



Section

I

# Organization and Delivery of Neonatal Care

1. Neonatal Mortality in India and National Programs for its Reduction
2. Levels of Neonatal Care: Organization and Norms
3. Neonatal Transport and Transferral

# Neonatal Mortality in India and National Programs for its Reduction

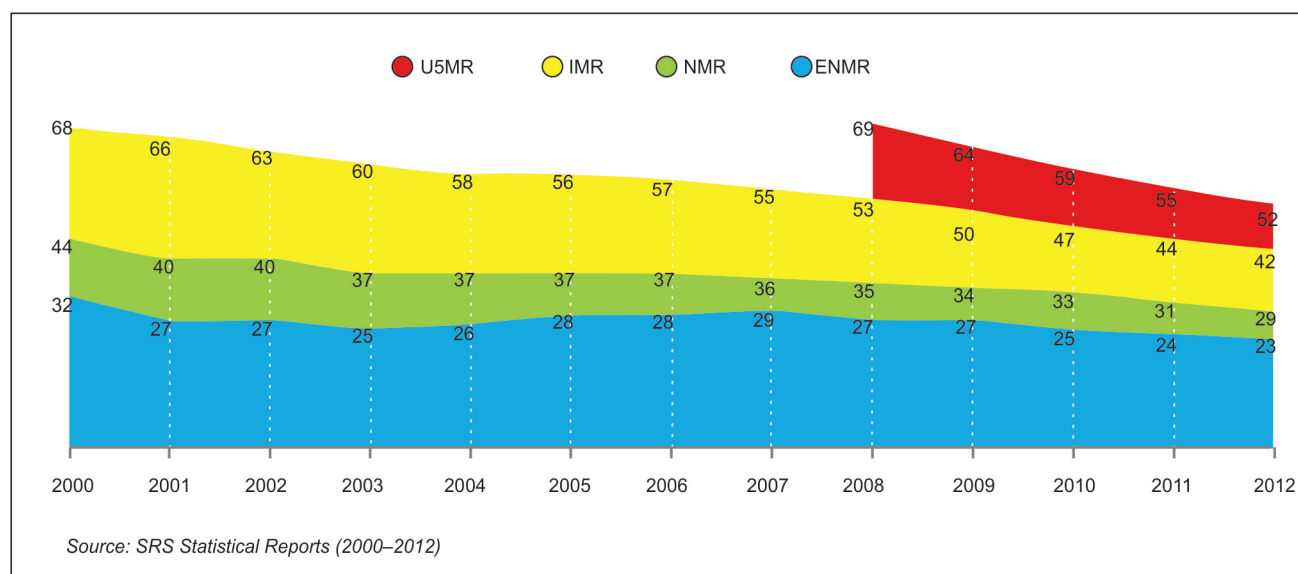
NB Mathur

## BURDEN OF BIRTHS AND NEONATAL DEATHS

India is home to 20% of global births (27 million infants per year) and to 1.2 million neonatal deaths (27% of the 3.9 million global neonatal deaths). The neonatal mortality rate (NMR) as per National Family Health Survey (NFHS)-3 was 39 in 2005–06 and has not been specified in NFHS-4 (2015–16). NFHS-4 estimates India's infant mortality rate (IMR) at 41 (versus 57 in NFHS-3) and under-5 Child Mortality Rate (U5MR) at 50 (74.3 in NFHS-3). As per SRS 2015, NMR is 25 while IMR and U5MR are 37 and 43, respectively (Table 2.1). NMR is 60% of U5MR and 67% of IMR. Trends of mortality rates are shown in Fig. 1.1. India also has the highest number of low birth

**Table 1.1:** Mortality indicators India SRS 2015

Deaths of <1 week to total infant deaths (%)	52.2
Under 5 mortality rate	43
Infant mortality rate	37
Neonatal mortality rate	25
Early neonatal mortality rate	19
Late neonatal mortality rate	6
Post-neonatal mortality rate	12
Perinatal mortality rate	23
Stillbirth rate	4



**Fig. 1.1:** Trends of U5MR, IMR, NMR and ENMR in India

weight (LBW) infants born each year globally—eight million out of the total of 20 million LBW babies (WHO 2014). The estimated stillbirth rate (SBR) is 22 per 1000 live births (Lancet 2011). The SBR estimates from SRS 2015 is 4 but is considered an under-estimation due to unavailable obstetric history.

