An **Exclusive Human Milk Diet**

is now possible in the NICU and beyond

**EHMD**

**PHBM STANDARD**
(Ready to feed)

As trophic feed, promotes initial gut priming

**PHBM 70 CAL**
(Ready to feed)

Lipid rich, promotes weight gain

**NEOLACT MMF**
(1 gm sachet in 25ml mother’s milk)

Protein rich fortifier, promotes linear “catch-up” growth

---

<table>
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<tr>
<th></th>
<th><strong>PHBM STANDARD</strong></th>
<th><strong>PHBM 70 CAL</strong></th>
<th><strong>Neolact MMF</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage Period</strong></td>
<td>24 to 48 hours</td>
<td>Day 2 - Day 4</td>
<td>Day 5 onwards</td>
</tr>
<tr>
<td><strong>Feed Volumes</strong></td>
<td>10-15 ml/kg/day</td>
<td>15-40 ml/kg/day</td>
<td>40 ml/kg/day onwards</td>
</tr>
<tr>
<td><strong>Benefit</strong></td>
<td>Gut-priming</td>
<td>Improved weight gain</td>
<td>Safer “catch-up” growth</td>
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Principles and Practices of Developmentally Supportive Care (DSC) in the NICU & Clinical Applications in Neonatal Medicine

Chief Scientific Editor
Dr Amitava Sengupta

Supplement - August 2019

Development and Supportive Care (DSC) Foundation for Newborn & Children (India)
B - 106, Chitranjan Park, New Delhi - 110 019, India
Email: dscnicupeds@gmail.com
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The field of Neonatology has experienced some remarkable progress over the last four decades in care of the newborn. This has reflected with dramatic reductions in both neonatal and infant mortality and has enabled the neonatal team to save more babies of lower gestational age and extremely low birth weight (ELBW). In the present times, the incidence of prematurity is high in both western and eastern worlds. However, morbidity rate of neurodevelopmental impairment has not decreased for this population.

The preterm infant experiences a hostile environment in the intensive care (NICU) setting as compared to the womb. This altered sensory experience can have a negative impact on an infant’s brain development.

The in-utero environment of a developing fetus is characterized by generalized extremity flexion and containment, limited light and noise exposure, sleep cycle preservation, and unrestricted access to mother via somatosensory, auditory, and chemosensory pathways. This environment is favorable for positive sensory input which is crucial for normal fetal brain development.

A newborn preterm infant is deprived of these basic developmental needs upon transition from the womb to the environment of the newborn intensive care unit. This environment is typically characterized by painful procedures, excessive light and noise exposure, interrupted and inadequate sleep, and separation from mother. Negative replaces positive sensory input into the developing fetal brain which, as research shows, can permanently alter normal brain development.

Developmentally Supportive Care (DSC) practices are evidence based interventions that promote newborn brain and neurobehavior development. They minimize the stress of NICU environment, support autonomic stability, normal motor, sensory neurological development and promote behavior state organization.

Developmental Care in the NICU involves efforts in unit design, equipment selection, policies, care protocols, and staff training to maintain the basic physical, sensory, and interpersonal needs of the preterm infant while minimizing exposure to noxious and painful stimuli.

A successful developmental care program is the product of a multidisciplinary team of parents, nurses, nurse practitioners, neonatologists, occupational/physical therapists, administrators, architects, engineers, and social workers.

It requires a shift of attitudes regarding ownership of an infant’s care and the personhood of the preterm patient. As neonatal care providers, our goal should be to improve functional outcome, have positive neuro developmental outcome and achieve the gold standard of “INTACT SURVIVAL” of the preterm, fragile and/or critically ill infants.

Dr Amitava Sengupta, Fellowship Neonatology (Neth), FNNF
Director: Mother & Child Unit, Neonatology & Pediatrics
Paras Hospitals, Gurgaon (NCR), India
Chairperson & Executive Director
Development and Supportive Care (DSC) Foundation for Newborn & Children (India)
Chairman Workshop Committee
37th Annual Convention of National Neonatology Forum (NEOCON 2017)
National Assessor, NICU Accreditation Program (NNF-UNICEF).
National Instructor, FBNC Program (NNF-UNICEF).
National Faculty, NNF-IAP Advanced NRP.
Email: amit19762000@yahoo.com
Development and Supportive Care (DSC) Foundation for Newborn and Children

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Chairperson & Executive Director

Amitava Sengupta, Fellowship Neonatology (Neth), FNNF
Director: Mother & Child Unit, Neonatology & Pediatrics
Paras Hospitals, Gurgaon (NCR), India
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National Assessor, NICU Accreditation Program (NNF-UNICEF).
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Win Tin, FRCPCH and Neonatal Fellow
Professor of Paediatrics, University of Durham
& Senior Consultant Paediatrician.
The James Cooke University Hospital
Middlesbrough, TS4 3BW
United Kingdom (UK)

Governing Body Trustee

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Governing Body Trustee
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Executive Members

Vikram Datta, MD, DNB, FNNF
Director Professor, Department of Neonatology,
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Amy Carroll, OTD, OTR/L
Assistant Professor, Post-professional Doctoral
Program in Occupational Therapy
Jefferson College of Health Professions
Thomas Jefferson University
Philadelphia, PA 19107, USA

Sushil Srivastava, MD, MBA (HCA)
Associate Professor
Division of Neonatology, Department of Pediatrics
University College of Medical Sciences
& G.T.B. Hospital
Dilshad Garden, Delhi, India

Ashok Kumar, MD, FIAP, FNNF, FAMS
Professor & Head, Department of Pediatrics
Institute of Medical Sciences
Banasar Hindu University (BHU), Varanasi
Commonwealth Fellow in Neonatology (UK)
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Suman Rao, MD, DM (Neonatology)
Professor & Head, Department of Neonatology
St John’s Medical College and Hospital
Bengaluru, India

Satish Ghanta, MD (Paed) Manipal
Neonatal fellowship (Sydney, Aus)
Bayley Scales Accredited Developmental Pediatrics (Sydney, Aus)
Pediatric & Cardiac Intensive Care Fellowship (Sydney, Aus)
Director, Neonatal & Pediatric Intensive Care Services
Little Stars Children’s Hospital, Hyderabad

Satish Ghanta, MD (Paed) Manipal
Neonatal fellowship (Sydney, Aus)
Bayley Scales Accredited Developmental Pediatrics (Sydney, Aus)
Pediatric & Cardiac Intensive Care Fellowship (Sydney, Aus)
Director, Neonatal & Pediatric Intensive Care Services
Little Stars Children’s Hospital, Hyderabad

S P Senthil Kumar, M.D. (PAED)
Fellowship Pediatric Critical Care
Consultant Pediatric Intensivist, Department of Neonatology & Pediatrics
Columbia Asia Hospital, Bangalore
National Faculty: NNF-IAP Advanced NRP 2010

S P Senthil Kumar, M.D. (PAED)
Fellowship Pediatric Critical Care
Consultant Pediatric Intensivist, Department of Neonatology & Pediatrics
Columbia Asia Hospital, Bangalore
National Faculty: NNF-IAP Advanced NRP 2010

Sudip Dutta, MD
Professor & HOD
Department of Pediatrics
Sikkim Manipal Institute of Medical Sciences
Gangtok, Sikkim, India

Sudip Dutta, MD
Professor & HOD
Department of Pediatrics
Sikkim Manipal Institute of Medical Sciences
Gangtok, Sikkim, India

Sanjay Wazir, MD, DM Neonatology
(PGI Chandigarh)
Director: Neonatology
Cloudnine Hospitals, Gurgaon (NCR), India
National Faculty: NNF-IAP Advanced NRP 2010

Sanjay Wazir, MD, DM Neonatology
(PGI Chandigarh)
Director: Neonatology
Cloudnine Hospitals, Gurgaon (NCR), India
National Faculty: NNF-IAP Advanced NRP 2010

