validity of laboratory tests in combination against blood culture as gold standard test

Lab tests	Sensitivity	Specificity	PPV	NPV
WBC count >15000 + IT ratio >0.2	36	87	43	84
IT Ratio >0.2 + Toxic granules	52	89	57	88
WBC count >15000 + Toxic granules	36	84	38	83
WBC count >15000 + IT ratio >0.2 + Toxic Granules	32	93	53	84

The above table shows the sensitivity, specificity, positive predictive value and negative predictive value when hematological parameters are combined. The sensitivity of CRP was higher than the sensitivity of any of these combinations. But the specificities of varying combinations were higher than the specificity of CRP. So in the absence of CRP, combinations of hematological parameters can be used to exclude sepsis.

DISCUSSION

8.DISCUSSION

In this study, out of 120 neonates enrolled, blood culture was positive in 25(20.8%) neonates, C-reactive protein positive in 59(49.2%) neonates, abnormal WBC counts in 56(46.6%) neonates, IT ratio > 0.2 in 39(32.5%) neonates and neutrophil toxic granules in 46(38.3%) neonates.

In this study, the rate of culture positive sepsis is 20.8%. This rate ranged from 20% to 48.38% in other studies. A low blood culture isolation rate in this study might be due to several reasons, e.g. different study population, administration of antibiotics before blood collection either to

Table 22: Culture positivity in various studies

Study	Culture positive %
DKL Chan et al.	20
Present study	20.8
Mathur M et al	24.8
Roy I et al.	28.3
ASM Nawshad uddin et al	34.9
R.S Jaswal et al	42
Chacko Betty et al	43

mother or to the baby or the possibility of infection with anaerobes, which cannot be ruled out. In this study 11 neonates were administered antibiotics before referral and 59 neonates were referred from institutions with referral slips. Moreover, negative blood cultures do not exclude sepsis
and neonates with negative blood culture have been reported with fatal illness and post-mortem evidence of infection.

In this study, the case fatality rate is 17.5% which is 14.4% with Kurien Anil Kuruvilla et al, 40% with A.S.M Nawshad uddin ahmed et al, 11.32% with Jain N.K et al and Das PK et al has shown a overall case fatality was 17.1% in his study

In this study, the common clinical presentations are lethargy (65.8%), refusal to suck (65.8%), tachypnea (98.3%) and fever (58.3%) which were comparable with studies done by A.S.M Nawshad uddin ahmed et al, Jain N.K et al and Chacko Betty et al.

Among the maternal risk factors in the early onset sepsis group, 13(28.9%) out of 45 neonates were home deliveries. The percentage of proven and probable sepsis was high among home deliveries conducted by untrained dais. A.S.M Nawshad uddin ahmed et al have shown that more than half of the culture positive neonates were delivered at home (60%).

This may be due to the fact that traditional birth attendants are not trained to conduct deliveries in a sterile manner.

In this study, the incidence of sepsis was shown to be higher among illiterate mothers, those with premature rupture of membranes (PROM) >18 hours and vaginal examination >3 times during delivery (statistically significant). Kurien Anil Kuruvilla et al have found that multiple vaginal examinations were significantly associated with early onset sepsis. Anne Schuchat et al have also shown that among the maternal risk factors,
PROM >18 hours and multiple vaginal examinations during delivery are significant risk factors. Premature rupture of membranes and multiple vaginal examinations during delivery are important for the organisms in the genital tract to gain access into the amniotic fluid to cause ascending infections.

In this study, the mean duration of hospitalization in proven sepsis group was significantly longer. The mean age of admission was significantly longer among female neonates which show the sex discrimination in the health seeking behavior of the family.

The occurrence of sepsis was high (69.2%) in the neonates who were not exclusively breast fed in this study. RN Ashraf et al have shown that even partial breast feeding protects against neonatal sepsis. The percentage

of proven and probable sepsis was significantly higher in neonates who were given native medicines and bad child rearing practices like vasambu ingestion, nose blowing, oil bath, etc.