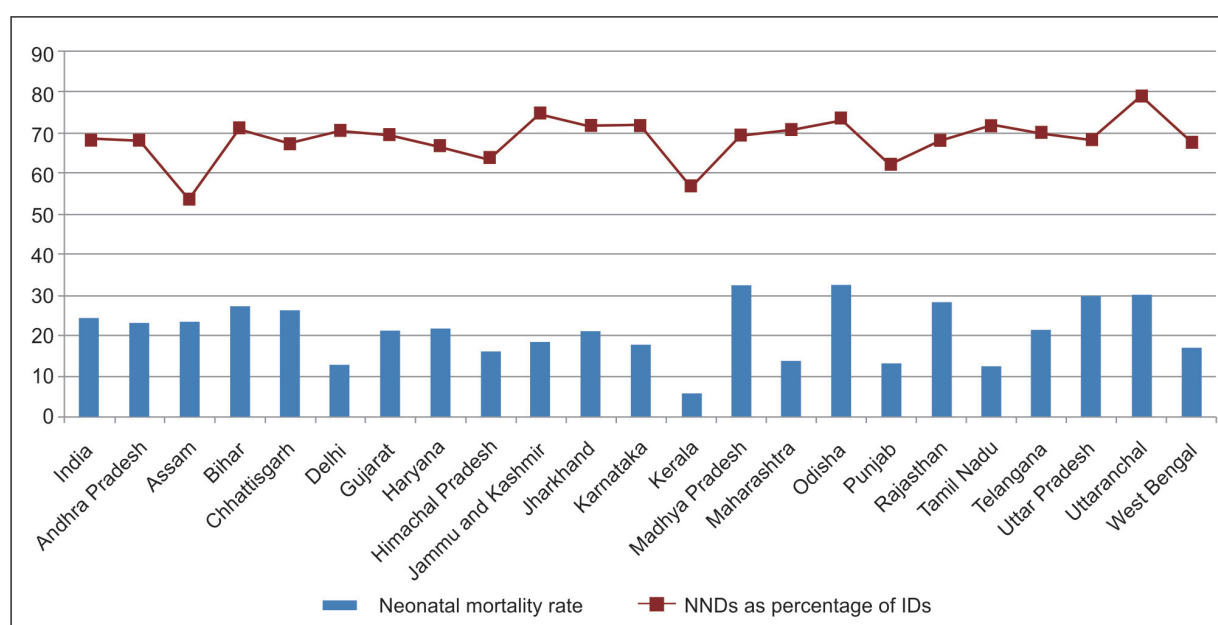
### Neonatal Mortality in Different States

There is a wide variation in neonatal mortality rate in different states and variation within states in urban and rural areas. The highest number of neonatal deaths occur in Madhya Pradesh, Odisha and Uttar Pradesh. Infant mortality rates in different states are shown in Fig. 1.2.

According to a UNICEF report on child survival (2018), the neonatal mortality rate in India is 25 per 1000 live births and accounts for more than two-thirds of the infant deaths.

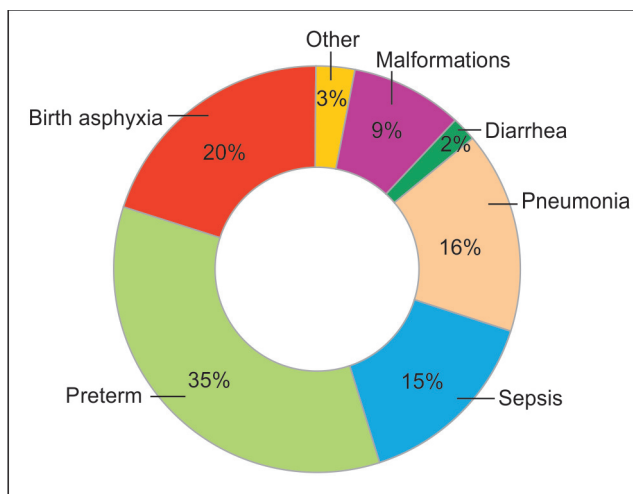
### Determinants of NMR

Birth weight, gestational age, antenatal and perinatal care, skilled attendance and institutional deliveries, gender, rural/urban residence, economic status, birth interval, birth order and maternal age are important determinants of neonatal mortality. Related findings of National Family Health Survey 3 (NFHS 3) in 2005–06 and NFHS 4 (2015–16) are summarized in Table 1.2.



**Fig. 1.2:** State-wise neonatal mortality rates in India and percentage share of neonatal deaths [NNDs to infant deaths (IDs)] (Source: Sample Registration System 2016)

Table 1.2: NFHS key indicators (NFHS 4 and 3)		
Maternal and child health indicators	NFHS 4 (2015–16)	NFHS 3 (2005–06)
At least 4 antenatal care visits (%)	51.2	37.0
Iron folic acid for $\geq 100$ days when pregnant (%)	30.3	15.2
Institutional births (%)	78.9	38.7
Births by cesarean section (%)	17.2	8.5
Births in a private health facility by cesarean section	40.9	27.7
Births in a public health facility by cesarean section	11.9	15.2
Women who are literate (%)	68.4	55.1
Total fertility rate (children per woman)	2.2	2.7
15–19 years old already mothers or pregnant (%)	7.9	16.0
Infant mortality rate (IMR)	41	57



**Fig. 1.3:** Causes of neonatal mortality in India (Liu *et al*/Lancet 2012)

### Causes of Neonatal Deaths

Three-fourths of all deaths occur within the first week. Low birth weight infants have a higher mortality rate. Major causes of death include neonatal sepsis, perinatal asphyxia, prematurity and congenital malformations (Fig. 1.3).

### NATIONAL PROGRAMS FOCUSING ON NEONATAL MORTALITY

Neonatal mortality has reduced much less than post-neonatal deaths.

Contribution of neonatal deaths to under 5 deaths has increased from 41% in 1990 to 56% in 2012. National programs to reduce neonatal mortality are summarized in Box 1.1 and the major milestones have been the National Rural Health Mission (NRHM) and the Reproductive, Maternal, Newborn, Child and Adolescent (RMNCH + A) strategy.

#### **Box 1.1:** National programs related to neonatal survival in India

- 1992—Child Survival and Safe Motherhood Programme
- 1997—Reproductive and Child Health Programme I
- 2005—Reproductive and Child Health Programme II
- 2005—National Rural Health Mission
- 2013—Reproductive, Maternal, Newborn, Child and Adolescent Strategy
- 2013—National Health Mission
- 2014—India Newborn Action Plan (INAP)

### Interventions under National Health Mission Focussing on Newborns since the Launch of National Rural Health Mission 2005

**Janani Suraksha Yojana** (JSY) (2005). The objective is safe motherhood intervention to increase institutional delivery through demand-side financing and conditional cash transfer. Currently, it is implemented in all states and union territories (UTs) with special focus on low-performing states.

