1.1 Introduction

Baby birth is one of the most wonderful and memorable moment in the world for the mother and the family. The memorable moment will be cherished when the mother and the baby are in good health condition. But it’s not happening in all the cases, where most of the cases complexity arise in health condition of neonates especially in Premature Delivery. Neonatal health care thus plays a vital role during deliveries for both full term and free term babies.

When a baby enters the world, within fraction of seconds all the organs of the newborn has to function independently which was totally dependent on mother till birth. Before birth, breathing, eating, elimination of waste, and immunologic protection all came from the mother. Organs like lungs, heart, digestive system, kidney, liver and other systems should start functioning on their own and adjust with the environment without any illnesses.

Full-term healthy babies are lucky enough to cross the intensive care unit without facing health challenges and quickly accustomed with the new world. But pre-term babies and full-term sick babies find difficulties in coping with the new environment and
face many health challenges for their survival. In olden days, it’s highly impossible for the survival of pre-term babies and their mortality rates were high. Neonates Intensive Care Unit is the boom for the pre-term babies and full-term sick babies and thus the neonate’s mortality rates are considerably low.

NICU with advance technology and trained neonatal nurses ensures specialized care for the babies until they reach normal health condition and thus provide happiness to the mother and family. Now- a-days preterm babies are more common throughout the world and high risk neonate’s who undergone special new born care are discharged with parents in a good health.

**What is Neonatal Intensive Care Unit?**

In general any Neonatal Hospital, Children Hospital and the Maternity Hospitals have NICU (Neonatal Intensive Care Unit) and NICU is exclusively for neonates (new born babies) whether premature or full-term babies. It is provided with all equipment’s necessary for the baby to have safe, clean, warm and infection - prone environment as the neonate’s are very sensitive to temperature change and infections. Continuous Health Monitoring System in the NICU enables constant measurement of heart beat, temperature, blood pressure and SPO2 which are the vital parameters to be measured in case of pre-term babies and high-risk full-term babies. Uninterrupted mother’s feeding in NICU gives satisfaction for the mother and improves neonate’s health in a long run. Dedicated neonatal nurse in NICU cares sick and premature babies and notify the specialist or duty doctors in case of emergency or any abnormalities found in the measurement of health parameters.

Now in modern technology, neonatal nurse are minimized with Alarm System, GSM Based System where notification will be send to the doctor or staff nurse when the measured parameters of neonates exceeds the critical value. However, still total replacement of neonatal nurse in NICU is not yet achieved.

**Under Special Care for Neonates**

The Newborn or called as Pre-Term Babies who are born before 37 weeks of pregnancy are admitted in majority. As they born before there term gets completed, they are mostly low birth weight i.e. less than 5.5 pounds and the baby’s body is small and
their organs are not completely developed, they are subjected to breathing disorder, chronic disease, jaundice, etc. Not only premature babies are less in weight, twins, triplets and other multiples who even complete their full-term in mother’s womb are less in weight than single birth babies.

Apart from all these pre-term and low-birth weight babies, high risk full-term babies are also admitted in NICU. These high risk full-term babies have serious health problems like heart problems, infections, or birth defects are also admitted in NICU. The factors that cause full-term baby at high-risk and increase the chance of being admitted to NICU are classified as maternal factors, delivery factors and neonate factors. Maternal factors are Early Marriage, Old age marriage, over usage of drug or alcohol, diabetes, multiple pregnancies, bleeding, sexually transmitted disease, premature rupture of amniotic sac, etc. Delivery Factors are fetal distress, Breech delivery, Meconium, Nuchal cord, Cesarean delivery, etc. Neonatal Factors are pre-mature baby, low-birth baby, birth-defects, respiratory disorder, seizures, Hypoglycemia, etc.

**Care Takers of Neonates In NICU**

The Neonatologist is the chief and supervises neonatal nurse practitioners, staff nurse and neonates relatives in the NICU. It is very important in the NICU to isolate the neonate from the visitors and immediate relative of the neonate’s family who are eager and willing to see and carry the new born baby without aware of the neonates health condition. Kangaroo-Care or Skin to Skin Contact of neonates and its mother is very important for the mental bond and physical health reasons of neonates. This is achieved with the help of neonatal nurse who transfer the baby from NICU to mother’s ward for feeding and kangaroo-care at regular intervals.