Shalabh Garg, MD FRCPCH PGCIIR
Consultant Neonatologist
James Cook University Hospital
Middlesbrough, UK

Rakesh Tiwari, MD, MBA (HCA)
Consultant, Department of Neonatology & Pediatrics
DSC Team, Mother & Child Unit
Paras Hospitals, Gurgaon (NCR), India

Rakesh Tiwari, MD, MBA (HCA)
Consultant, Department of Neonatology & Pediatrics
DSC Team, Mother & Child Unit
Paras Hospitals, Gurgaon (NCR), India

Dr Sandeep S Patil, MBBS, MD (Pediatrics)
DM(Neonatology), Fellow PCCM(ISCCM)
Director CARE Advanced Neonatal Center
Nanded, Maharashtra

Dr Sandeep S Patil, MBBS, MD (Pediatrics)
DM(Neonatology), Fellow PCCM(ISCCM)
Director CARE Advanced Neonatal Center
Nanded, Maharashtra

Arnab Sengupta, BDS, MDS (Pedodontics)
BLS Certified from AHA (American Heart Association)
Director
KIDZ Dental Centre
Gurgaon (NCR), India
Advisor, Pediatric Dental Sciences
DSC Foundation (India)

Arnab Sengupta, BDS, MDS (Pedodontics)
BLS Certified from AHA (American Heart Association)
Director
KIDZ Dental Centre
Gurgaon (NCR), India
Advisor, Pediatric Dental Sciences
DSC Foundation (India)

Ajay Lal, Fellowship Neonatology (NNF, India), DCH
Medical Director
Lal Superspeciality Hospital
“Institute of Newborn Sciences” Gurugram (NCR)
India

Ajay Lal, Fellowship Neonatology (NNF, India), DCH
Medical Director
Lal Superspeciality Hospital
“Institute of Newborn Sciences” Gurugram (NCR)
India

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Background

Significant technologic advances over the past three to four decades in Antenatal and Neonatal intensive care have resulted in increased survival of Extremely Low Birth Weight (ELBW) micro preemies in tertiary level NICUs across the Globe. Infants born as early as 24 weeks gestation now have a fair chance of survival.

Medical Advances

<table>
<thead>
<tr>
<th>Survival of Extremely Low Birth weight Premies</th>
<th>Understanding of Pulmonary Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>Respiratory Support devices</td>
</tr>
<tr>
<td>Cellular Biology</td>
<td>Micro methods for Parameters in</td>
</tr>
<tr>
<td>Pharmacologic agents</td>
<td>Neonaotes</td>
</tr>
<tr>
<td>Antenatal Steroids</td>
<td>Genetics</td>
</tr>
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<td>Surfactant</td>
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</table>

However, this progress comes with great physical, emotional, and financial costs because premature infants spend many weeks and months in the neonatal intensive care unit (NICU). Because development continues outside the protective environment of the womb for the prematurely born fetus, many have impaired short- and long-term outcomes.1, 2

Preterm birth interrupts the precise process of fetal maturation in utero, hence forcing critical neurologic growth to continue within the Neonatal Intensive Care Unit (NICU). There is increasing concern for the impact of the NICU experience on the developing brain. The typical NICU provides a very different environment for the continued maturation of the preterm infant’s CNS.

INTRAUTERINE ENVIRONMENT (MATERNAL WOMB) is favorable for POSITIVE SENSORY INPUTS which are crucial for normal brain development in a growing fetus. It protects the developing fetus against harsh outside stimulation and provides a variety of sensory stimuli in an integrated Multimodal fashion1. These include: (1) Tactile and Vestibular, (2) Chemical and Hormonal (3) Auditory and Visual systems.

The Intrauterine milieu is characterized by:

1. **UTERINE WALL** which provides secure boundaries for generalized flexion and gentle, secure containment for the developing fetus.
2. **VESTIBULAR** and TACTILE stimuli -
   - Maternal and fetal parts movements
   - Contact of body parts with warm amniotic fluid, and walls of the uterus.
3. **HORMONAL** cycles of the mother provide rhythmic and cyclical stimulation.
4. **NUTRITIONAL** needs of the fetus → met via placenta.
5. **AUDITORY** stimuli (Inputs)
   - Maternal voice and Heart sounds
   - Maternal bowel sounds
   - Bloodflowthroughtheplacentaaandumbilicalcord, Filtered sounds from extraterine environment, transmitted through liquid and solid media.

NICU Environment

In contrast, this exposes the micropreemie to an array of painful procedures with separation from mother and disturbance in sleep cycles.

FLUCTUATIONS IN STIMULI include:
- Temperature and Tactile (Touch)
• Vestibular
• Olfaction (Smell) and Gustatory (Taste)
• Auditory (Sound) and Visual (Light)

There are also FLUCTUATIONS in Oxygenation and Nutrients and the infant experiences scenarios which are very different from those experienced in Utero.

**Negative Sensory Inputs replace the Positive Sensory Inputs into the developing brain, which can permanently alter normal brain development.**

**Preterm Birth**

In the present times, the incidence of prematurity is high in both western and eastern worlds and it is worthwhile to be acquainted with some facts and figures regarding preterm birth.

Preterm is defined as babies born alive before 37 weeks of pregnancy are completed. There are subcategories of preterm birth, based on gestational age:

<table>
<thead>
<tr>
<th>26 to 28 weeks Gestational Age - Extension</th>
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</thead>
<tbody>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
</tr>
<tr>
<td>Gravitational pull on body further enhances the posture of Extension</td>
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<table>
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<tr>
<th>34 to 36 Weeks Gestational Age - Flexion</th>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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</table>

- a. Extremely preterm (<28 weeks)
- b. Very preterm (28 to <32 weeks)
- c. Moderate preterm (32 to 34 weeks).
- d. Late-preterm infants (34 \( \frac{1}{7} \) to 36 \( \frac{6}{7} \) weeks)

**Categorization of birth weights**

- a. Low birth weight (LBW) <2500 grams
- b. Very Low birth weight (VLBW) <1500 grams
- c. Extremely Low birth weight (ELBW) <1000 grams
- d. Incredibly Low birth weight (ILBW) <800 grams

Infants born prematurely miss an important intrauterine motor milestone which is Development of flexor tone. This critical component of muscle development occurs throughout the third trimester of pregnancy.

Hence, preemies born at 26 to 28 weeks Gestational Age are in a posture of Extension with Hypotonia.
Preterm Birth & Neuroplasticity

“In 3rd trimester of fetal development and even in early infancy the brain is drastically changing with new brain cell production and migration, synaptic pruning and brain organization”.

Third trimester of pregnancy is a most crucial period, during which the basic Foundation for the Neuromotor and Neurobehavioral systems is being laid in the growing fetus.


Over 60% of preterm births occur in sub-Saharan Africa and south Asia, but preterm birth is truly a global problem. Countries with the highest numbers include India, China, Nigeria, United States of America, Brazil, and many others.

An estimated 15 million babies are born preterm every year. That is more than one in 10 babies. Around one million children die each year due to complications of preterm birth. Many survivors face a lifetime of disability, including learning disabilities and visual and hearing problems. In almost all countries with reliable data, preterm birth rates are increasing.

India has the maximum number of preterm births with 3,519,100 of them, almost 24% of the total number. Comparative figures are China: 1,172, 300, Nigeria: 773, 600,

United States of America: 517, 400.

With the strong evidence of increase in incidence of preterm births, there is also increased survival rate of preterm infants as a result of huge medical advances. However, inspite of the rapid progress in clinical applications of neonatal medicine, the morbidity rate of Neurodevelopmental Impairment has not decreased for this population. Pulmonary morbidity and neurodevelopmental outcome still remain two major issues of concern for these infants.

Our goal should be to improve functional outcome, have positive neuro developmental outcome and achieve the gold standard of “INTACT SURVIVAL” of the preterm, fragile and/or critically ill infants.