**Integrated Management of Neonatal and Childhood Illnesses** (IMNCI). IMNCI is at the community level and F-IMNCI has been started at health facilities in 2007. The objective is standard case management of major causes of neonatal and childhood morbidity and mortality. Currently it is operationalized in more than 500 districts. Training under IMNCI has been provided to physicians, nurses, Anganwadi worker (AWW) and Accredited Social Health Activist (ASHA). Medical officers and specialists placed at the community health centre (CHC) and first referral unit (FRU) have been trained under F-IMNCI.

**Navjat Shishu Suraksha Karyakram** (NSSK) (2009). It is a training program in basic newborn care and resuscitation.

**Janani Shishu Suraksha Karyakram** (JSSK) (2011). The objective is zero out-of-pocket expenditure for maternal and infant health services through free healthcare and referral transport entitlements. Currently it is implemented in all states and UTs. The benefits have been extended to sick children up to one year old.

**Facility Based Newborn Care** (FBNC) (2011). Newborn care facilities have been established at various levels of public health system. These include *Newborn Care Corner* (NBCC) to provide immediate care at birth at all points of childbirth. *Newborn Stabilization Unit* (NBSU) is established at CHC and FRU for management of selected problems and to stabilize sick newborns before referral to higher centres. *Special Newborn Care Units* (SNCUs) are established at district/sub-district hospitals to provide all care for sick newborns except assisted ventilation and major surgeries. As per Government of India data, currently, 14,135 NBCCs, 1,810 NBSUs and 548 SNCUs have been established. An online data reporting system for 245 SNCUs has been established

in seven states and more than 2.5 lakh newborns registered in the data base.

**Home Based Newborn Care (HBNC)** (2011). The package of services provided by ASHA under HBNC includes provision of essential newborn care to all newborns, special care of preterm and low-birth-weight newborns; early detection and referral of illness and support to family for adoption of healthy practices. It has been implemented all over India.

**Rashtriya Bal Swasthya Karyakram (RBSK)** (2013). The package of services in this program comprises of screening of children with birth defects, diseases, deficiencies, developmental delays and disabilities. All children between 0 and 18 years old are the beneficiaries.

**India Newborn Action Plan (INAP)** (2014). The India Newborn Action Plan (INAP) was developed in response to the global Every Newborn Action Plan (ENAP), launched in June 2014 at the 67th World Health Assembly. The ENAP aims to eliminate preventable newborn deaths and stillbirths globally and reduce IMR and SBR to <10 by 2035. INAP aims at attaining single digit NMR and SBR by 2030. The key features of INAP are summarized in Box 1.2.

Figure 1.4 outlines the NMR projections to achieve the INAP target.

#### Box 1.2: India Newborn Action Plan (INAP)

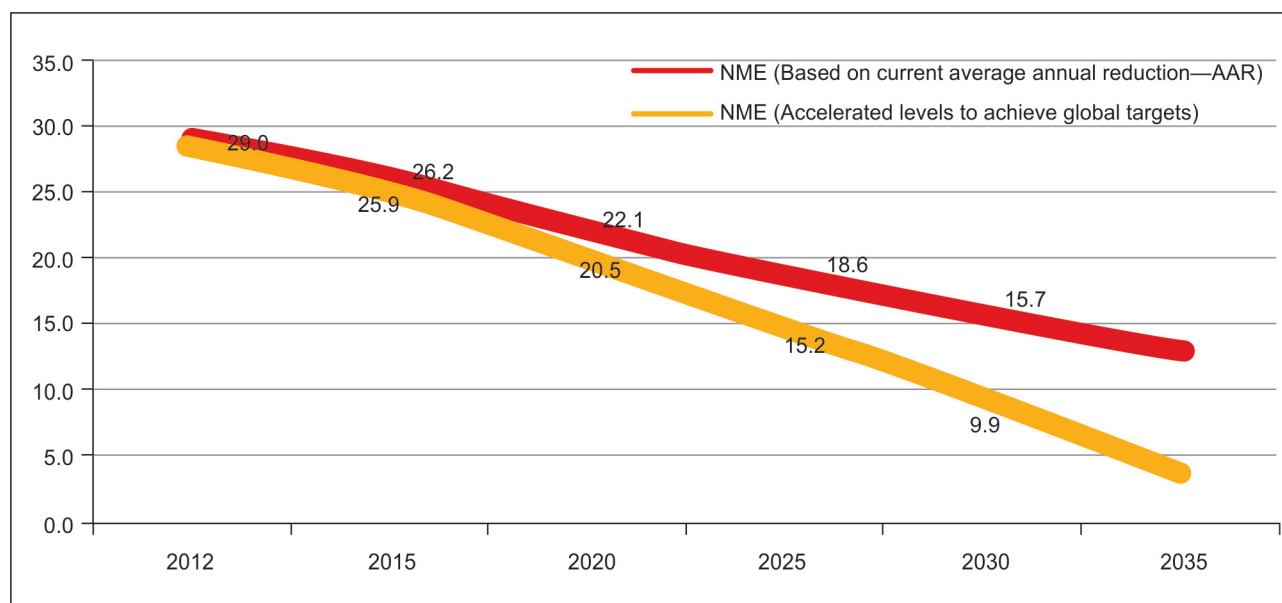
- Single digit neonatal mortality rate by 2030
- Surveillance mechanism for tracking stillbirths
- Improving quality of care and care beyond survival
- Prioritizes preterm, low birth weight and sick neonates
- Defines six pillars of interventions: Pre-conception and antenatal care; care during labour and child birth, immediate newborn care, care of healthy newborn, care of small and sick newborn and care beyond newborn survival

INAP used the estimates provided by the Lancet Stillbirth Series (SBR of 25 per 1000 births in 1995, and SBR of 22 per 1000 births in 2009) to set the target for SBR shown in Fig. 1.5.