The premature babies and congenital babies who need special and high level of health monitoring and care are admitted to Neonatal Intensive Care Unit in the hospital to avail intensive care. Neonates are highly prone to infections from mother, visitors and external disturbances and hence they are isolated and protected from external factors. Continuous monitoring of these neonates plays a vital role in the finding and treatment of
disease at an early stage which improves the health condition and hence the survival rate of neonates at lower risk.

Factors that are to be monitored for the survival of neonatal are temperature, heart rate, respiratory rate, blood pressure, hyper tension, degree of blood oxygen saturation. In case of premature babies, yellowing of skin or eye (jaundice), low blood sugar, lack of red blood cells (anemia) is the mild illness that can affect the neonates. Serious illness like apnea (episodes of stopped breathing), infection, bleeding in the brain, impaired hearing and vision are also possible for the neonates. Continuous health monitoring of neonates is crucial to increase their survival rate.

The Neonatal Intensive Care Unit should be technically equipped with Monitoring System in such a way that a nurse can directly visualize and monitor more than 10 to 20 babies at a time. The Vital parameters like temperature, heart rate, blood pressure, etc. of neonates examined by the duty nurse should be recorded for further analysis. If any abnormalities in the parameters, it should be notified to the duty nurse who will inform the concerned Pediatrician for further medication for the neonate. In India, there is no Neonatal Nurse Practitioner who is a registered nursed with clinical expertise in neonatal nursing as in Western Countries. The general nursing staff closely observing any abnormalities of the neonates in NICU, informs the doctor on duty early and immediately to reduce further complications.

New-born care is of immense importance for the proper development and healthy life of a baby. Although childhood and infant mortality in South Asia has reduced substantially during the last decade, the rate of neonatal mortality is still high. According to one source, 60% of all neonatal deaths and 68% of the world’s burden of perinatal deaths occur in Asia (Paul and Beorari, 2002). Further, although 70% of infant deaths occur during the first month of life, the policy-makers and health professionals in developing countries, until recently, neglected newborn care (Costello and Manandhar, 2000).
The foremost and basic care to the provided for the neonates for the first 24 hours is very crucial for their survival. Artificial Respiration for respiratory problem neonates, Warmth to avoid hypothermia, breastfeeding which is a natural immunisation from the mother, infection prone environment and treatment for low-birth weight or sick babies.

Infant’s mortality occurs mostly during the first month of their life, within the first month the first week is important and within the first week the first 24 hours of birth is vital. So this is the crucial period for the neonates whose survival depends on the care and treatment provided to them by the hospital.

The infant mortality rate have been reduced considerably for the last few decade in Asia Countries. But the neonatal mortality and perinatal mortality is high in South Asian Countries where doctors and hospital are more but still not concentrating on neonatal care. Table-1 shows new born health status for countries in South Asia. It can be observed from the table that both neonatal and perinatal mortality rates are highest in Pakistan (51 and 68-81 respectively), followed by Bangladesh (50 and 57 respectively). The issues of perinatal and new born infant health, therefore, require focused attention in South Asia.

The developing countries should improve their health care centres concentrating on neonatal intensive care unit will only lead to the decrease neonatal mortality. Many organisations like UNICEF, WHO insists upon improved health care centre’s with Neonatal Intensive Care Unit which are still neglected by the developing countries which leads to higher mortality rate of neonates. The survived pre-term neonates and high-risk full-term neonates are having more health problems in their life due to neglected and poor treatment during their birth in the hospitals.
### Table 1: Newborn health status for countries in South Asia

<table>
<thead>
<tr>
<th>Countries</th>
<th>Neonatal mortality rate</th>
<th>Infant mortality rate</th>
<th>Child mortality rate</th>
<th>Under-five mortality rate</th>
<th>Perinatal mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>50</td>
<td>80</td>
<td>33</td>
<td>110</td>
<td>57</td>
</tr>
<tr>
<td>Bhutan</td>
<td>47</td>
<td>74</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>39</td>
<td>61-64</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maldives</td>
<td>51</td>
<td>91</td>
<td>30</td>
<td>117</td>
<td>68-81</td>
</tr>
<tr>
<td>Nepal</td>
<td>13</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


This lead to unhealthy younger generations in the future with respiratory problem, chronic diseases which leads to life-long burden for the parents and society. To avoid these cyclic problem neonates should be given proper care after birth.