CRP was measured qualitatively at the onset of signs of infection in this study. This study has demonstrated that CRP had a high negative predictive value (NPV- 95%) but low positive predictive value (PPV -37%) with the sensitivity and specificity of 88% and 61% respectively. Hajiehe Borna et al have demonstrated that CRP had a high NPV (97%) but low PPV (36%) with the sensitivity and specificity of 79% and 85% respectively. A CRP level measured at the beginning of septic work-up has a sensitivity of 67% and NPV of 87% in Garland SM,et al study. These figures were 76% and 96% in another study, respectively by Manucha V. Beger C, et al have measured CRP qualitatively, with cut off point of >20 mg /l, reported 75% of sensitivity and 86% of specificity rate. Most studies measured CRP quantitatively with different cut off point and different times from onset the signs of infection. Nuntnarumit P ,et al have reported a sensitivity of 100% specificity of 94% positive predictive value and negative predictive value of 91.6% and 100% respectively for CRP in detecting proven sepsis and localized infection at cut off point >or =5mg/l.

The variations in the population studies with respect to age and gestational age, the definition of sepsis and different evaluation methods as well as different cut–off point setting and various methods of measuring CRP with respect to the number and timing of sample collection, lead to getting different results. There is not an established standard practice for the use of CRP in infants, and a variety of approaches are described in the literature. However, it can be emphasized that a single CRP level measured at the first contact with health care professional lacks sufficient sensitivity to be useful in identifying neonate with septicemia. In addition CRP can not be recommended as a sole indicator of neonatal sepsis, but it may be used as part of a sepsis workup and in combination with other laboratory tests.

In this study the sensitivity, specificity, positive predictive value and negative predictive value were 48%, 70.5%, 30%, 83.8% for leukocyte (WBC) count >15000 /mm³ respectively. These figures were 53%, 83%, 25% and 94% respectively in the study by Hajiehe Borna et al. The sensitivity and specificity of leukocytosis was reported 41% and 73% by Ottolini MC, et al and 14% and 93% by Anwer SK. et al respectively. The sensitivity, specificity, positive predictive value and negative predictive value were 64%, 75.8%, 41% and 88.9% with respect to IT Ratio > 0.2. The sensitivity, specificity, positive predictive value and negative predictive

value were 60%, 74.4%, 32.6% and 86.5% respectively for toxic granules in leukocytes. Results of white cell counts and ratios varied widely across studies, with sensitivity and specificity ranging from 17% to 90% and 31% to 100% respectively. In general, studies have shown that I/T ratio >0.2, tend to have high sensitivity, whereas abnormal leukocyte counts, tend to have high specificity.

The varying microbiological pattern of neonatal septicemia warrants the need for an ongoing review of the causative organisms and their antibiotic sensitivity pattern. In this study, majority of infections were caused by gram negative organisms. About 76% of infections were caused by gram negative organisms whereas 24% by gram positive organisms. Ecoli was the commonest organism causing sepsis (52%). The pattern of organisms isolated was similar, regardless of time of onset of disease, birth weight or gestational age. A.S.M. Nawshad Uddin Ahmed et al have shown that of the total organisms isolated, nearly three-fourths (73%), were gram-negative bacilli; (27%) were gram-positive. Escherichia coli was the most common organism (30%), followed by Klebsiella pneumoniae (23%) and Staphylococcus aureus (17%) which is comparable to this study.

Roy I et al and Mathur M et al in their studies have shown that gram negative organisms constituted the major group of isolates and klebsiella

was the commonest organism in their study. The major causative organism in EOS was E. coli, similar to the findings of Kurien Anil Kuruvilla et al.