INAP has set out specific outcomes and selected coverage targets as summarized in Table 1.3.

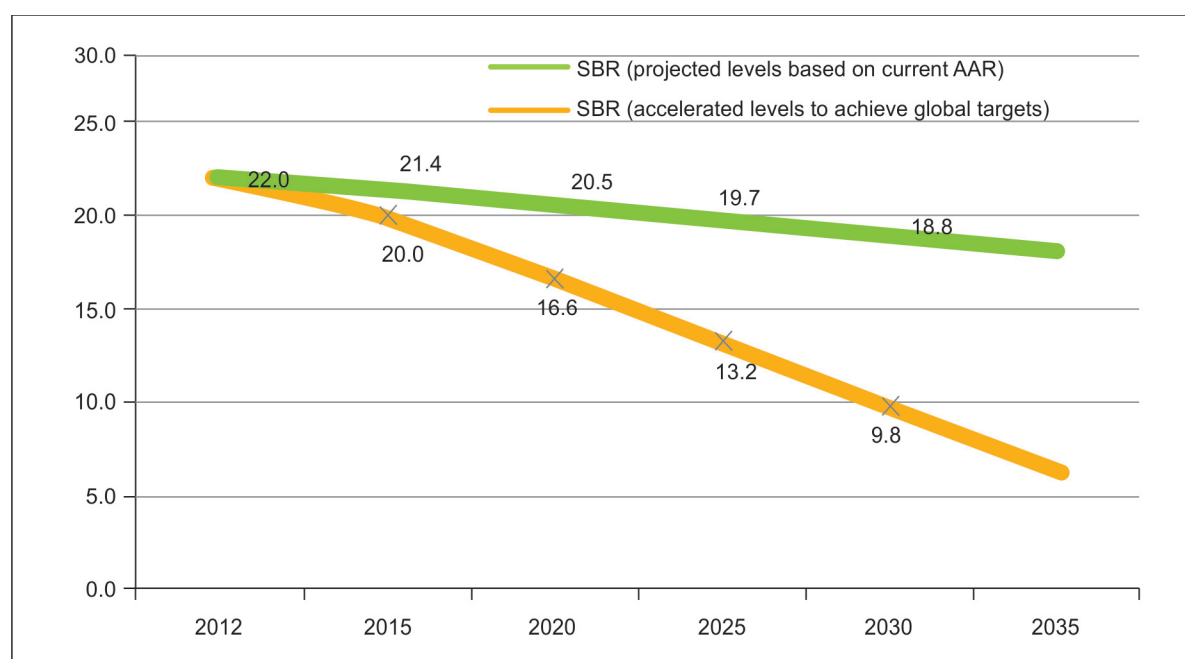
#### Strategic Intervention Packages/Pillars of INAP

Under INAP, 6 pillars or packages of intervention have been envisaged. The newborn care has been categorised in four categories and antenatal and natal care included to form the 6 pillars as follows: Pre-conception and antenatal care; care during labour and child birth, immediate newborn care, care of healthy newborn, care of small and sick newborn and care beyond newborn survival.



**Fig. 1.4:** Projected neonatal mortality estimates (NME) in India 2012–30 (Source: INAP, Ministry of Health and Family Welfare, Government of India, 2014)





**Fig. 1.5:** Projected stillbirth rates in India 2012–30 (*Source:* INAP, Ministry of Health and Family Welfare, Government of India, 2014)

**Table 1.3:** Impact targets and coverage targets of INAP

<i>Targets</i>	<i>2020</i>	<i>2025</i>	<i>2030</i>
<b>Impact target</b>			
NMR	21	15	<10
SBR	17	13	<10
<b>Coverage targets</b>			
Safe delivery by skilled birth attendant	95%	95%	95%
Initiation of breastfeeding within 1 hour	90%	90%	90%
Antenatal steroids use in preterm labour	90%	95%	95%
Neonatal resuscitation in birth asphyxia at health facility	90%	95%	95%
Home visits by ASHA	75%	95%	95%
Gentamicin by ANM in sepsis in community	75%	75%	75%
1 year follow-up of SNCU discharges	50%	75%	75%
KMC for low birth weights in facility	50%	75%	90%

Interventions in each package have been categorized as: Essential [E], to be implemented universally; Situational [S], implementation depending on epidemiological context; Advanced [A], based on capacity of the state or district. The components of strategic interventions are as follows.

### Preconception and Antenatal Care Interventions

#### *At family/community level*

1. Reproductive health and family planning [E]: Adolescent reproductive health, delaying age of marriage and first pregnancy, birth spacing.