Apart from the Non-Governmental Organisation (NGO), the governments should also allocate funds and insists hospital to give more attention towards Neonatal care which in turn gives them healthy and high economic yielding generation in future. Parents should be aware of the medical facilities provided in the hospital before delivery and give their best to have a healthy baby. There is a misconception that Neonatal Intensive Care Units are expensive because of their expensive equipment’s. It is not fact, neonatal deaths can be avoided with cost-effective solution that do not depend on expensive equipment’s in NICU and highly trained neonatologist. These are needed only when the neonates facing emergency and they undergo surgeries for major problems like heart surgery. Remaining cases, proper nutrition, hygiene, keeping baby warm, umbilical cord clean, breast feeding and infection-prone environment itself can avoid many complications. Taking care of mother’s health before and after delivery itself will solve many health problems of neonates. Family planning and family history also plays a vital
role in neonatal care. By following all mentioned low-cost principles of new born care will reduce the new born death considerably.

The Principles for new-born care to be followed

1. Air – Resuscitate and maintain airway
2. Warmth – Keep the new-born baby warm and avoid unnecessary hypothermia or cold stress
3. Food – Encourage early breast feeding and high-risk babies should be feed frequently
4. Hygiene – Ensure neonate hygiene during delivery, while cutting umbilical cords
5. Love – Mother should have access to her baby especially when neonates are in high-risk

There are several approaches to reducing new born deaths that have proven to be both feasible and cost-effective including tetanus toxoid immunization, skilled health care delivery, immediate and exclusive breastfeeding. Therefore, improving new born health is not a matter of developing new solutions to the old problems; but rather a matter of applying, replicating and scaling up the proven solutions via existing mechanisms. In other words, the real challenge is to spread up the awareness of sound new born health practices or “what works” to those who need it, especially mothers, other primary caregivers, and health providers, and to integrate essential new born health care into existing maternal and infant care programs.

1.1.1 Causes of New-born Death

The reasons for New-born deaths are not only medical causes, social factors and lack of knowledge, lack of skilled health care for neonates, unawareness about breast feeding in initial stages and low-birth weight are also few factors for neonates mortality.

Still in many Asian countries delivery is carried out at home by uneducated old ladies where accessibility of hospital or health care systems is far from their locality. These type of delivery cause birth asphyxia/birth injuries, infections, complications of pre-term birth and birth defects. The healthy neonates survive in these deliveries, but sick neonates
cannot survive as they do not have facilities to give initial care and monitoring of neonates health condition.

The major causes of fetal-neonatal death presented in Table-2.

**Table 2: Major Causes of fetal-neonatal death**

<table>
<thead>
<tr>
<th>Late fetal deaths (28 weeks up to delivery)</th>
<th>Early neonatal (0-7 days)</th>
<th>Late neonatal death (8-28 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Intrapartum birth</em></td>
<td><em>Birth asphyxia/birth asphyxia</em></td>
<td>Infection</td>
</tr>
<tr>
<td><em>Preterm birth</em></td>
<td><em>Infection</em></td>
<td>- Sepsis</td>
</tr>
<tr>
<td><em>Birth defects</em></td>
<td>- Sepsis – Tetanus</td>
<td>- Meningitis</td>
</tr>
<tr>
<td></td>
<td>- Meningitis</td>
<td>- Acute lower respiratory infection</td>
</tr>
<tr>
<td></td>
<td>- Tetanus</td>
<td>- Diarrhea respiratory infection</td>
</tr>
<tr>
<td></td>
<td>- Acute lower infection</td>
<td>- Diarrhea</td>
</tr>
<tr>
<td>Macerated still birth</td>
<td><em>Complications of preterm birth</em></td>
<td><em>Early feeding (more common for preterm and LBW babies)</em></td>
</tr>
<tr>
<td><em>Infection, especially syphilis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hypertension/preec - Respiratory distress preterm and LBW lampsia - Jaundice babies</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Placental abruption - Increased risk of 1 Infanticide/neglect</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Maternal sexually transmitted infections (STI) are a major, preventable cause of stillbirth. WHO (1991) and Van dam (1995) reported that STI could cause spontaneous
abortion, low birth weight baby, congenital abnormalities, neonatal infections, and blindness. The estimates in Table-3 of neonatal mortality by major causes of neonatal mortality are mostly based on hospital data, which may not be representative. Every year babies are dying for asphyxia and birth injuries, infection and birth defects.