Group B Streptococcus (GBS) was not isolated in this study, unlike western, developed countries where it is the major agent of neonatal septicemia. The insignificance of GBS as a pathogen in many developing countries is supported by a number of other studies. This may be attributable to low prevalence of GBS colonization of pregnant mothers in this area, or, possibly, to the presence of strains with low virulence. The prevalence of E.coli may be due to the fact that it is commonly found as part of the intestinal and vaginal flora, and most deliveries were conducted at home, presumably under conditions of poor hygiene.

In this study, gram negative organisms e.coli and Klebsiella were found to be sensitive to amikacin followed by ciprofloxacin, third generation cephalosporins and gentamycin. For most of the gram-negative organisms, gentamycin and third-generation cephalosporins were effective. Staph. aureus were sensitive to amikacin and cloxacillin in 66.7% neonates and to ceftriaxone in 58.33% neonates. E coli were resistant to ampicillin in 53.8% neonates and to cefotaxime in 23.1% neonates and klebsiella to ampicillin in 33.3% and cefotaxime in 23.1% neonates. Staph aureus were resistant to ampicillin in 50% and ciprofloxacin in 66.7% neonates.

In general, the sensitivity of the gram-negative isolates to gentamicin supports continued use of this agent in the initial, empirical treatment of septicemic neonates in our hospital, and also supports WHO recommendations that management of young infants up to age 2 months include parenteral use of benzyl penicillin or ampicillin plus an aminoglycoside such as gentamycin. This fact is supported by A.S.M Nawshad uddin ahmed et al.

CONCLUSION

9. CONCLUSION

- Blood culture was positive in 25**(20.8%)** neonates.
- About 76% of infections were caused by gram negative organisms, **E coli** being the commonest organism causing sepsis
- For most of the gram-negative organisms, gentamycin and third-generation cephalosporins were effective.
- The common clinical presentations are lethargy (65.8%), refusal to suck (65.8%), tachypnea (98.3%) and fever (58.3%).
- When clinical signs like chest retractions, grunt and bulging fontanelle were present the likelihood of proven sepsis is high.
- The incidence of sepsis was shown to be higher among neonates with maternal such as risk factors, premature rupture of membranes (PROM) >18 hours and multiple vaginal examination during labour.
- The occurrence of sepsis was high (69.2%) in the neonates who were not exclusively breast fed and when given home remedies.
- CRP has a high negative predictive value but low positive predictive value with sensitivity and specificity of 88% and 61% respectively
- The specificity of combinations of hematological parameters were higher than that of CRP.

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ANNEXURES

Annexure – 1

PROFORMA FOR NEONATAL SEPSIS

SR.NO ☐ IP NO ☐

NAME SEX: Male/Female TERM/PRE-TERM

GESTATIONAL AGE: ____ weeks AGE ON ADMISSION: ___days__hrs

BIRTH WEIGHT: _____ gms

WEIGHT AT ADMISSION: ____ gms

DATE OF BIRTH: ☐☐☐☐☐☐☐☐

DATE OF ADMISSION: ☐☐☐☐☐☐☐☐

DATE OF DISCHARGE: ☐☐☐☐☐☐☐☐

DATE OF DEATH: ☐☐☐☐☐☐☐☐

DURATION OF STAY: ____ days

SELF REFERRAL: [Y/N]

REFFERED FROM FACLILITIES:

1. Home
2. HSC
3. PHC
4. Taluk HQ hospital
5. District HQ hospital
6. Tertiary referral unit
7. Private OP
8. Private Nursing Home
9. None

ANTE-NATAL DATA

1. Total no of hospital visits
   [0/1/2/3/4/5/more]

2. Total no of home visits by health worker
   [0/1/2/3/4/5/more]

3. IFA intake [Y/N]

4. Tetanus toxoid injections: [Y/N]

MATERNAL DELIVERY DATA

1. Mode of delivery: [1/2/3] [1-Vaginal/2-Assisted/3-caesarian]

2. Place of delivery: [1/2] [1-Home/2-Institution]

   - Home: [1/2]
     [1-Untrained/2-Trained personnel]