2. Nutritional [E]: Balanced diet, energy protein supplementation and nutrition counselling, periconceptional folic acid, maternal calcium, iron, folic acid, iodine supplementation.
3. Birth preparedness [E]
4. Malaria prevention [S]

*Outreach/subcentre level (All the above, plus)*

5. Antenatal screening for anemia and hypertensive disorders of pregnancy [E]
6. Antenatal screening for malaria [S]
7. Prevention and management of mild to moderate anemia [E]
8. Maternal tetanus immunization [E]
9. Adolescent friendly health services (*nutrition and reproductive health counselling*) [E]
10. Interval IUCD insertion [E]

*At health facility (All the above, plus)*

11. Antenatal screening and management of severe anemia, hypertensive disorders of pregnancy, gestational diabetes, syphilis [E]
12. Antenatal screening and management of hypothyroidism, hepatitis B, HIV, malaria [S]
13. Adolescent friendly health clinics [E]
14. Postpartum family planning services [E]
15. Prevention of Rh disease using anti-D immunoglobulin [S]

### Care during Labour and Child Birth

*Family and community level*

1. Skilled birth attendance [E]
2. Clean practices [E]

*Outreach/subcentre level (All the above, plus)*

3. Identification of complications and referral [E]
4. Pre-referral care by ANM [E]: Antenatal corticosteroids in preterm labour, antibiotics for premature rupture of membranes

*Health facility level (All the above, plus)*

5. Emergency obstetric care [E]
6. Management of preterm labour [E]: Antenatal corticosteroids, antibiotics for premature rupture of membranes

### Interventions for Immediate Newborn Care

*At family and community level*

1. Delayed cord clamping [E]

2. Interventions to prevent hypothermia [E]: Immediate drying, head covering, skin-to-skin care, delayed bathing
3. Early initiation and exclusive breastfeeding [E]
4. Hygiene to prevent infection [E]

*Outreach/subcentre (All the above, plus)*

5. Vitamin K at birth [E]
6. Neonatal resuscitation [E]

*Health facility (All the above, plus)*

7. Advanced neonatal resuscitation [E]

### Care of Healthy Newborn

*Family and community level*

1. Home visits till 6 weeks by ASHA [E]: Counselling, prevention of hypothermia, cord care, early identification of danger signs, prompt and appropriate referral
2. Exclusive breastfeeding [E]
3. Clean postnatal practices [E]

*Outreach/subcentre level (All the above, plus)*

4. Immunization [E]: BCG, OPV, Hepatitis B

*Health facility level*

All the above interventions (except home visits)

### Care of Small and Sick Newborns

*Family/community level*

1. Thermal care, feeding support (for home deliveries) [E]

*Outreach/subcentre level (All the above, plus)*

2. Management using IMNCI and use of oral antibiotics [E]
3. Injectable gentamicin by ANMs for sepsis [E], pre-referral completion of antibiotic course if referral refused/not possible "OR" as advised by treating physician

*Health facility level (All the above, plus)*

4. Kangaroo mother care at facility [E]
5. Full supportive care at block and district level [E]: NBSU at block level, SNCU at district level
6. NICU at regional level [A] for assisted ventilation, surfactant use, surgery

### Care Beyond Newborn Survival

*Family and community level*

1. Screening for birth defects, failure to thrive and developmental delays [E]

2. Follow-up visits of [E]: SNCU discharged babies till 1 year of age, LBW babies till 2 years of age

*Outreach/subcentre level*

3. All the above.

*Health facility level (All the above, plus)*

4. Newborn screening [A]
5. Management of birth defects [E]: Diagnosis, treatment, including surgery
6. Follow-up of high-risk infants (discharged from SNCUs, and small newborns) for detecting and managing developmental delay

#### Bottleneck Analysis in INAP (Gaps and Challenges in INAP Implementation)

This analysis enlisted the following problems affecting service delivery, pinpointed the underlying causes of these problems and determined the order in which they ought to be resolved.

**Human resources for health:** Key bottleneck to service provision and utilization was found to be the lack of appropriate manpower. The issues ranged from shortage of human resources to lack of trained/skilled providers, in-service issues of recruitment, posting, transfer, and promotion. Suggested action is formulation of a national comprehensive human resource for health policy in concurrence with NHM.

**Quality of care:** The issues ranged from lack of quality assurance and standards, no accreditation processes, low user satisfaction or poor patient safety, and weak monitoring and evaluation of quality of care at the facility level:

- **Leadership and governance:** Role of leadership with respect to timely dissemination of guidelines, involvement of various stakeholders, and fixing accountability in private sector were highlighted.

**Financing:** Timely flow of funds was recognized as a bottleneck to ensure the fulfillment of JSSK entitlements to mothers and newborns or timely payment of JSY incentives. Existing reporting platforms were found not covering the entire component.

**Reports:** The reports are not being used for planning or midcourse correction. The bottleneck analysis has helped to acknowledge the need to strengthen health systems in order to translate strategies into action.

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# Levels of Neonatal Care: Organization and Norms

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## LEVELS OF CARE

In India, three levels of neonatal care were designated initially by the National Neonatology Forum although subsequently need for a higher level of care (level IIIB or IV) has been realized. A facility providing higher level of care (say level III) also needs to have lower levels of care (level I and II).

Levels in the United States are elaborately designated by the guidelines published by the American Academy of Pediatrics. In Britain, the guidelines are issued by The British Association of Perinatal Medicine, and in Canada, they are maintained by The Canadian Paediatric Society.

### Level I Care

Level I units may also be referred to as the well baby nursery. Well newborn nurseries have the capability to provide neonatal resuscitation at every delivery; evaluate and provide postnatal care to healthy newborn infants; stabilize and provide care for infants born at 35 to 37 weeks' gestation who remain physiologically stable; and stabilize newborn infants who are ill and those born less than 35 weeks' gestation until transfer to a facility that can provide the appropriate level of neonatal care. Care provider includes pediatricians/medical officers, and nurses. This level of care can be given at subcentre, primary health centre and first referral units. The floor area should be 25 Sq ft per baby and there should be 1 nurse for 8 babies.