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Percentage</th>
<th>Number of Deaths/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth asphyxia/trauma</td>
<td>29</td>
<td>1,160,000</td>
</tr>
<tr>
<td>Prematurity</td>
<td>24</td>
<td>960,000</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>15</td>
<td>600,000</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>10</td>
<td>400,000</td>
</tr>
<tr>
<td>Neonatal sepsis</td>
<td>9</td>
<td>360,000</td>
</tr>
<tr>
<td>Neonatal tetanus</td>
<td>7</td>
<td>280,000</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>200,000</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>24</td>
<td>40,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>4,000,000</strong></td>
</tr>
</tbody>
</table>


Traditional delivery practices at home affect maternal and new-born health. Giving birth too many babies affect the mother’s physical and mental health. When a mother go for third or fourth baby, her health is already week and mentally also she have more responsibility in home to feed other kids, husband and she finally neglect her health condition which obviously lead to low-birth babies. Financial situation to pay for high maternity and neonatal care, also another reason for delayed neonatal care. Apart from these ladies are still denied education which makes them unaware of best maternal, neonatal, health care and hygiene.
New-born care is very important in preventing neonatal deaths, particularly essential care of the normal neonates to prevent illness, extra care of low birth weight babies, and access to quality emergency care for the sick. Hence the care is strongly influenced by women’s social and health status and by home care and practices for mother and new-born, as well as by maternal and new-born cares services (Rodolfo et al. 2000).

1.1.2 Interventions to Improve New-born Health

Due to many Non-Government Organisation interventions, many awareness programs have been conducted in many Asian countries about the importance of women education which directly relates to neonate’s health, maternal health and general women health and hygiene. These program create awareness among women in rural area of developing countries about the hygiene, clean environment, safe sex, vaccination during pregnancy and after delivery, healthy eating, complete diet during pregnancy, and importance of

<table>
<thead>
<tr>
<th>Countries</th>
<th>Percent Prevalence</th>
<th>Number of Infants/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>20</td>
<td>228,000</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>50</td>
<td>1,752,000</td>
</tr>
<tr>
<td>Bhutan</td>
<td>15</td>
<td>11,400</td>
</tr>
<tr>
<td>India</td>
<td>21.8</td>
<td>8,081,000</td>
</tr>
<tr>
<td>Maldives</td>
<td>18</td>
<td>2,000</td>
</tr>
<tr>
<td>Nepal</td>
<td>30-50</td>
<td>235,800-393,000</td>
</tr>
<tr>
<td>Pakistan</td>
<td>25</td>
<td>1,337,000</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>18</td>
<td>18 59,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>28</strong></td>
<td><strong>11,800,000</strong></td>
</tr>
</tbody>
</table>

balanced diet which plays a vital role in delivering healthy babies. Governments also promote these types of awareness through media like Television Ads, Short films and through school. These general awareness played a great role in the maternal and neonates health.