This would facilitate increasing the number of “High risk” NICU graduates who would grow and mature into healthy, robust children without any Neurodevelopmental compromise.

These children would then as adults lead fruitful and productive lives and contribute to building of the nation.

To reduce developmental dysfunctions in preterm infants, neonatal care giving needs to be modified to support infants’ brain, social, and emotional development during hospitalization.

Developmentally Supportive Care for High Risk Infants

<table>
<thead>
<tr>
<th>Whole Baby</th>
<th>Whole Environment</th>
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Approach to Intervention in the NICU

NICU Environment

For preemie infants born early, we should aim to mimic the “In-Utero” environment as far as achievable in the infant care area and NICU setting.

The Neonatal Intensive Care Unit (NICU) environment is dominated by complex life support systems and interventions. In the midst of such ever increasing high level technologies, “Developmental assessment and Care” of the critically ill newborn is often relegated to being a “Follow-Up” issue. The preterm infant experiences a hostile environment in the intensive care setting as compared to the womb.
Developmental care for high-risk infants has been a recognized practice strategy in neonatal intensive care units. Developmental care has been linked to a variety of favorable clinical outcomes. It is a professional practice, education and research opportunity that neonatal caregivers should explore, evaluate and refine continuously within the rapidly changing technological environment of the NICU.

**Definitions**

**Traditional Care:** This involves a medical model which is task oriented; without regard to individual’s need. Care giving is homogenous and families are regarded as visitors.

**What is Developmentally Supportive Care (DSC)?**

Developmentally Supportive Care (DSC) practices are evidence based interventions that promote newborn brain and neurobehavior development. They support autonomic stability, normal motor, sensory neurological development and promote behavior state organization.

DSC practices are designed to minimize the stress of the NICU environment and include elements such as control of external stimuli (auditory, visual, tactile, vestibular), clustering of nursing care activities to avoid disrupting sleep, positioning or swaddling of the preterm infant and calming techniques.

The aim is to provide a structured care environment which supports, encourages and guides the developmental organization of the premature and/or critically ill infant.

**Benefits of DSC**

When in the NICU neonates are under severe and often life threatening stress. They have immature and or fragile autonomic and nervous systems. DSC can give them more reserve to heal, minimize effects of trauma, and promote normal development of nervous system.

It also decreases length of hospital stay, improves weight gain and shortens the time to full enteral feeding. The neuro-developmental scores at 9-12 months age were seen to be improved.

**Who provides DSC? NICU Team**

<table>
<thead>
<tr>
<th>Doctors</th>
<th>Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Baby</td>
</tr>
<tr>
<td>Support Staff</td>
<td>Lactation Counselor</td>
</tr>
<tr>
<td>Therapists</td>
<td></td>
</tr>
</tbody>
</table>

*Teams vary across settings and may include developmental psychologists, nurture specialists and others*

**Neuroprotective Care**

Neuroprotection encompasses all strategies that support the developing brain, facilitating normal development and reducing disability. In the event of neuronal injury, these interventions are intended to help the brain limit neuronal cell death and permit healing by creating functional synaptic connections and pathways (Bader, 2014; McGrath et al., 2011).

The newborn brain can make both temporary and permanent changes to its synaptic neuronal connections, which are based upon sensory input from different environmental stimuli and experiences. This adaptive capacity is known as neuroplasticity, and can either be positive or negative.

It is mandatory that every effort be made to minimize negative experiences for the preterm infant. Parents and professional caregivers can work together to minimize the adverse impact of the NICU experience, hopefully reducing subsequent impairment and disability (Altimier & Phillips, 2013).

**Evolution of DSC Models**

1. **COUGHLIN ET AL, 2009 - PROPOSED FIVE DEVELOPMENTAL CARE CORE MEASURES.**

**Focus on Care Actions**

Core measures for developmental care are focused on neonatal caregiver actions which are disease independent but nonetheless essential to promote healthy growth and development of the infant and
family. The proposed five core measures represent the first step in operationalizing evidence-based developmental care.

The core measures are as given below:
1. Protected sleep
2. Pain and stress assessment and management
3. Activities of daily living (positioning, feeding and skin care),
4. Family-centred care
5. The healing environment.

Each core measure set represents an organized group of caring activities that relate to the holistic needs of the infant-family dyad with context to the hospital experience. Presenting care strategies in this format creates an opportunity for neonatal care providers, to take the focus off the care ‘task’ and placing it on the care ‘experience’.


2. THE NEONATAL INTEGRATIVE DEVELOPMENTAL CARE MODEL

Seven Neuroprotective Core Measures For Family-Centered Developmental Care

There is ample evidence that family-centered developmental care in the NICU results in improved neonatal and neurodevelopmental outcomes, increased family satisfaction and even enhanced employee satisfaction once the culture change has been accomplished.10-13

The Neonatal Integrative Developmental Care Model utilizes neuroprotective interventions as strategies to support optimal synaptic neural connections, promote normal development and prevent disabilities.

The Neonatal Integrative Developmental Care Model (Leslie Altimier Raylene M. Phillips, 2013)

This provides more practical guidance for NICU staff in delivering developmental care to preterm infants in the NICU. The five neonatal core measures first introduced by Coughlin et al in year 2009 have been reclassified and expanded into Seven distinct core measures of Neuroprotective neonatal care.

Seven neuroprotective core measures for family-centered developmental care of the premature neonate are depicted on petals of a lotus (Leslie Altimier Raylene M. Phillips, 2013, Newborn & Infant Nursing Reviews 13 (2013) 9–22)

1. The Healing Environment
2. Partnering with Families
3. Positioning & Handling
4. Safeguarding Sleep
5. Minimizing Stress & Pain
6. Protecting Skin
7. Optimizing Nutrition and Feeding.
Neuroprotection in the NICU

Seven Neuroprotective Core Measures
Depicted on petals of a LOTUS

The Overlapping Petals of the Model
Demonstrate the Integrative Nature of Developmental Care

The Neonatal Integrative Developmental Care Model (IDC) (Philips Healthcare Andover, MA. USA).
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References
Chapter 2: Sensory Systems

Amitava Sengupta
Fellowship Neonatology (Neth), FNNF

It is essential to understand the basics of neurosensory development of the neonate, paying particular attention to the stage of development that occurs in the third trimester of gestation. During this period of time, the brain of the preterm infant is developing in the NICU, in an environment which is entirely different from the protective environment of the womb.

The neurologic and sensory systems do not exist as separate entities, but are interdependent and comprise the neurobehavioral and neurosensory development of the infant.

SENSE is a physiological capacity of organisms that provide data for PERCEPTION.

The 5 main senses are as given below
1. Touch: Tactile
2. Smell: Olfactory
3. Taste: Gustatory
4. Hearing: Auditory
5. Sight: Visual

Prenatal Sensory Development

A sequential order of development and maturation is present in the fetus and infant.

Given below is an overview of each sensory system, listed in the order of maturation to a full functional capacity.

The last column in the table provides clinical observations and applications/implications related to the sensory development of preterm infants.

It is to be clearly understood that the final weeks of development in a micro preemie usually take place in an unnatural environment of the Neonatal Intensive Care Unit (NICU) as compared to that of the intrauterine environment.

*One must keep in mind to be extremely cautious regarding stimulating any specific Sensory System, out of turn from the natural sequence of maturation of all Sensory Systems.