### Level II Care

It is provided in the special care neonatal unit (SCNU). In addition to providing level I neonatal care, Level II units are able to provide care for infants born  $\geq 32$ -week gestation and weighing  $\geq 1500$  g or neonates who are moderately ill with problems that are expected to resolve rapidly and do not need sub-specialty services. Care providers include pediatricians/neonatologists, and trained nurses in addition to Level I health care providers. This level of care can be provided in medical colleges, district hospitals or other large hospitals.

The equipment and facilities used for this level of care include all equipment for resuscitation, pulse oximeters and blenders, maintenance of thermo-neutral environment using radiant warmers and incubators, intravenous infusion sets, feeding tubes, phototherapy units and facilities for exchange blood transfusion. This level of care can be given at district hospitals, medical colleges and nursing homes. The estimated requirement of level II care beds is 10 per 1000 live births.

Some SCNUs may also provide care for infants who are growing or convalescing after intensive care, provide mechanical ventilation for a brief duration ( $<24$  h) or continuous positive airway pressure, stabilize infants born before 32-week gestation and weighing less than 1500 g until transfer to a neonatal intensive-care facility.

### Level III Care

Level III care is provided in a neonatal intensive care unit. Very low birth weight neonates ( $<1500$  g) and

preterm babies less than 32 weeks are recipients of level III care. The care is provided at medical colleges and apex hospitals. Mechanical ventilation, management of very low birth weight (VLBW) babies and pediatric surgery services are essential in addition to care required for level II and level I. Infrastructure and equipment would include centralized oxygen, compressed air and suction facilities, vital signs monitors, ventilators and servo-controlled radiant warmers and incubators, syringe infusion pumps and level II facilities. At least two-thirds of the bed strength should be of open care systems. Adequate number (3 per patients) of infusion pumps should be available. Electronic monitoring of heart rate,  $\text{SaO}_2$ , respiration, ECG and  $\text{EtCO}_2$  (1 per bed) are needed.

This level of care is provided by neonatologists, pediatricians and neonatal nurses. Ultrasonography,

computed tomography, MRI, and echocardiography are required. Services of pediatric surgeon, pediatric medical subspecialists, pediatric anesthesiologists, and pediatric ophthalmologists are also required. The requirement of NICU beds is 1–1.5 cots per 1000 live births.

### Regional NICU (Level IIIB or IV)

Regional advanced care has been designated as level IIIB or level IV care and is the highest level of care. Level IV NICUs have capability to provide surgical repair of complex congenital or acquired conditions. Care is provided by neonatologists, pediatric surgical subspecialists, and pediatric anesthesiologists at the site. They facilitate transport and provide outreach education. Regional NICUs should also have the capabilities of Level I, II, and III care (Table 2.1).

**Table 2.1:** Levels of care, services and service providers

Level	Services	Providers
Level I	Provide neonatal resuscitation at every delivery. Evaluate and provide postnatal care to stable term newborn infants. Stabilize newborn infants who are ill and those born at <35 weeks gestation until transfer to a higher level of care	Pediatricians, family physicians, nurse practitioners, and other advanced practice registered nurses
Level II SCNU	Level I capabilities plus Provide care for infants born $\geq 32$ weeks gestation and weighing $\geq 1500$ g who have physiologic immaturity or who are moderately ill with problems that are expected to resolve rapidly and are not anticipated to need subspecialty services urgently. Provide care for infants convalescing after intensive care. Provide mechanical ventilation for brief duration (<24 h) or continuous positive airway pressure or both. Stabilize infants born before 32 weeks gestation and weighing less than 1500 g until transfer to a neonatal intensive care facility	Level I providers plus Pediatric specialist, neonatologist, and neonatal nurse practitioners
Level III NICU	Level II capabilities plus Provide sustained life support. Provide comprehensive care for infants born <32 weeks gestation and weighing <1500 g and infants born at all gestational ages and birth weights with critical illness. Provide prompt and readily available access to a full range of pediatric medical subspecialists, pediatric surgical specialists, pediatric anesthesiologists, and pediatric ophthalmologists. Provide a full range of respiratory support. Perform advanced imaging, with interpretation on an urgent basis, including computed tomography, MRI, and echocardiography	Level II providers plus Pediatric medical subspecialists, pediatric anesthesiologists, pediatric surgeons, and pediatric ophthalmologists
Level IIIB/IV Regional NICU	Level III capabilities plus Located within an institution with the capability to provide surgical repair of complex congenital or acquired conditions. Maintain a full range of pediatric medical subspecialists, pediatric surgical subspecialists, and pediatric anesthesiologists at the site. Facilitate transport and provide outreach education	Level III providers plus Pediatric surgical subspecialists

### COST OF NEONATAL CARE

Renovation at district hospital in India to create a level II unit costs the government Rs 40 lakhs. SCNU treatment costs the Government Rs 4581 per neonate treatment and Rs 818 per bed-day treatment. In the event of entire medical expenditure being borne by the health system, cost of SCNU treatment is Rs 4976 per neonate and Rs 889 per bed-day. These costs would be higher in private sector. Cost of running level III units could be 10 times more than level II units.

### Physical Facilities for Establishing Level III NICU

The unit should be close to delivery services and on the same floor and should be equipped with laminar air flow system. Air-conditioning with millipore filters and at least six air changes per hour are required, with a minimum of two changes being outside air. The temperature should be maintained at 22–26°C and humidity 30–60%. For patient care, 120–150 sq. feet is required for each baby (Table 2.2). There should be a gap of 6 feet between two beds and 8 feet aisle. Separate room is required for cleaning and storage of equipment, conference room, waiting hall for family, hand wash near the entrance, a side laboratory, mother's room, and a room for keeping the portable X-ray, echocardiography and ultrasound machines. One room each would be needed for doctors and nurses on duty. Minimum number of simultaneously accessible gas outlets is: Air 3, oxygen 3, and vacuum 3.