Programs of safe motherhood and child health and strategies of Integrated Management of Pregnancy and Childhood illnesses (IMCI) and Integrated Management of Pregnancy and Childbirth (IMPAC) are being implemented in some of the countries of the region. In India and Bangladesh, neonatal care has been included as an integral component of essential service delivery or primary health care. During the 1990s, the countries in the region instituted a number of programs including the Child Survival Program, Baby Friendly Hospital initiatives, acute respiratory infection (ARI) control program, and training of traditional birth attendants (TBA), the Extended Program of immunization (EPI), Control of diarrheal diseases, the National Program for family planning and Primary care, the RHSP and IMCI. Currently all these programs are active and in various phases of implementation. Despite these plans, neonatal care policy has been low on the list of policy priorities.

1.2  Importance of Neonatal Intensive Care Unit

Preterm Neonates or Congenital Neonates are highly vulnerable to external disturbances and should be continuously monitored by specialized staff nurse in order to improve the neonate’s survival rate and to prevent them from long term health effects at an earlier stage. This cannot be achieved in labor ward where the normal infants are taken care who does not need special care from the doctors and nurse.

Preterm birth has long term effects on neural development, impaired hearing and vision, increased risk of chronic disease.[1]. Congenital Neonates are by birth having difficulties in their survival. An estimated 270000 newborns die over 3.2 million Congenial Neonates every year, during the first 28 days of life every year from congenital anomalies.[3].
Neonatal Death Rate in 193 countries in 2010


Preterm & Congenial Neonates should be observed in special environment where there is no external disturbance and continuous monitoring of neonates is possible. Neonatal Intensive Care Units provides the technology needed for the neonates to be observed round the clock by neonatologist or experienced and well trained staff nurses.

1.2.1. Causes of Congenital Birth

Congenital disease is a condition existing at birth, even before birth during the development of first month of fetus (neonatal disease). Of these, those characterized by structural deformities are termed as “Congenital Anomalies” which leads to defects and damage in developing fetus. [2]. A congenital disorder may be due to genetic abnormalities, chromosome abnormalities, infections, exposure to environmental toxins, medications and women with pre-existing medical conditions such as diabetes. The common congenital anomalies are neural tube defects, heart defects and Down syndrome.

1.3 History of Neonatal Intensive Care Unit

In late October 1960, the organization of Intensive Care Unit for premature babies, new born, critically ill babies and young infants began at Yale-New Haven Hospital [4]. Before this the premature or ill neonates are transferred to pediatric floor or
separate ward where they are monitored by ward-nurses who are not specialized in caring premature or congenial infants. Neonates were not isolated with Intensive Care Units. Atlas in 1950, the Epidemiology of Staphylococcus gives way for the isolation of neonates to prevent most dangerous and most permanent nasal colonization.

In the beginning, premature babies, babies with critical illness, babies infected with staphylococcus and babies with surgical conditions are admitted in the Unit. During this period, there were few good NICU techniques and no NICU standards to follow. [4]. Infants were not observed, as they were viewed as diffusely organized, unstructured, lacking in sensing and motor abilities.[5]. But the whole scenario changed after Sir Charles Scott Sherrington’s model of reflexes which was associated with infant’s functioning.

1.4 Equipment’s used in Neonatal Intensive Care Units

Neonatal Intensive Care Unit contains many equipment’s, devices, sensors and connecting probes connected to neonates for monitoring vital parameters and to provide healthy environment for their survival. Progress in the field of Information Technology and Instrumentation Engineering added more and more advanced devices to improve the neonate’s health condition from critical situation to normal condition. Following are the vital equipment’s used in Neonatal Intensive Care Units to monitor and assist the neonates to improve their health condition.

1. Incubator
2. Radiant Warmer
3. Phototherapy Light
4. Pulse Oximeter
5. Ventilator
6. Temperature Monitor
7. NIBP Monitor
1.4.1 Incubators

Incubators are for neonates whose health condition is not stable and need special attention or intravenous fluid. It keeps the baby warm with moistened air in clean environment and helps to protect the baby from noise, infection and excess handling. A transport incubator is used for moving premature or congenital babies from one hospital to another hospital for surgery or any other medical emergencies which cannot be handled in the same hospital. Transport incubator is like a self-contained intensive care unit on wheel with all necessary devices like ventilator, pulse oximeter, cardio-respiratory monitor, oxygen supply, etc.