*This would have a most negative and harmful effect on the growing preemie

<table>
<thead>
<tr>
<th>Sensory System</th>
<th>Description &amp; Salient Feature</th>
<th>Maturation</th>
<th>Clinical Observations Implications &amp; Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactile</td>
<td>• System of touch and reflexes</td>
<td>• Early fetal movement detected by ultrasound as early as 7 weeks</td>
<td>• At any viable gestational age, infant perceives pressure, pain and temperature.</td>
</tr>
<tr>
<td></td>
<td>• System for protection and discrimination</td>
<td>• Perioral area sensitive to stimulation by 7.5 weeks</td>
<td>• Entire system is extremely sensitive and easily over-stimulated</td>
</tr>
<tr>
<td></td>
<td>• Communicates sensory input from periphery to cortex</td>
<td>• Sensory nerve endings in place and functioning by 11 weeks</td>
<td>• Perioral area is very refined by 24 weeks</td>
</tr>
<tr>
<td></td>
<td>• Communicates both pleasant and painful stimuli</td>
<td>• Primitive tactile reflexes are elicitable by 26 weeks; rooting is present</td>
<td></td>
</tr>
</tbody>
</table>
### Sensory Systems

<table>
<thead>
<tr>
<th>Vestibular</th>
<th>Olfactory</th>
<th>Gustatory</th>
<th>Auditory</th>
</tr>
</thead>
</table>
| - System of balance and motion  
  - Function → Provide input from inner ear to vestibular center in brainstem  
  - Maintenance of equilibrium  | - System of smell  
  - Purpose → Recognition & discovery  
  - One of the most well-developed senses in newborn  
  - Assists in gastro-intestinal functions  
  - Elicits adaptive behaviors (breast feeding, rooting) →  
  - Warns of potential dangers  | - System of taste  
  - Function → To transmit impulses to taste center in cerebral cortex  
  - Facilitates developmental skills (hand-to-mouth, readiness for oral feeding, midline play)  
  - Encourages exploration  | - System of hearing  
  - Consists of external, middle, inner ear and auditory center in cortex  
  - Important for attention and learning  
  - Basis of foundation for development of spoken language  |
| - Primitive semicircular canal → Day 44  
  - Sensor innervation completed → Week 14  
  - Myelination completed → Week 16  
  - System is functional by → Week 21  | - Nasal pits present → Week 5  
  - Nasal structure and components in place → Week 8  | - Mouth begins to form tongue bud → Week 4  
  - Mouth and tongue development completed → Week 8  
  - Taste buds emerging → Week 20  
  - Withdrawal response to bitter taste → Weeks 26-28  
  - Differentiation between glucose and water with calming → Week 35  
  - Differentiate between sweet, sour, bitter; between breast milk and formula → Newborn (Day 3 to 6)  | - First anatomical division of inner ear → Week 4  
  - System is structurally complete and functional → Week 24  |
| - Behaviors resulting from over-stimulation include pulling away from stimulus, squirming, crying, inability to settle/get comfortable, feeding aversions  
  - Tactile defensiveness can be an over active protective response  | - Sense of smell and taste are closely linked  
  - Approach/withdrawal reactions present to olfactory stimuli  
  - Recognition of mother through smell  
  - Over-stimulation of system can lead to disinterest in feeding  
  - Hypoxia can affect smell, which affects feeding interest  | - Fetus sucks/swallows average of 1 liter amniotic fluid daily in utero; This provides practice in feeding and helps maturation of suck-swallow reflex and self-regulation  
  - Preterm babies miss this chance of practice and acclimatization to feeding practices  
  - They are confused because conditions outside the womb add new variables  
  - Infants have a high level of discriminatory taste. It is very easy to over stimulate this system  
  - Impacts infant ability in areas such as coordination of suck/swallow/breathe patterns and later feeding  | - Auditory system is very sensitive  
  - Observed behaviors in response to increased auditory levels in NICU:  
  - Changes in color, heart rate and respiration rate  
  - Desaturation in oxygen levels  
  - Inability to sleep  
  - Increased motor activity  
  - Wait to introduce musical toys/tape recorders until after discharge (or greater than 39-40 weeks gestational age)  |
### Reference
Table for development and maturation of sensory systems taken and adapted from:

The NICU Experience: Its Impact and Implications; Virginia Early Intervention Conference; Roanoke, VA; March 7-8, 2005. Presenter: Barbara Purvis, M.Ed., NTAC Technical Assistance Specialist;

NTAC (National Technical Assistance Consortium for Children and Young Adults with Deafblindness) is supported by the U.S. Department of Education, Office of Special Education Programs (OSEP).

### Senses other than 5 Main Senses
1. **Thermoception** - Temperature
2. **Proprioception & Kinesthetic source** *(sense of position + balance & movement of parts of one’s own body)*
3. **Nociception** - Pain
4. **Equilhibreoception** - Balance
5. **Mechanoreception** - Vibration

### Chemosensory Systems
These are highly specialized sensory systems of which taste, smell and the vomeronasal system are prototypical examples.

The systems detect a variety of soluble and volatile stimulants with a range of biological effects on feeding, reproduction, social interactions, mood, territoriality and other aspects.

**SOMATESTHESIA** is the sensation or consciousness of having a body.

**KINESTHESIA** is the perception and recognition of Movement of Body and Body parts.

**PROPRIOCEPTION** is the sense of Position & Balance.

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<table>
<thead>
<tr>
<th>SENSES</th>
<th>DEVELOPMENT</th>
<th>MATURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VISUAL</strong></td>
<td>System of sight</td>
<td>Provides input for processing information to the brain</td>
</tr>
<tr>
<td></td>
<td>Most complex system—one of earliest to begin development, but takes longest to reach full maturation.</td>
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</tr>
<tr>
<td></td>
<td>Complements the vestibular system by correlating visual reference with equilibrium</td>
<td>Strong connection between visual and tactile system</td>
</tr>
<tr>
<td></td>
<td>Development continues from 40 weeks gestation to 3-4 months postnatally to increase differentiation skills</td>
<td></td>
</tr>
<tr>
<td><strong>VISUAL</strong></td>
<td>Eye formation begins → Day 22</td>
<td>Retinal differentiation → 2nd month</td>
</tr>
<tr>
<td></td>
<td>Optic nerve → 6-8 Weeks</td>
<td>Precursors of rods and cones → 3rd month</td>
</tr>
<tr>
<td></td>
<td>All retinal layers present → 22 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>VISUAL</strong></td>
<td>Immature rods and cones → 23 weeks</td>
<td>Myelination of optic nerve begins → 24 weeks</td>
</tr>
<tr>
<td></td>
<td>All neurons of visual cortex present → 25-26 weeks</td>
<td>Eyes open → 7th month</td>
</tr>
<tr>
<td></td>
<td>General rapid ocular growth → 28-40 weeks</td>
<td>Iris sphincter develops → 34.3 Weeks (8th month)</td>
</tr>
<tr>
<td></td>
<td>Awake visual alertness → 36 weeks</td>
<td>Retinal vessels reach the periphery → 38.5 weeks (9th month)</td>
</tr>
<tr>
<td><strong>VISUAL</strong></td>
<td>Prior to 8th month, there is no way for preterm infant to control the amount of light into the retinal field</td>
<td>Behaviors observed in response to increased visual stimulation in NICU:</td>
</tr>
<tr>
<td></td>
<td>Behaviors observed in response to increased visual stimulation in NICU:</td>
<td>squinting,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>shading face with hands,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>turning away</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The visual cortex is one of the last to be myelinated,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher levels of perception occur later (visual spatial relationship, visual motor coordination, visual memory, figure ground)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long term developmental outcomes indicate visual perceptual deficits</td>
</tr>
<tr>
<td><strong>VISUAL</strong></td>
<td>Optimal time for delivery of Full term infants is at 38 to 39 weeks GA</td>
<td>3. Nociception - Pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Equilhibreoception - Balance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Mechanoreception - Vibration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Somatesthesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Kinesthetian</td>
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</tbody>
</table>
Chapter 3: Octopus Therapy for Preemies in NICU
Amitava Sengupta
Fellowship Neonatology (Neth), FNNF

This most innovative Idea originated at Aarhaus University Hospital in Denmark. The initiative appeared in Denmark in 2003 in the context of The Danish OCTO Project.

