



Neonatal Mortality and Morbidity: The Burden

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Usha Saha

The greatest risk of death in the pediatric age is in the first 28 days of neonatal period life. **Neonatal Mortality Rate (NMR)** is a huge burden globally. Ninety eight percent of neonatal deaths occur in the developing countries. In 2019, 2.4 million children died in the 1st month of life (6,700/day), with 1/3rd within 1st 24 h and 3/4th within the 1st week of life. (UNICEF 2020)

Neonatal, infant, and maternal mortality rates represent the health status of a country, and can be used to compare the health of a country, state, or city, and are indicators of poor public health awareness, and inappropriate government and health department initiatives.

1.1 Causes of Neonatal Morbidity and Mortality

Global scenario: many deliveries that occur at home are unsupervised, and many newborn and neonatal deaths go unreported; hence, actual NMR is higher than that reported. Global causes of high NMR include **birth asphyxia** (21%) and **injuries** (11%), **infections** (11%) (common being pneumonia 19%, tetanus 14%, sepsis 7%, and diarrhea 2%), **congenital defects** (11%), **prematurity** (10%), and **others** (5%), such as low birth weight, hypothermia, hyperbilirubinemia, HIV, **sexually transmitted disease** (STD), and **asphyxia, infections, birth defects, and prematurity** are responsible for early neonatal deaths (in 1st week of life) [1–7].

Indian scenario: India is a huge country with many states and huge population. Neonatal deaths are not a hospital or state problem as they continue to occur across India. Most neonatal deaths occur at home, at the time of birth or later, especially in rural and remote areas, where health facilities may be inadequate or inefficient [8].

U. Saha (✉)

Department of Anesthesia, Pain and Palliative Care, Lady Hardinge Medical College, Smt Sucheta Kriplani and Kalawati saran Childrens Hospitals, New Delhi, India

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Though most neonatal deaths occur at the time of birth, but problems start much before, preconception, and many are preventable. India contributes to 16% of global maternal deaths and 27% of global newborn deaths. Reducing the burden of maternal and newborn mortality requires active interventions at government level. In 2001, a study reported that nearly, 50% of infants developed high-risk morbidities (fatality >10%), such as **infections, birth asphyxia, birth injuries, preterm birth, and birth defects**.

As per the United Nation child mortality estimates, there were 721,000 neonatal deaths in 2018 (1975 deaths/day), with highest NMR in Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Rajasthan, Odisha, Chhattisgarh, Assam, Maharashtra, and Gujarat, common causes being **diarrhea and sepsis**. NMR was lowest in Goa, Kerala, and Tamil Nadu and mainly from **congenital or genetic causes**.

India is making an improvement in NMR, but need more focused attention to bring down NMR comparable to developed countries. A report from Rajasthan stated a decrease in NMR from 124/1000 live births in 1975–38 in 2015, over four decades [9, 10].

NMR has a wide regional variation, because variations related to:

1. **Structural issues:** lack of appropriate facility at primary centers
2. **Delayed referral to specialist care**
3. **Lack of transportation facilities**
4. **Poor quality of primary health care**, poor maternal health/antenatal/post-natal care
5. **Social problems:** malnutrition, immunization, potable water supply, and sanitation
6. **Poor living conditions:** overcrowding, indoor air pollution, and risk of pneumonia
7. **Medical causes:** prevalence of infections, diarrhea, and sepsis
8. **Congenital and genetic defects**
9. **Overcrowded tertiary care centers**

Reducing NMR Requires Stringent Simultaneous Approach at All Levels, Including:

1. Higher coverage of quality antenatal care, skilled birth care, improved post-natal care
2. Care of sick newborns
3. Institutional deliveries at hospitals with good infrastructure (rate doubled from 38.7% in 2005 to 78.9% in 2015–16) and institutions need to keep pace with this rise in numbers
4. Adoption of cost-effective neonatal care interventions, e.g., **Kangaroo care** (skin-to-skin contact with mother, thermal control, breastfeeding support, and basic care)
5. Formation of newborn care corners at every point of childbirth, of newborn stabilization units at first referral units, and of special newborn care units at district hospitals (under National Rural Health Mission 2005)

6. Sufficient qualified and experienced staff, well-equipped facilities with functioning equipment
7. Most care to be provided at district levels so as to unburden the tertiary care units, enabling them to provide care to sick and needy neonates
8. Preconceptional and antenatal care, early identification and management of risk factors
9. Preventive measures in mother—health, immunization, antenatal surveillance, timely detection, and early treatment of infections and diseases
10. Counseling on importance of healthy pregnancy, and clean, safe, assisted delivery by skilled attendant
11. Clean and safe newborn care to reduce risk of neonatal infections
12. Recognition of early signs of illness and timely medical help
13. Sensitive and empathetic attitude of officials in implementation of public health policy
14. Effective maternal and newborn health (MNH) care services and lowering the barriers to the use of such services, especially availability and accessibility
15. Saving Newborn Lives (SNL) programme, supported by Bill & Melinda Gates Foundation from 2000–2020, addresses these issues.