![Incubator](image)

1.4.2. Radiant warmers

Radiant warmers and Phototherapy lights are in the Neonatal Intensive Care Unit to improve the health conditions of neonates. Radiant warmers are used to improve the body temperature of the neonates who have less body volume and fat and cannot maintain their body temperature. The open nature of the Radiant warmers provides way for the staff nurse and doctor to monitor and note down the other device readings of babies.
1.4.3. Phototherapy light

Phototherapy light or “Bili” Light are used in the NICU when the neonates are jaundiced (yellowing of skin and eyes) which is common in normal and full-term new born babies also. If jaundice not cured at early stage, it may lead to severe brain damage to even adults. The bright blue fluorescent light causes a chemical reaction which converts the bilirubin [6] molecule in blood into harmless form. Phototherapy light is safe and does not contain UV or harmful radiation for neonates and as a safety measure baby’s eyes are covered with delicate cloth.
1.4.4. **Ventilator or Respirator**

Ventilator or Respirator is a mechanical breathing machine which temporarily breathes for the preterm or ill babies until their lungs able to function normally. Ventilator supplies warmed and humidified air to babies’ lungs through an endotracheal tube. The amount of air pressure, oxygen and number of breaths per minutes varies depending on the health factors of babies. Some babies with respiratory disease need ventilation for prolonged time until their respiratory organ began function normally and some babies need after surgery.

![Ventilator](image)

**1.4.5. IV Pump & Blender**

IV Pump which is to deliver medication or blood to babies through IV line, blender which mixes oxygen, air and other gases in precise ration and provide to babies, and few more devices are used in Intensive Care Units to help the critically ill infants and pre-term babies to survive initially and to develop their health condition on further examination, medication or surgical procedure.

**1.5 Vital Parameters monitored in Neonatal Intensive Care Unit**

Continuous health monitoring of the neonates provides crucial parameters for early detection of adverse events (such as cessation of breathing, heart rhythm disturbances and drop in blood oxygen saturation), and possible complications (such as
seizures). Immediate action based on this detection increases survival rates and positively supports further development of the neonates. Advances in medical treatments over the last decades resulted in a significant increase of survival. Survival and long-term health prospects strongly depend on medical care and the reliable measurement of parameters like SPO2, Temperature, Blood Pressure, respiratory rate, etc.

1.5.1. SPO2

SPO2 stands for Peripheral Capillary Oxygen Saturation. It is the estimation of saturation level of oxygen in blood. Normal blood oxygen level are considered to be 95 to 100 percent. If it goes below 90, it is considered to be low and result in hypoxemia. Blood oxygen levels below 80 percent may compromise organ function such as brain, heart and may lead to respiratory or cardiac arrest. Oxygen therapy may be used to assist in raising blood oxygen levels. Oxygenation occurs when oxygen molecules enter the tissues of the body. Blood is oxygenated in the lungs when oxygen molecules travel from the air and into the blood.[10]

1.5.2. Temperature Monitor

Temperature measurement is a vital part of daily neonatal care. Accurate measurements are important for detecting deviations from normal values for both optimal incubator and radiant warmer functioning. The purpose of monitoring the temperature is to maintain the infant in a thermo neutral environmental zone. This physiological zone is defined as the narrow range of environmental temperatures in which the infant maintains a normal body temperature without increasing his or her metabolic rate and thus oxygen consumption.[11]

The electrical and optical devices can be used for temperature measurements. Transcutaneous thermometry is currently used in hospitals for core temperature monitoring. A thermistor is placed between the infants back and the mattress of the incubator, attached to the skin with a foam adhesive disk insulator. [12]
1.5.3. NIBP Monitor

The recognition and treatment of hypotension is particularly important to avoid complications such as cerebral ischemic injury or interventricular hemorrhage. In general hypotension indicates inadequate systemic blood flow or left ventricular output and therefore inadequate tissue perfusion, although this is not always the case. Hypertension in the newborn is increasingly seen as a complication in infants with Broncho pulmonary dysplasia (BPD) and who are receiving steroid treatment.[13]

Invasive direct arterial BP measurement is recommended in hospital for neonates, but it is not possible in all infants. Hence non-invasive blood pressure monitoring is common in neonatal intensive care unit, even though there is a controversy about the reliability in the non-invasive blood pressure measurement.[14]

1.6 Neonatal Nursing

The first 28 days of pre-term and congenital babies are crucial as major growth, changes and challenges unique for existence occurs. Neonatal nurses are specially trained to monitor and care the babies around the clock for their well-being. The care and attention given by the neonatal nurse does not remain the same for all neonates. It varies depending upon the health condition of babies, preterm or full term, normal or critically ill, baby’s gestational age, method of deliver and so on.