In Denmark, there’s an actual community—known as spruttegruppen—that’s dedicated to crocheting octopuses for hospitals.

(Reference- The Octo Project, Spruttegruppen. Denmark, Available at https://www.spruttegruppen.dk/danish-octo-project-english/, (2013)

This form of therapy is also popular in Finland and other parts of Scandinavia and St. Petersburg State Pediatric Medical University, Russia. It is catching up in other parts of Europe too.

Octopus Therapy Makes Preemies Feel Safe and Helps Them Thrive
This special form of therapy also involves the mother (Partnering with Family) and helps the infant in maintaining a “Well organized State” with good “Self-regulation” and Sleep cycles.

Before Initiating therapy the Octopus is put through Kangaroo Mother Care (KMC) with the mother of the Preemie for about 10 to 12 hours. Maternal body odour is transferred on to the octopus during this process.

After completion of the KMC session, the octopus is placed next to the infant in an optimal position as desired.

When the Infant is lying next to the octopus, there is stimulation of the Chemosensory system as the infant recognizes the familiar maternal smell. The constant stimulation of the Chemosensory system also helps in enhancing it’s maturation.

The mother may provide KMC to the octopus separately or along with the infant. Octopus KMC sessions should total to an optimal period of approximately 4 to 6 hours in a day.

KMC for the octopus by mothers of our Preemie babies is a regular practice in the NICU of Paras Hospitals.

Paras NICU

Soft, curled Tentacles of the octopus mimic the umbilical cord and remind the babies of their time in utero and evoke the comfort and safety of the womb.

Gripping the Tentacles is a similar experience as with the umbilical cord in utero along with CHEMOSENSORY Stimulation. Squeezing of the tentacles of Octopus creates a sense of safety and
comfort, which translates into improved breathing, increased regular heartbeats and increased levels of oxygen in their blood.

According to the project supporters another benefit is to prevent preterm babies from attempting to pull out their monitors and tubes.

**OCTOPUS THERAPY** helps the infant in being in a “Well organized State” with good Self-regulation and Sleep states.
Octopus Therapy for Preemies in NICU

<table>
<thead>
<tr>
<th>Octopus Therapy in PARAS NICU</th>
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<tbody>
<tr>
<td><img src="image1.jpg" alt="Image 1" /></td>
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<tr>
<td><img src="image3.jpg" alt="Image 3" /></td>
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</tbody>
</table>

Octopus Therapy in NICU

Lal Superspecialty Hospital (Institute of Newborn Sciences)

NICU - St. Petersburg State Pediatric Medical University, Russia
Chapter 4: Use of Human-Based Human Milk Fortifier in Very Low Birth Weight Infants manifesting with Intolerance to Bovine-Based Human Milk Fortifier

Amitava Sengupta
Fellowship Neonatology (Neth), FNNF

Human milk is the ideal source of nutrition for infants. Human milk alone is not sufficient to fulfill the complex nutritional requirements of very low birth weight and preterm infants.\(^1\,^2\) As compared to formula fed infants, exclusive human milk diet has been shown to reduce rates of necrotizing enterocolitis (NEC) in preterm infants.\(^3\)

However, preterm infants require fortification of human milk to achieve optimal growth and developmental outcomes, which until recently has been exclusively produced from bovine sources. Fortification of human milk with a bovine-based human milk fortifier (BHMF) may lead to variable degrees of gastrointestinal (GI) symptoms that, owing to similarity with early stages of NEC, may prompt the clinician to withhold enteral feeds or milk fortification.\(^4\) Withholding either milk fortification or enteral feeds results in suboptimal nutrition for the infant or extends the duration of parenteral supplementation.

Intolerance is defined by GI signs and symptoms which include significant abdominal distension, increased residuals, emesis and passage of fresh bloody stools occurring after addition of BHMF. Withdrawal of BHMF leads to improvement in symptoms and upon re-challenge with BHMF similar symptoms recur, necessitating cessation. After two failures a diagnosis of intolerance to Bovine human milk fortifier (BHMF) is considered.\(^5\)

Since 2012, a human milk-based human milk fortifier (HMHMF) became available after it was approved by Health Canada.

This product offers the opportunity to provide fortification and deliver an exclusive human milk diet for a maximal duration of an infant’s neonatal intensive care unit (NICU) stay. The use of HMHMF was initially introduced as a rescue treatment for those with failure to tolerate traditional BHMF. Studies were carried out to describe the efficacy of HMHMF as rescue therapy for infants in the NICU setting with manifestations of intolerance to Bovine human milk fortifier (BHMF).

A human milk-based human milk fortifier (HMHMF) has become available in India very recently from the beginning of year 2019.

One sachet (1 gram) of the product is to be mixed in 25ml of Expressed Breast Milk (EBM) or Pasteurized Human Donor Milk (PHDM). Fortification of human milk with this preparation may be started on reaching a feed volume of 40 to 50 ml/kg/24 hours.

In comparison, fortification with (BHMF) is initiated on reaching an optimal feed volume of 80 to 100 ml/kg/24 hours.

An Exclusive Human Milk Diet has Short Term and Long Term Benefits

**Short term** advantages include Risk reduction of NEC, Improved outcomes in sepsis, BPD, ROP, PDA and IVH, Lower antibiotic usage, Healthier gut microbiome and Improved feed tolerance with reduction of number of days to achieve full feeds.

**Long term** benefits include Enhanced immunological profile, Improved neurocognitive development, Reduced risk of developing antibiotic resistance, Reduced risk of allergies, asthma, obesity and diabetes. Micro preemies essentially thrive with access to an Exclusive Human Milk Diet

References

5. Amanjot Sandhu, Sharla Fast, et al Human-Based Human Milk Fortifier as Rescue Therapy in Very Low Birth Weight Infants Demonstrating Intolerance to Bovine-Based Human Milk Fortifier; BREASTFEEDING MEDICINE Volume 12, Number 9, 2017
Appendix A: Seven Neuroprotective core measures

Advanced clinical applications of Neuroprotective interventions related to the seven core measures of Neuroprotective family-centered developmental care.

Core Measure 1: Healing environment

**Standard:** A policy/procedure/guideline on the healing environment including physical space and privacy as well as the protection of the infant’s sensory system exists and is followed throughout the infant’s stay.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
</table>
| Stability of the infant’s autonomic, sensory, motoric, and state regulation systems | An environment will be maintained that promotes healing by minimizing the impact of the artificial extrauterine NICU environment on the developing infant’s brain | **General**  
  • Educate, coach, and mentor parents on the importance of creating a healing environment that protects the developing sensory system of the preterm infant. Emphasize the central role of parents in the healing environment. |
|                         |       | **Skin-to-skin contact**  
  • Facilitate early, frequent, and prolonged skin-to-skin contact (SSC)  
  • Encourage an intense connect between mother/ parents with their infants and avoid separation. between them  
  • Provide comfortable and safe reclining chair or adult bed for early, frequent, and prolonged SSC | |
|                         |       | **Tactile**  
  • Provide a neutral thermal environment for the infant incorporating the following factors:  
  • Facilitate early, frequent, and prolonged skin-to-skin contact.  
  • If ELBW, provide humidity during the first one - two weeks after birth  
  • Provide care in incubator or SSC until infant can maintain own temperature | |
|                         |       | **Vestibular**  
  • Change infant’s position gently and slowly without sudden movements  
  • Eliminate moving infants to different bed-spaces to accommodate staffing patterns | |
|                         |       | **Olfactory**  
  • Maintain a scent-free & fragrance-free unit  
  • Minimize exposure to noxious odors  
  • Expose infant to mother’s scent when possible via breast pad, or soft cloth. | |
|                         |       | **Gustatory**  
  • Position infant with hands near face / hands to face.  
  • Provide colostrum or expressed breast milk (EBM) oral care per protocol  
  • Provide positive oral feeding experiences | |
|                         |       | **Auditory**  
  • Support infants with consistently calm, relaxing environment with muted sounds during caregiving interactions Vigilance on sound levels of voices of Neonatal caregivers and those coming from equipment  
  • Monitor sounds levels to maintain average sound levels of 45 to 55 dB in infant care area.  
  • Silence alarms as quickly as possible and avoid unnecessary alarms. Use visual alarm systems when possible.  
  • Expose infant to audible maternal/paternal voice | |
**Visual**