   - Institutional: [1/2/3/4/5/6]
     [1-HSC/2-PHC/3-Taluk HQ hospital/4-District HQ hospital/5-Tertiary referral unit/6-Private Nursing home]

   - Conducted by: [1/2/3/4]
     [1-Nurse/2-Doctor/3-Obstetrician/4-None]

3. Type of facility:

   - Equipment: [1/2/3] [1-Labour room/2-Theatre facilities/3-facilities for neonatal care]

MATERNAL RISK FACTORS

1. Birth order [1/2/3/4/5/more]
2. Multiple gestations [Y/N/NK]
3. Intrapartum fever [Y/N/NK]
4. PROM > 18hrs [Y/N/NK]
5. Vaginal examinations >3 in labour [Y/N/NK]
6. Meconium staining: [Y/N/NK]
7. Cloudy amniotic fluid: [Y/N/NK]
8. Foul smelling amniotic fluid: [Y/N/NK]
9. UTI in the last trimester: [Y/N/NK]
10. Maternal Illness: [1/2/3/4/5]

    [1-PIH/2-Anaemia/3-Diabetes/4-Heart disease/5-Others]

11. Maternal education: _____Paternal education: _____

NEONATAL RISK FACTORS

1. Birth asphyxia: [Y/N/NK]
2. Cord status: [1/2/3] [1-Bandage/2-Ointment/3-Dry]
3. Feeding
    a. Feeding pattern [1/2/3] [1-Exclusive/2-Not exclusive]
    b. Prelacteal feeds: [Y/N] If Yes specify _____
4. Clean clothes: [Y/N]
5. Bath to the baby: [Y/N]
6. Home remedies: [Y/N/NK] If Yes specify _____

CLINICAL EXAMINATION

1. Superficial infections

    - Umbilical sepsis: [Y/N]
    - Pyoderma: [Y/N]
    - Conjunctivitis: [Y/N]

2. Apneic spells: [Y/N]

SYMPTOMATOLOGY

General

Lethargy
Refusal to suck
Poor cry
Poor weight gain
Incessant cry

Respiratory System

Respiratory rate ___/min
Chest retractions
Grunt
Apnea
Central nervous system

ALOC
Seizures
Bulging Fontanels
Poor neonatal reflexes

Shock

Temperature

Fever
Hypothermia

Gastro intestinal tract

Abdominal distention
Vomiting
Diarrhea
Others

Sclerema
Bleeding

LABORATORY FINDINGS

Blood culture: [Positive/Negative]
If positive- organism and sensitivity

C-reactive protein: [Positive/Negative]

Peripheral smear studies:

WBC Count: [1/2/3] [1-<5000/2-5000-15,000/3->15,000]

IT Ratio>0.2: [Y/N]

Toxic granules: [Y/N]

X-Ray chest and abdomen

Lumbar puncture

Cells
Protein
Sugar
Culture & sensitivity

OUTCOME

1. Recovered
2. Expired

FINAL DIAGNOSIS

Annexure – 2

BLOOD CULTURE

Blood for culture should be drawn under strict aseptic condition. The media is warmed to room temperature prior to inoculation. The skin over the vein is prepared as for a surgical procedure. It is cleaned with 70% alcohol and povidone iodine is applied. One minute is allowed for the iodine to act. With sterile gloves adequate quantity of blood using a sterile dry syringe is taken and inoculated directly into blood culture media (brain heart infusion broth), using the same needle. Blood to medium ratio was 1:10.

Annexure – 3

RHELAX CRP

Principle:

RHELAX CRP slide test is a qualitative test for detection of CRP which is based on the principle of agglutination. The test specimen (serum) is mixed with RHELAX CRP latex reagent and allowed to react. If CRP concentration is greater than **0.6 mg/dL** a visible agglutination is observed. If CRP concentration is less than 0.6mg/dL, then no agglutination is observed.