1.2 Causes of Neonatal Mortality (Table 1.1)

- (a) **Infectious diseases** are the major cause of mortality in under 3 months of age and **major cause of death in late neonatal period (8–28 days)** [11]. Nearly, 40% of neonates die of infections. Globally, common infections are acute respiratory (30%), bacterial (40%), meningitis (40%), tetanus (70%), and diarrhea (0.6%), mortality being higher in LBW, malnourished, preterm babies, and in those not breastfed. **Maternal TB** increases the risk of fetal loss, preterm delivery, and LBW [12]. **Neonatal Diarrhea** contributes to 3% of all deaths, and early, exclusive breastfeeding, is protective. **Neonatal Tetanus is fatal within 3–10 days**, and can be contracted anytime from unimmunized mother, and unhygienic delivery and cord care [13]. **STD: syphilis** is transmitted transplacental, and is a cause of fetal death or disability [14]. **Congenital syphilis** is associated with FGR, anemia, thrombocytopenia, jaundice, hepatosplenomegaly, and neurological manifestations (mental retardation, hydrocephalus, cranial nerve palsies, and seizures) [15]. **Maternal Gonorrhoea** increases the risk of conjunctivitis and blindness in the baby. **Neonatal Herpes** increases the mortality and risk of neuro-developmental sequelae [16]. **Untreated UTI** increases the risk of preterm labor and LBW babies. **Malaria** is associated with FGR and LBW. **Omphalitis** (umbilical infection) is a unique problem in developing countries, because of home deliveries in unsterile environment and poor cord hygiene, and increases the risk of neonatal sepsis and death.
- (b) **Noninfectious conditions: perinatal asphyxia** defined as failure to initiate and sustain normal breathing, and includes apnea or gasping with bradycardia (<80)

Table 1.1 Causes of neonatal mortality

Factors	Effects on pregnancy/Fetus/Neonate
Infectious diseases	
Maternal infections	Fetal loss, FGR, and late neonatal deaths
Tuberculosis	High fetal loss, preterm delivery, and LBW
Untreated UTI	Preterm labor and LBW babies
Malaria	FGR and LBW
Syphilis	Fetal death/disability. Congenital syphilis associated with FGR, anemia, thrombocytopenia, jaundice, hepatosplenomegaly, and neurological manifestations
Gonorrhea	Conjunctivitis and blindness in the baby.
Neonatal infections: respiratory (30%), bacterial (40%), meningitis (40%), tetanus (70%), diarrhea (0.6%),	40% neonatal deaths. Higher in LBW, malnourished, preterm, and those not breastfed.
Neonatal diarrhea (3% of all deaths)	Early, exclusive breastfeeding, is protective.
Neonatal tetanus	Fatal within 3–10 days, can be contracted anytime from unimmunized mother, unhygienic delivery, and cord care.
Neonatal herpes	High mortality and neuro-developmental sequelae.
Omphalitis (umbilical infection)	Neonatal sepsis and death
Noninfectious conditions	
Perinatal asphyxia	Most common cause of NMR.
Birth injury	11% neonatal mortality and long-term morbidity.
Neonatal hypothermia	Risk of infection, coagulation abnormalities, acidosis, and death
Neonatal jaundice and kernicterus	Rare cause of neonatal death. Kernicterus in preterm baby and encephalopathy. Late sequel: extrapyramidal abnormalities, choreo-athetosis, involuntary muscle spasms, and sensorineural deafness.

at birth, absent or poor respiratory effort and/or gasping at 1 min, low Apgar score, and the need for assisted ventilation for more than 1 min [17–20]. The incidence is higher in developing countries because of higher prevalence of risk factors and lack of appropriate interventions [21]. Mortality is greater among preterm and LBW babies who are at risk of developing encephalopathy [7, 22–26]. Risk factors for asphyxia include: antepartum hemorrhage (APH), prolonged labor and/or prolonged rupture of membranes (PROM), drugs given to mother (magnesium sulfate, narcotics), cord accidents, vaginal breech deliveries, multiple gestation, pregnancy-induced hypertension (PIH), congenital anomalies, and IUGR/FGR with placental dysfunction.

- (c) **Birth injury** contributes to 11% of neonatal deaths worldwide. It is a nonspecific term used for potentially preventable and unavoidable injuries; mechanical or hypoxic–ischemic, suffered by the neonate during labor and delivery, such as intracranial hemorrhage (ICH); blunt trauma to the liver, spleen, or other organs; injury to spinal cord or peripheral nerves, cord transaction, brachial plexus

injury, and fractures (clavicles, extremities). They may result in transient or long-term morbidity and death. Predisposing factors include macrosomia, cephalopelvic disproportion, dystocia, prolonged or obstructed labor, breech presentation, and prematurity.