- Provide adjustable light levels up to a maximum of 600 Lux.
- Gently shield infant’s eyes during cares if overhead light is needed
- Structure an infant’s visual field to support alert wakefulness as appropriate, transition to sleep, or quiet, restful sleep
- Minimize purposeful visual stimulation until 37 weeks gestation

**Overall healing environment**

- Consider all sources of light, sound, movement, smell and taste confronting an infant during care, and eliminate all inappropriate or unnecessary sources of stimulation
- Create and implement an individualized developmental care plan for each infant
- Provide guidance to parents on how to create and sustain a healing environment with respect to sensory exposures and experiences
- When renovating the NICU environment, advocate for optimal family support spaces and resources

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**Core Measure 2: Partnering with families**

**Standard 1:** A policy/procedure/guideline on partnering with families to include unlimited access to ensure around-the-clock information and access to their baby exists and is followed throughout the NICU.

**Standard 2:** NICU staff are competent in educating, coaching and mentoring parents in infant caregiving skills and in providing psychosocial support to NICU families.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant’s response to parental interactions</td>
<td>• Family-centered care is supported from birth or as soon as a NICU stay is anticipated (antenatally if possible)</td>
<td>• Facilitate early, frequent, and prolonged skin-to-skin contact</td>
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<tr>
<td></td>
<td>• Parents will NOT be viewed as “visitors” but as equal &amp; vital members of the caregiving team with minimal separation.</td>
<td>• Encourage minimal-separation between parents and infant</td>
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<tr>
<td></td>
<td>• Parents will be supported &amp; encouraged as the primary and most important caregivers for their infant.</td>
<td>• Educate, coach, and mentor parents in becoming active participants in their baby’s care in supporting their infant’s developmental goals</td>
</tr>
<tr>
<td></td>
<td>• Infant will develop emotional connection &amp; secure attachment with parents</td>
<td>• Support families with a warm, respectful, and welcoming manner</td>
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<td></td>
<td>• Actively listen to families’ feelings and concerns (both verbal and non-verbal)</td>
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<td>• Incorporate parents as full participants in parenting their baby in the NICU</td>
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<td>• Share information with families in a tone of voice that preserves confidentiality</td>
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<td></td>
<td>• Provide parents with access and input to medical records</td>
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<td></td>
<td>• Accommodate the presence of families in the NICU and seek ways to endure their comfort</td>
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<tr>
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<td>• Communicate the infant’s medical, nursing, and developmental needs in a culturally appropriate and understandable way, avoiding acronyms and medical jargon</td>
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<tr>
<td></td>
<td></td>
<td>• Support breast milk expression and breastfeeding</td>
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<td>• Provide social networking opportunities for parents of infants in the NICU</td>
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<td>• Provide peer-to-peer support with parents who have gone through similar NICU experiences and help in creating support groups</td>
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<td></td>
<td>• Encourage and empower parents as they develop confidence in their own abilities to continue caring for their baby when going home</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provide psychosocial support for all members of the family, including grandparents and the baby’s siblings</td>
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<tr>
<td></td>
<td></td>
<td>• Provide staff education related to principles of family-centered care and how to support parents’ caregiving roles</td>
</tr>
</tbody>
</table>
### Core Measure 3: Positioning & handling

**Standard:** A policy/procedure/guideline on positioning & handling exists and is followed throughout the infant’s stay that includes educating, coaching and mentoring parents on how to position and handle their infant.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Autonomic stability during handling</td>
<td>• Autonomic stability will be maintained throughout positioning changes and handling activities as well as during periods of rest and sleep</td>
<td>• Facilitate early, frequent, and prolonged skin-to-skin contact</td>
</tr>
<tr>
<td>• Ability to maintain tone and flexed postures with and without supports</td>
<td>• Parents will be educated, coached, and mentored in how to position and handle their infant</td>
<td>• Educate, coach, and mentor parents in how to position, contain and handle their infant in a developmentally appropriate manner.</td>
</tr>
<tr>
<td>• Preventable positional deformities will be eliminated or minimized by maintaining infants in a midline, flexed, contained, and comfortable position throughout their NICU stay</td>
<td></td>
<td>• Provide infants with positioning supports needed to maintain optimal tone and position and to remain either in a quiet restful sleep or a relaxed, comfortable wakefulness.</td>
</tr>
</tbody>
</table>

- Utilize a validated & reliable positioning assessment tool [i.e. Infant Positioning Assessment Tool (IPAT)] routinely to ensure appropriate positioning and encourage accountability.
- Maintain a midline, flexed, contained, and comfortable position at all times utilizing appropriate positioning aids and boundaries.
- Provide appropriate ventral support to ensure flexed shoulders/hips.
- Provide swaddling when bathing and weighing. Avoid doing procedures with infant in a prone position where he/she is unable to use self-comforting abilities.
- Engage with infant and let behavior of infant guide care. Do cares “with the infant, rather than “to” the infant.
- Assess infant sleep–wake cycle to evaluate appropriate timing of positioning and care.
- Reposition infant with cares and minimally every 4 hours.
- Provide 4-handed support during positioning and caring activities.
- Promote hand to mouth/face contact.
- When providing caregiving activities:
  - Collect all supplies prior to approaching infant so infant is not left unattended or unsupported once hands-on care has begun.
  - Seek another person to support infant care during a potentially stressful experience, including bathing and weighing.
  - Include parents in providing support when available and willing.

### Core Measure 4: Safeguarding sleep

**Standard 1:** A policy/procedure/guideline on safeguarding sleep exists and is followed throughout the infant’s stay.

**Standard 2:** A policy/procedure/guideline on back-to-sleep practices exists and is followed prior to discharge.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Infant sleep–wake states, cycles, and transitions</td>
<td>• Infant sleep–wake states will be assessed before initiating all caregiving activities</td>
<td>• Facilitate early, frequent, and prolonged skin-to-skin contact</td>
</tr>
<tr>
<td>• Infant’s maturity and readiness for back-to-sleep protocol</td>
<td>• Prolonged periods of uninterrupted sleep will be protected</td>
<td>• Educate, coach, and mentor parents on sleep-wake states and how to safeguard their baby’s sleep, recognizing the importance of sleep for healing, growth and brain development</td>
</tr>
<tr>
<td></td>
<td>• Infants will be transitioned to back-to-sleep when developmentally appropriate</td>
<td>• Recognize and protect sleep cycles, especially REM sleep</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote a quiet environment to ensure uninterrupted sleep.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Avoid sleep interruptions from bright lights, loud noises and unnecessary disturbing activities.</td>
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<tr>
<td></td>
<td></td>
<td>• Protect quiet sleep states by providing flexibility in timings of care</td>
</tr>
<tr>
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<td></td>
<td>• During a 24 hours period, the Unit Protocol should have preferably two “Quiet Time” periods in place.</td>
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<tr>
<td></td>
<td></td>
<td>• Engage with infant and let behavior of infant guide care</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Individualize all caregiving activities by clustering cares based on infant sleep–wake states. Take care not to over-stress infant with too many clustered cares at once</td>
</tr>
</tbody>
</table>