Each patient station should have 8–12 voltage-stabilized electrical outlets. The unit must have an uninterrupted clean water supply and each patient care area must also have a wash basin with elbow operated water taps. A hand washing sink should be 24 inches wide, 16 inches front to back and 10 inches deep from the bottom of the sink to the top of its rim (61 × 41 × 25 cm). Hand washing instructions should be provided above all sinks. The walls of the unit should be washable and white or slightly off-white for better appreciation of colour of the neonates. The light should provide shadow-free adjustable illumination varying from darkness to 100 foot candles at the baby's level. Spot illumination should be available for each baby for procedures. Uninterrupted power supply or generator backup is mandatory. The combination of continuous background sound and transient sound in any bed space or patient care area should not exceed an hourly Leq of 50 dB and an hourly L10 of 55 dB, both A-weighted slow response. The Lmax (transient sounds) should not exceed 70 dB, A-weighted slow response.

### Nurses

A nurse:Patient ratio of 1:1 maintained in each shift throughout day and night (total 4 per bed) is absolutely essential for level III care and 1 per bed (1 nurse for 4 neonates in each shift) for level II care. One nurse for 8 neonates in each shift is required for level I.

**Table 2.2:** Desirable facilities for neonatal care unit

Facilities	Level III NICU	Level II SCNU
Patient care floor area/bed	120–150 sq feet (each beds 8 ft apart)	50 sq feet
Floor area for other services	120–150 sq feet per bed	50 sq feet per bed
Nurses	4/bed	1/bed
Electric outlets	10/bed	4/bed
Electronic monitors	1/bed	1/5 beds
Illumination at baby's level	10 to 600 lux (1- to 60-ft candles)	10 to 600 lux (1- to 60-ft candles)
Noise	<45 dbA	<45 dbA
Bed requirement/1000 annual births	1	10

### Education Programs

There should be continuing medical education programs for physicians and nurses. A manual highlighting the various housekeeping activities, user's manual of all equipment, and management protocols of neonatal emergencies and feeding policy should be available in the unit.

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# Neonatal Transport and Transferral

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India contributes to 30% of global neonatal deaths. Well-organized neonatal transport system leads to reduction of neonatal mortality and ensures optimum utilization of neonatal services. However, optimal neonatal transferral poses multiple challenges including availability of adequate personnel, beds, neonatal care units, lack of prioritization under public health program and suitable guidelines. The goal of neonatal transport is to keep the baby stabilised till he receives care at the referral centre.

## NEONATAL TRANSFERRAL—NEEDS AND CHALLENGES

According to a UNICEF report on child survival (2018), the neonatal mortality rate in India is 25 per 1000 live births and accounts for more than two-thirds of the infant deaths.<sup>1</sup> The major causes of neonatal deaths are birth asphyxia, sepsis and problems related to low birth weight and malformations. Although *in utero* transfer is the safest mode of transfer, preterm delivery, perinatal illness and congenital malformations cannot always be anticipated. Hence, there is a continued need for transfer of high-risk babies and 40% of neonatal deaths occur within first 24 h of admission.<sup>2</sup>

According to the National Family Health Survey-4 data, 25% of deliveries in rural areas and 10% in urban areas still occur at home assisted by unskilled birth attendants.<sup>3</sup> With the development of special care newborn units (SCNU) at district hospitals, many sick neonates can be provided better care if they are transported in a stable condition. However, most sick neonates are transferred by their parents or paramedical personnel either in private vehicles or

poorly equipped ambulances. Dedicated neonatal transport service provided by the state is inadequate. Most neonates are transported without any pre-transport stabilization or care during transport. Any available vehicle is used, which often takes long hours and the referral centre is also not well recognized. There is an acute shortage of neonatal beds and majority of the sick neonate in need of urgent admission are dumped in facilities with inadequate infrastructure, or shunted from one health facility to another.<sup>4</sup>

## Organized Neonatal Transport

Neonates requiring intensive care should be transported in specially equipped ambulances with personnel trained to handle neonatal emergencies. Organized transport services provide the same level and quality of care as is available at the advanced care facility. It should ideally be equipped to provide mechanical ventilation, multiple infusion therapy and cardiorespiratory monitoring.

## Indications of Transferral

These depend on facilities available at the referring and referral hospital. Common indications for transfer to level III NICU include very low birth weight, prematurity gestational age <32 weeks, respiratory distress or apnea, requirement of assisted ventilation, hypoxic-ischemic encephalopathy, sepsis with signs of systemic infection, congenital malformations requiring surgery, heart failure, seizures, need of exchange transfusion and active bleeding from any site.

### Types of Neonatal Transferral

Neonatal transfers can be from home to hospital, intrahospital transport or from hospital to another referral hospital. Reverse transport is returning infants to local neonatal units following care at a referral hospital.

### Components of a Neonatal Transport System<sup>4</sup>

The key components of a neonatal transport system are human resource, ambulance and equipment. The care includes communication with family, consent and documentation. It needs to have a leader physician with specialty training in neonatology or equivalent expertise, and a manager who works closely with the medical director and controls day-to-day management, budget and maintenance of equipment. The manager may be a nurse or paramedic personnel. Most transport teams in western countries have a neonatal-trained nurse or paramedics. In India, accredited social health activist (ASHA), the community worker, is supposed to accompany during neonatal transferral.