There are three level of neonatal nursing. The levels are care for healthy infants, care for premature and sic babies and last one is critically ill babies who needs special and constant attention over their health. In all the levels, the neonatal nurse works under the pediatrician or specialist and educate the new mother’s about breast feeding, health condition of neonates and answering their queries. Even though the nurse works under doctors, they play vital role in the neonate’s health monitoring system. An efficient Neonatal nurse will have a good understand physiological and psychological needs of new born babies and they should also be technically good to handle advanced monitoring equipment’s, devices and sensors.
1.7 Earlier Literature of Neonatal Intensive Care Unit

The advancement in various filed like medicine, instrumentation engineering, information technology, etc. as a whole contribute more to the development of Neonatal Intensive Care Unit.

At present, neonate’s temperature is measured using adhesive thermistors, ECG and respiration rate are measured using adhesive skin electrodes and oxygen saturation level of blood is measured using pulse oximeter with sensors which is fixed to foot or palm of neonate. Even though the sensors, electrodes and wires fixed to the neonates give theirs vital health parameter values crucial for their survival, they provide a greater discomfort to the neonates. As the neonates are premature or ill they have week central nervous system which are highly sensitive to external stimuli such as noise, bright light and pain. As the survival rate of preterm and congenital babies has improved the quality of life the neonates experience in Neonatal Intensive Care Unit becomes an important issue to be handled. This leads to lot of research and resulted in many innovative non-invasive sensors, thermistors and smart jacket with sensors.

Recent advancement in sensor technology and wireless communication system enable the creation of new generation of health care monitoring system with wearable sensors and photonics.

1.7.1. Neonatal Smart Jacket

The objective of this neonatal smart jacket is unobtrusive continuous monitoring system realized by sensor network and wireless communication system, suitable for monitoring neonates inside the incubator as well as outside during kangaroo-mother care. The Neonatal Smart Jacket aims for providing reliable health monitoring as well as a comfortable clinical environment for neonatal care and parent-child interaction. The concept offers a solution for skin contact, without jeopardizing comfort by tightness. It might also solve the problem of searching optimal electrode positions in the jacket, which varies per baby. [7].
1.7.2. Reliable Textile Neonatal ECG Monitoring using Multi-Sensor Recordings

ECG monitoring system embedded with textile electrodes for comfort, it is challenging to ensure reliable monitoring, because textile electrodes suffer from motion artifacts and incidental poor signal quality. For the design of a comfortable monitoring system for prematurely born babies in the Neonatal Intensive Care Unit (NICU), we propose the concepts of ‘diversity measurement’ and ‘context awareness’ to improve reliability. Clinical multi-modal sensor data was collected in the NICU with the Smart Jacket connected to a state-of-the-art amplifier. ECG signals quality varied among sensors and varied over time, and found correlations between ECG signal, acceleration data, and context, which support the feasibility of the concepts. [8].

1.7.3. Automated Multi-Parameter monitoring of neonates

Alarm generates when any one of the physiological parameter like temperature, heart rate, oxygen saturation level, blood pressure, etc lies outside the predetermined limits. Although this method correctly detects patient deterioration, it produces more false alerts which make the nurse not to respond as well as to ignore genuine alerts by mistake. This inefficiency occurs as each physiological parameter is analysed independently in single dimension, rather than using a multiple-parameter approach.

The objective of automated multi-parameter monitoring system is to generate alarm based on the analysis done as a single point in multi-dimensional space where each parameter takes a dimension instead of analyzing each parameter separately which results in reliable monitoring of neonates critical condition.