- Facilitate early, frequent, and prolonged skin-to-skin contact.
- Educate, coach, and mentor parents on sleep-wake states and how to safeguard their baby’s sleep, recognizing the importance of sleep for healing, growth and brain development.
- Recognize and protect sleep cycles, especially REM sleep.
- Promote a quiet environment to ensure uninterrupted sleep.
- Avoid sleep interruptions from bright lights, loud noises and unnecessary disturbing activities.
- Protect quiet sleep states by providing flexibility in timings of care.
- During a 24 hours period, the Unit Protocol should have preferably two “Quiet Time” periods in place.
- Engage with infant and let behavior of infant guide care.
- Individualize all caregiving activities by clustering cares based on infant sleep–wake states. Take care not to over-stress infant with too many clustered cares at once.
• If necessary to arouse a sleeping infant, approach using a soft voice/whisper followed by gentle touch.
• Support smooth transitions back to restful sleep before stepping away from bedside
• Protect infant’s eyes from direct light exposure and maintain low levels of ambient light
• When developmentally appropriate, provide some daily exposure to light, preferably including shorter wavelengths, for entrainment of the circadian rhythm
• Encourage use of “Cycled Lighting” protocol in the unit.
• Avoid (when possible) high doses of sedative and depressing drugs which can depress the endogenous firing of cells thus, thus interfering with visual development, REM, and NREM sleep cycles, and thus optimal brain development.
• Provide tummy-time/prone-to-play time routinely for infants that are Back-to-Sleep
• Coach, educate, and mentor parents about the importance and rationale for back-to-sleep and tummy-time

Core Measure 5: Minimizing stress & pain

**Standard:** A policy/procedure/guideline on the assessment and management of pain exists and is followed throughout the infant’s stay.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral cues indicating stress or self-regulation</td>
<td>Promote self-regulation and neurodevelopmental organization</td>
<td>Facilitate early, frequent, and prolonged skin-to-skin contact</td>
</tr>
<tr>
<td></td>
<td>Reduce excessive stress and pain in the NICU</td>
<td>Educate, coach, and mentor parents on infant cues related to stress and pain and how to provide their infant with non-pharmacological support during stressful or painful procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use Formatted Tool for assessment of stress, self-regulation and sleep states.</td>
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<td></td>
<td>Utilize a validated &amp; reliable pain assessment tool to evaluate the need for pharmacologic pain relief measures.</td>
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<td>Provide non-pharmacologic support (breastfeeding, skin-to-skin contact oral sucrose, pacifier and containment) prior to with all minor invasive interventions</td>
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<td></td>
<td>Provide midline, flexion, and containment with all positioning (whenever possible) to promote comfort</td>
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<td>Provide therapeutic positioning aids to maintain supportive positioning</td>
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<td></td>
<td>Provide guidance to parents on how to collaborate with NICU staff to minimize their baby’s stress and pain</td>
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<td></td>
<td>Invite parents to help support their baby during painful procedures if they are available and willing to participate</td>
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<td></td>
<td>Reserve parenting activities for parents (feeding, diapering, etc.)</td>
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</table>

Core Measure 6: Protecting skin

**Standard:** A policy/procedure/guideline on skin care exists and is followed throughout the infant’s stay.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity and integrity of infant skin</td>
<td>Reduce trans-epidermal water loss of ELBW infants</td>
<td>Facilitate early, frequent, and prolonged skin-to-skin contact</td>
</tr>
<tr>
<td></td>
<td>Maintain skin integrity of the infant from birth to discharge</td>
<td>Educate, coach, and mentor parents on skin care, swaddled bathing, and delivery of developmentally appropriate infant massage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilize a validated &amp; reliable skin assessment tool on admission and routinely according to hospital protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide additional humidity for ELBW infants during the first one to two weeks after birth (50% humidity is provided when infant is in skin-to-skin contact)</td>
</tr>
</tbody>
</table>
Core Measure 7: Optimizing nutrition

Standard 1: A policy/procedure/guideline on optimizing nutrition using cue-based/infant-driven breast or bottle feeding (which includes infant readiness, quality of feeding and caregiver techniques) is followed throughout the infant’s stay.

Standard 2: A policy/procedure/guideline on skin-to-skin contact (kangaroo care) exists and is followed throughout the infant’s stay.

<table>
<thead>
<tr>
<th>Infant characteristics</th>
<th>Goals</th>
<th>Neuroprotective interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic stability with feeding &amp; handling</td>
<td>Feeding will be safe, functional, nurturing, and developmentally appropriate</td>
<td>Facilitate early, frequent, and prolonged skin-to-skin contact</td>
</tr>
<tr>
<td>Feeding readiness cues</td>
<td>Optimized nutrition will be enhanced by individualizing all feeding care practices</td>
<td>Educate, coach, and mentor parents about positive oral stimulation, infant feeding cues, and feeding techniques</td>
</tr>
<tr>
<td>Coordinated suck/swallow/breathing (SSB) throughout breast or bottle feeding</td>
<td>Oral aversions will be prevented by assuring feeding is a positive experience for infant</td>
<td>Promote positive oral/olfactory stimulation during early skin-to-skin contact by letting infant lick, nuzzle and smell the nipple if interested</td>
</tr>
<tr>
<td>Endurance to maintain nutritional intake and support growth</td>
<td>First oral feeds will be at the breast for babies whose mothers are pumping their milk</td>
<td>Minimize negative perioral stimulation (adhesives, suctioning, etc.)</td>
</tr>
<tr>
<td>Infants of breastfeeding mothers will be competent at breastfeeding prior to discharge</td>
<td>Infants will be safe, functional, nurturing, and developmentally appropriate</td>
<td>Utilize indwelling gavage tubes rather than intermittent tubes.</td>
</tr>
</tbody>
</table>

Reference
Newborn & Infant Nursing Reviews 16 (2016) 230–244
L. Altimier, R. Phillips / Newborn & Infant Nursing Reviews 16 (2016) 230–244
Table taken and adapted from; The Neonatal Integrative Developmental Care Model: Advanced Clinical Applications of the Seven Core Measures for Neuroprotective Family-centered Developmental Care
Leslie Altimier, DNP, RN, MSN, NE-BC *Raylene Phillips, MD, FAAP, FABM, IBCLC**
*Philips Healthcare, 35 Warren St., Newburyport, MA 01950
**Loma Linda University Children’s Hospital, Department of Pediatrics, Division of Neonatology, 11175 Campus Street, CP 11121, Loma Linda, CA 92354
Appendix B: Quick Tips for all NICU Caregivers

Core Measure 1: Healing environment
A healing environment protects the developing sensory system of preterm infants
a. Protect auditory system by minimizing noise
   • Talk in a “library voice” when near bedsides
   • Keep pagers and phones on vibration mode
b. Protect visual system by minimizing direct light
   • Cover baby’s eyes during exams and procedures
   • Protect eyes of infant during phototherapy and prevent spillover of light to baby on neighbouring bed
c. Protect olfactory system by minimizing odors
   • Let hand sanitizers dry before putting hands inside isolette
   • Leave perfumes and colognes at home to maintain a fragrance-free NICU
d. Protect vestibular and tactile system
   • Use slow gentle movements during handling
e. Skin-to-skin contact (SSC) provides the most healing environment
   • Facilitate early, frequent, and prolonged skin-to-skin contact

Core Measure 2: Partnering with families
Parents are the most important caregivers in a baby’s life
a. Go out of your way to make parents feel welcome in the NICU
   • Always greet parents and introducing yourself with name and role
   • Having a baby in the NICU is usually an unexpected crisis for families
   • Expect the need to repeat conversations and explanations more than once
   • Use lay language free from acronyms when talking with parents
b. Involve parents as active members of the caregiving team
   • Educate, coach and mentor parents in caring for their baby in the NICU
   • Ask parents how they think their baby is doing – then listen
c. Skin-to-skin contact helps to heal the wounds of interrupted bonding and attachment
   • Recognize importance of parent-infant attachment on brain development, frequent, and prolonged skin-to-skin contact