The ambulance and equipment for transport should have consideration of weight, fixation, power and gas requirements. The ambulance should have secure fixation of the transport incubator to the cot rails, secure fixation of oxygen cylinders and monitoring equipment. Mounting of incubator should be quick and easy. European Committee for Standardization has produced standards for the securing of all persons, items and transport incubators in ambulances. The entire system should be able to withstand a 10 G force in 5 directions (forward, rearward, left, right and vertical). This 10 G represents the forces encountered when a vehicle travelling at moderate speed is involved in a collision resulting in rapid deceleration.

### Organization of Transport<sup>4</sup>

#### Pretransport Stabilization

Hypoglycemia, hypothermia, poor perfusion and oxygenation have been shown to be associated with high mortality in transported neonates.<sup>5,6</sup> TOPS, a simplified assessment of neonatal acute physiology, gives a good prediction of mortality in these neonates.<sup>6</sup> Prior stabilization and adequate care during transport results in decreased incidence of hypothermia,

hypoglycemia, hypoperfusion, acidosis and mortality.<sup>6</sup> Available models for stabilization, care during transport and outcome are: (1) STABLE: Sugar, temperature, artificial breathing, blood pressure, laboratory work, emotional support,<sup>7,8</sup> (2) SAFER: Sugar, arterial circulatory support, family support, environment, respiratory support,<sup>9</sup> (3) TOPS: Temperature, oxygenation (airway and breathing), perfusion, sugar.<sup>6</sup>

For pretransport stabilization, assess the baby, and depending on available facilities, check for temperature, airway, breathing, circulation and sugar. Correct hypothermia, if present before transport. Provide kangaroo mother care (KMC), warm clothing or keep under radiant warmer at stabilization unit or referring centre. Assess airway for presence of any secretions (suction if present) and position of neck (place shoulder roll). Assess for respiratory distress. If baby requires ventilation, use the self-inflating bag. A lower threshold for intubation should be kept to minimize any destabilization and need for intervention during transport. General indications where intubation is preferable before transport: Assess circulation by checking heart rate, capillary refill time (CRT), urine output, blood pressure (if feasible). Check the fluid the baby is getting and the patency of intravenous (IV) line. Assess the need for fluid bolus and inotrope requirement and adjust the infusion accordingly. Check blood glucose with a glucometer; if blood glucose is <40 mg/dl, give 2 mL/kg of 10% dextrose through intravenous line followed by continuous infusion and breastfeeding. Pre-referral treatment includes administration of antibiotics and surfactant.

#### Care during Transport<sup>4</sup>

**Temperature maintenance:** Use a transport incubator, if available. KMC by mother or attendant is a useful way to maintain temperature in resource limited conditions when transport incubators are not available. Other methods like adequately covering the baby, and using improvised containers (thermocool box, basket, polythene covering) may help in maintaining temperature.

**Airway and breathing:** Keep neck of the baby in slight extension (sniffing) position. If airway is unstable, it is better to intubate and transport. If intubation is not considered necessary/possible, continuous positive

airway pressure (CPAP) can be provided. Check oxygenation using pulse oximeter and observe for cyanosis.

**Circulation:** Assess perfusion by evaluating for warm peripheries, CRT of  $\leq 3$  seconds, tone and activity, and blood pressure (if possible). Stabilize perfusion before moving the baby to the ambulance. Syringe pumps are required to administer inotropes with accuracy.

A well-baby at risk of hypoglycemia may be breastfed.

**Communication:** Inform SCNU/NICU to arrange and keep the over-head radiant warmer on. Communicate with the family for need of transfer. The family should be informed about the clinical condition and details of the referral hospital. The referral hospital should be informed in advance.

## NEONATAL TRANSPORT IN INDIA

The Janani Shishu Suraksha Karyakram of the Government of India provides, for the pregnant women and newborns, free transport from home to health institutions and between facilities in case of referral and free drop back home after 48 hours of hospitalization.<sup>10</sup> Call centres have been set up at the district hospitals having special care newborn units. These coordinate with the drivers of the government ambulances to ferry neonates from home or primary health centre to the district hospital. A few states have implemented National Ambulance Service (NAS). Public-private partnership models are being evolved and Emergency Management and Research Unit (EMRI), a public-private partnership, is an example existing.<sup>2</sup> States have been given the flexibility to establish their own transport system. An example of local innovation is boat clinics in Assam.<sup>2</sup> The Ganapathy Venkata Krishna Reddy Emergency Management and Research Institute (GVK EMRI) is emergency service provider effort by Government of Tamil Nadu under public-private partnership model. It provides emergency response services and quality pre-hospital care to any sick person, pregnant mothers, and sick neonates and has deployed specialized neonatal ambulances to ensure safe transport of newborns.<sup>11</sup>

The Government of Madhya Pradesh, India, in 2006, launched the Janani Express Yojana (JEY), a decentralized, 24 × 7, free emergency transport service for all pregnant women under public-private partnership. In this partnership, the service is paid for by the state, while private operators are responsible for vehicle procurement, maintenance and upkeep. A total of 893 vehicles operate under the JEY in MP and transport nearly 60000 women from home to hospital for delivery every month.<sup>12</sup>

Since the introduction of the emergency medical services, institutional deliveries have increased in all states and union territories where the ambulances have been deployed and the majority of mothers have been provided the required emergency care at the appropriate time.

## CONCLUSION

The development of efficient transport systems is crucial to the optimal utilization of perinatal care. Appropriate personnel, equipment and vehicle customized for neonates should be available for safe transport. Pre-transport stabilization, communication with the family and, referral hospital are essential.

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