1.7.4 Intelligent Baby Monitoring System

An intelligent based baby monitoring system [15] was developed using PIC microcontroller on 2 x 16 LCD display to monitor the Neonatal health parameters.
1.7.5 Wireless Health monitoring System for Neonatal Intensive Care Unit

A wireless health monitoring system for Neonatal intensive care unit [16] was also developed. A Multi-parameter measurement of ICU patient using GSM and Embedded Technology[17] for health parameters and also an Embedded, GSM based, Multi-parameter, Real-time [18] Patient Monitoring System and Control

1.7.6 Body temperature and Electrocardiogram Monitoring System

The Body Temperature and Electrocardiogram monitoring using SMS based Telemedicine was developed [18]. This system alerts the doctor the concerned personal taking care about the heart patient who is in the ICU. A Portable Wireless Biomedical Temperature Monitoring System [20] for neonates also developed.

1.8 Thesis Overview

- GSM based Real time Health Monitoring and Care system provides integrated result of neonate’s temperature, blood pressure and oxygen saturation level of blood

- The parameters are measured as single parameters and further integrated inside the processing unit to display the all the parameters in display unit connected with the processing unit as required by the user.

- Neonates medical data is parallel intimated to the concerned doctors through GSM to achieve real time monitoring of health care system.

1.9 Backlog of Neonatal Intensive Care Unit

The economic cost of neonatal intensive care unit is high if the number of days the neonate to be monitored prolonged time based on the neonate’s health condition. The mental stress experienced by the parents and their inmates stay in the hospital is also more due to the increased number of days the neonate under observation. Experienced Neonatal Nurses are less in numbers which leads to utilize available nurse who were not specialized in neonatal caring and results in poor neonatal care. Neonates admitted to
neonatal intensive care unit have very delicate and sensitive skin and hence usage of electrodes, sensors and other devices create discomfort and pain to the babies. On the long run, they affect the neonate’s central nervous system as they are week and highly sensitive to external stimuli.

   Observing and monitoring many parameters of more neonates at a time is the real challenge for staff nurse or neonatal nurse. Not only monitoring, the nurse should also inform the concerned doctor or specialist about the critical condition of any neonate. Its tedious task for the staff nurse and there are chances for the nurse to miss out or avoid monitoring by chance which will leads to serious complication for the tiny patients.

1.10 Benefits of Neonatal Intensive Care Unit

    The survival rate of neonates increased only because of Neonatal Intensive Care Unit which is proved in surveys. The Non-Invasive monitoring system like electrode less sensors provides a better environment for the neonates with less external disturbance and thus avoid long term disability among the neonates.

    Parents are educated and trained about the Neonatal Intensive Care Unit and the treatments provided to their infants. Kangaroo mother (skin to skin) care is provided to the infants in Neonatal Intensive Care Unit which gives trust and satisfaction to the mother.

    Electronic Health Recording System integrated within the Neonatal Intensive Care Unit, enables the retrieval of neonate data for further and future analysis. With further development in the medical and engineering field the cost of neonatal care will be reduced. Reliable Neonatal monitoring, Real Time neonatal data transmission and comfortable environment with zero percent harm for neonates in neonatal intensive care unit are the latest upcoming research area in medical and engineering fields.
1.11 Objectives and Merits of the present proposed work

Present day systems of Neonatal Intensive care units are designed and developed by integrating the above all parameters. But most of the cases require minimum measurement equipment such as Pulseoxy (Spo2), Radiant Warmers, Phototherapy and NIBP meter for Blood pressure and pulse rate measurement rate. With the advancement in the field of wireless communication and information technology, it is easy to integrate the health parameters of neonates and communicate the same to the concerned doctors or specialist and nurses about the critical condition in no time. The doctors or specialist whose numbers are previously feed into the database will be notified about the neonates critical condition, in their GSM through message or alarm signal with the details about the neonates. Hence in the present proposed work an attempt has been made to design and develop an GSM based Intensive Care Measurement system for neonatal health care with low cost. The entire details of the present work described in detail in the following chapters.