Core Measure 3: Positioning and handling
Positioning should mimic the fetal position in the womb
a. Maintain head in a midline position
   • Be extra vigilant with ventilated ELBW infants
   • Help reposition ETT and/or reposition infant if needed
b. Maintain limbs and trunk in flexed, tucked position
   • Gently reposition infant after extending limbs during exams/procedures
   • Reposition infant in positioning aid after exams/procedures
c. Handle preterm and sick infants with slow, gentle movements
   • Ask for help with procedures or complicated handling
   • Ask staff or parent to provide 4-handed support if needed
d. Skin-to-skin contact is the “natural habitat” for all newborns
   • Skin-to-skin contact is the closest to being back inside the womb
   • Facilitate early, frequent, and prolonged skin-to-skin contact

Core Measure 4: Safeguarding Sleep
Sleep is essential for healing, growth, and optimal brain development
a. Never waken a sleeping baby unless absolutely necessary
   • Support long periods of restful, uninterrupted sleep whenever possible
   • Time routine cares/exams to coincide with baby’s sleep/wake cycles
b. Protect sleep states by minimizing noise and light
   • Talk in a “library voice” when near bedsides
• Be sure direct light is not shining on sleeping babies

c. Skin-to-skin contact promotes the most optimal sleep cycles
   • Newborns sleep best when in skin-to-skin contact
   • Facilitate early, frequent, and prolonged skin-to-skin contact

Core Measure 5: Minimizing Stress and Pain

Stress and pain are part of NICU life – but both can be minimized

a. Supporting a healing environment helps to minimize stress
   • Protect babies from excess noise and light
   • Talk in a “library voice” and cover baby’s eyes during exams
   • Watch for signs of stress during exams and pause when possible
     o Extended digits and limbs indicates stress
     o Excessive tone or absence of tone indicates stress

b. Use positioning and boundaries to provide containment
   • Baby should be well-contained during exams and procedures
   • Baby should be repositioned properly after exams and procedures

c. Use extra supports during painful procedures
   • Ask staff or parent to provide 4-handed support when needed
   • Many parents are willing and eager to help support their baby
   • Give them a chance to participate if they are available and willing

d. Sucrose / 10% Dextrose is to be given 2 minutes prior to painful procedures
   • Understand mechanism of action (activation of endogenous opioid receptors).
   • Understand absorption (via buccal mucosa and not via digestion).

e. Adequate analgesics are to be given prior to painful procedures if needed
   • Be proactive with post-op pain management

f. Skin-to-skin contact reduces stress and pain – Mother’s presence is analgesic
   • Encourage early, frequent, and prolonged skin-to-skin contact

Core Measure 6: Protecting Skin

Skin is a conduit for nerve cells to send sensory messages to the brain

a. Monitor humidity level inside incubator during first week for ELBW infants
   • Humidity is to be provided until skin is keratinized by about 5-10 days
   • Being skin to skin on mother’s chest provides about 50% humidity

b. Monitor nasal septum for skin breakdown if nasal prongs are used
   • Check prongs frequently – there should be no pressure on septum
   • Check septum each shift for erythema or breakdown

c. Monitor other susceptible skin areas
   • Check mouth for oral thrush and diaper area for rash
   • Check trunk/limbs for pressure ulcers and IV sites for erythema/infiltrates

d. SSC sends impulses to the brain to support maturation of the amygdala/limbic system
   • Encourage early, frequent, and prolonged skin-to-skin contact

The **amygdala** is part of the limbic system of the brain, which is involved with emotions, survival instincts, memory and other reactions to stimuli. It is highly involved with different emotional responses. It is a roughly almond-shaped mass of grey matter inside each cerebral hemisphere and there are two amygdalae per person normally, with one **amygdala** on each side of the brain.

Core Measure 7: Optimizing nutrition

Human milk is the optimal diet for most human infants

a. Discuss the medical need for breast milk with parents
   • Explain how breast milk is a medicine, especially for preterm infants
   • Explain need for early/frequent pumping if baby is unable to breastfeed
   • Optimal frequency of breast milk expression should be 6 to 8 times in a day
b. Support mother’s early and continued milk supply
   • Give enthusiastic support for any mother providing breast milk
   • Explain the importance of ongoing pumping to maintain milk supply

c. Provide ongoing breastfeeding education and support
   • Explain the importance of breast milk in decreasing risk of NEC and sepsis
   • Explain the importance of breast milk in healing and nutrition
   • Explain the importance of breast milk in brain development and vision

d. Skin-to-skin contact increases breastfeeding initiation and duration
   • SSC increases prolactin and oxytocin – both needed for lactation
   • Facilitate early, frequent, and prolonged skin-to-skin contact

e. Cue-based, infant-driven feeding prevents later oral aversions
   • Oral feedings should be safe, developmentally appropriate and nurturing
   • Provide cue-based rather than volume feedings

f. Support breastfeeding well before discharge
   • Babies can practice suckling when skin to skin whenever interested
   • The first oral feeding should be at the breast if mother has been pumping
   • If term baby has excessive difficulty latching, get lactation support
   • Check mouth for anomalies, e.g. cleft such as cleft palate or ankyloglossia (tongue-tie)
   • If present, alert physician to get appropriate treatment

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Appendix C: Implementing Potentially Better Practices (PBPs) to support the neurodevelopment of infants in the NICU

DSC Bundles

Full Form of Abbreviations In DSC Bundles

Abbreviations
A: Auditory development
C: Chemosensory development
S: Preservation of Sleep
T: Somatesthetic/Kinesthetic/Proprioceptive development
V: Visual development

(Potentially Better Practices (PBPs) may impact multiple developing sensory systems (T/C/A/V/S))

DSC Bundle I: Full implementation recommended for all NICU admissions beginning at 26 weeks gestation

T-1: containment and body flexion (T/S)
T-2: oral Stimulation/non-nutritive suck (T)
T-3a: gentle touch, hand grasping/facial stimulation (T)
T-4: decrease painful/negative stimulation (T/S)
C-1: exposure to mother’s scent (C)
C-2: minimize exposure to noxious odors (C/S)
A-1: noise abatement (A/S)
V-1: minimize ambient light exposure (V/S)
V-2: avoid direct light exposure (V/S)
S-1: develop strategies that preserve normal infant sleep cycles
  • Support family involvement in care practices that promote sleep
  • Non-emergent care provided at appropriate times to minimize the disruption of sleep (with diurnal implementation, as possible, after 30 weeks gestation)
S-2: minimize exposure to narcotics and other medications that may disrupt or disturb sleep cycles

DSC Bundle II - Full implementation recommended for all NICU admissions beginning by 31–32 weeks

T-3b: infant massage/diurnal implementation (T)
T-3c: skin-to-skin care (T/C/S)
A-2: exposure to audible maternal voice/diurnal implementation (A)
V-3: cycled lighting: minimum of 1–2 h (A/V/S)
V-4: provide more complex visual stimulation: after 37 weeks (V)

DSC Implementation Recommended for NICUs

A-0: develop methodology for noise assessment
V-5: provide night Staff exposure to adequate lighting
V-6: provide adequate staff and family lighting

Reference
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Implementing potentially better practices to support the neurodevelopment of infants in the NICU

S Laudert 1, WF Liu 2, S Blackington 3, et al on behalf of the NIC/Q 2005 Physical Environment Exploratory Group

1. Department of Neonatology, Wesley Medical Center, Wichita, KS, USA.
2. Department of Neonatology, The Children’s Hospital of Southwest Florida/Lee Memorial Health System, Fort Myers, FL, USA.
3. Department of Neonatology, Benefis Healthcare, Great Falls, MT, USA.
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- Lower antibiotic usage
- Improved feed tolerance reduces number of days to full feeds
- Healthier gut microbiome

**LONG-TERM**

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- Reduces risk of allergies
- Reduced risk of developing antibiotic resistance
- Lower rates of hospital re-admissions
- Improved metabolic profile reduces risk of asthma, obesity and diabetes

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