- (d) **Neonatal hypothermia** (body temperature <36.5 °C) is frequent in newborns, especially LBW. Severe hypothermia (body temperatures <32 °C) increases the risk of infections, coagulation abnormalities, acidosis, complications of preterm birth, and death [27, 28]. Warm environment at delivery, early breastfeeding and contact with mother, thermal protection, and care during transport can reduce the risk of hypothermia. Indian Kangaroo care system is specifically effective [29].
- (e) **Neonatal jaundice/hyperbilirubinemia** (*s. bilirubin* >7 – 8 mg%) is a rare cause of neonatal death, but extreme bilirubinemia can cause devastating neurologic injury, long-term disability, and death from encephalopathy or kernicterus (serum bilirubin >25 mg%). Causes include prematurity, ABO Rh incompatibility, and peripartum infection. Preterm babies are at greater risk for kernicterus. Early signs of encephalopathy are nonspecific (lethargy, poor feeding), bulging fontanel, opisthotonus, shrill cry, spasms, and seizures, and late sequel include extrapyramidal abnormalities, choreo-athetosis, involuntary muscle spasms, and sensorineural deafness.

1.3 Interventions

- (a) **Maternal immunization against tetanus, pneumonia** (*Streptococcus pneumoniae*, *Haemophilus influenzae* type B, and Group B streptococcal infections), and *H. influenzae*
- (b) **Prevention and treatment of anemia** [30] with iron and other micronutrient supplementation, prevention of malaria and hookworm infestation, and prevention and treatment of maternal infections
- (c) **Essential ANC**: counseling on birth preparedness and emergency readiness; provision of folic acid; tetanus immunization; prophylaxis and intermittent preventive treatment for malaria and hookworm; early detection and timely management of diseases/complications (anemia, hypertension, PIH, UTI, STD, and HIV), and of concurrent conditions (hepatitis, malaria, TB); and fetal malpresentation after 37th week [31]
- (d) **Corticosteroids**: to reduce RDS, IVH, and improve survival of preterm newborns [7]
- (e) **Breastfeeding** during 1st hour of life can prevent hypoglycemia [32]. Closeness between mother and baby reduces risk of hypothermia
- (f) **Vitamin A supplementation during pregnancy and lactation** is reduces neonatal morbidity and mortality [33]
- (g) **Neonatal resuscitation facilities**²¹
- (h) **Require special care for improved survival**: skilled care at delivery, immediate evaluation of newborn, basic resuscitation, thermal control, prevention of

hypoglycemia, prevention of infections and neonatal tetanus, growth monitoring; early detection and treatment of illness, frequent home visits by trained health workers, monitoring of breastfeeding, neonatal growth, and overall well-being. Home-based Neonatal care can reduce fatality by almost 64 % [34]

- (i) **Care of the newborn**, and LBW (<2500 g) and VLBW (<1500 g) [35–37]

Problems Begin Before Birth and Need to Be Addressed:

- (a) **Behavior during pregnancy and postpartum:** perceived physical and supernatural threats, constellation of traditional and biomedical practices, taboos, superstitions and rituals used to mitigate them and their impact on perinatal risk
- (b) **Maternal education (10 years or more):** improves outcomes
- (c) **Maternal nutrition, health, and financial status:** child born to a wealthy household has three times more chance of surviving than one born to a poor family.
- (d) **Time of marriage:** child marriages have higher NMR.
- (e) **Less frequent ANC visits (<4):** missing out issues such as anemia, malnourishment, hypertension, diabetes. LBW (<2.5 kg) babies have high mortality (21.4%).

1.4 Conclusion

Recognition of the burden of NMR and morbidity highlights the need for health care interventions specifically targeting the newborn. The basic improvements in care that could significantly improve neonatal survival include: ANC (immunization against tetanus, preventive treatment of malaria, tuberculosis, syphilis, and urinary tract infection), clean and safe-assisted delivery by health workers skilled in neonatal resuscitation, hypothermia prevention, initiation of early breastfeeding, recognizing complications, and prompt effective referral to a tertiary care facility, and clean hygienic postnatal care of mother and baby in home care settings. **Anesthesia-related morbidity and mortality** is higher in neonates compared to infants, children and adults, more so in those with low gestational age, low birth weight, birth asphyxia, neonatal hypothermia, and hyperbilirubinemia, congenital abnormalities, compounded by the surgical condition, surgery and anesthesia. Hence, preventive initiatives can have a great impact by reducing perioperative NMR and morbidity.

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