



## *Topic Expert Group: Infant- and family-centred developmental care*

### **Supportive sensory environment**

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#### *Target group*

Infants and parents

#### *User group*

Healthcare professionals, neonatal units, hospitals, and health services

#### *Statement of standard*

The hospital sensory environment is adjusted to the infants' sensory expectancies and perceptual competences.

#### *Rationale*

The hospital environment may be challenging for the infant and their parents. Developmental neurosciences and psychology have enlightened the complex relationships between the environment and brain development. (1) Sensory systems develop progressively and continuously from fetal to neonatal life, with a timeline specific to each sensory modality (2,3); even extremely preterm infants are sufficiently mature to react to their environment. (4) Early brain development is genetically driven, but as early as the third trimester of pregnancy it becomes also sensory driven. Thus the period of hospitalisation is critical, since the sensory experiences can impact neurodevelopment, through many factors including synaptogenesis, synapses elimination, and epigenetic factors. (1,5–8) The harmful role of stressful/painful (over)stimulations and their long-term potential impact have been described. (9–11) As maternal stimuli are particularly salient for newborn infants, the hospital environment poses also a risk of sensory deprivation of biologically meaningful inputs for the infant. (12) Early and prolonged separation from their family can alter the bonding process and later mutual interactions. (13)

Both basic and medical research support the provision of a sensory nurturing environment. It is essential to protect infants from deleterious environmental stimuli and to support their access to positive sensory stimulations from their parents and other caregivers. Sensory interventions in the NICU, adjusted to the infants' needs and responses, attuned to their current developmental stage, are at best implemented through individualised programmes. Skin-to-skin contact is the best strategy to restore some of the sensory discontinuity associated with preterm birth.

#### *Benefits*

Enhanced, natural and direct exposure of the hospitalised infant to hedonically positive and/or biologically meaningful stimuli is provided during social interactions mainly through intimate contact between the mother (partner) and the infant, and minimising exposure to environmental stressors (see TEG NICU design). These enhanced sensory experiences are mainly delivered through skin-to-skin care, early vocal contact (direct talking and singing), exposure to maternal/paternal scents, access to breast milk taste and smell, eye contact, touch, and massage. Benefits may also come from other sensory interventions which are individually attuned to the behavioral state of the newborn infant: hedonically positive tastes, postural support, oral stimulation, and music-based intervention.



*Short-term benefits*

- Increased physiological and behavioural stability (14–19)
- Increased feeding competences (14,20–22)
- Improved weight gain (14,23–27)
- Supported sleep (15,28,29)
- Improved social interaction and recognition (30,31)
- Reduced pain behaviour (32–38)
- Enhanced infant vocalisations (38)
- Reduced length of hospital stay (14,23,25,26)
- Enhanced maternal attachment (39,40)
- Improved interaction with the infant (39,40)
- Improved adaptation to the infants’ behavioural and social cues (41–44)
- Decreased parental stress/anxiety (41,45–47)

*Long-term benefits*

- Improved neurodevelopment for the infant (28,39,48–53)
- Improved language and cognitive outcome for the infant (54–57)
- Increased quality of life during childhood (58,59)
- Improved social interactions (57)
- Improved parental mental health (25)

*Components of the standard*

Component	Grading of evidence	Indicator of meeting the standard
<b>For parents and family</b>		
1. Parents are guided by healthcare professionals to respond to the infant’s behaviour and sensory needs through attuned vocal, visual, olfactory, tactile interactions with their infant. (12,25,51,60)	A (Moderate quality) B (Moderate quality)	Guideline, parent feedback, patient information sheet
2. Parents are supported by healthcare professionals to be continually present and involved in the care of their infant. (61,62)	A (Moderate quality) B (Moderate quality) C (High quality)	Guideline, parent feedback
3. Parents are supported by healthcare professionals to provide as much skin-to-skin contact as they are comfortable with. (14)	A (High quality) B (Moderate quality)	Guideline, parent feedback
<b>For healthcare professionals</b>		
4. A unit guideline to facilitate a supportive sensory environment and infant- and family-centred developmental care is adhered to by all healthcare professionals.	B (High quality)	Guideline



5. Training on care adapted to a supportive sensory environment and infant- and family-centred developmental care is attended by all responsible healthcare professionals.	B (High quality)	Training documentation
6. Environmental noise and excessive light exposure are minimised according to guidelines. (63–66)	A (High quality) B (Moderate quality)	Guideline, parent feedback
7. Exposure to deleterious hospital odours is reduced. (67–69)	A (Moderate quality) B (Low quality)	Guideline
8. Exposure to painful, stressful stimuli related to care are minimised. (70)	A (High quality) B (High quality)	Guideline, parent feedback
9. Parental knowledge about infant's behaviour and parental involvement during caring procedures to support the well-being and self-regulation of the infant are supported. (25)	A (High quality) B (Moderate quality)	Guideline, parent feedback
10. Care is taken to provide appropriate multisensory input during initiation of breastfeeding. (71)	A (High quality) B (High quality)	Guideline, parent feedback
11. Intimacy, quietness and speech privacy are preserved and supported. (64,66,72)	A (Moderate quality) B (Low quality)	Guideline
12. Early meaningful interactions between parents and infants, in particular through skin-to-skin and vocal contacts according to the condition and status of each infant are supported. (14,15,60)	A (High quality) B (Moderate quality)	Guideline, parent feedback
<b>For neonatal unit</b>		
13. A unit guideline on care adapted to a supportive sensory environment and infant- and family-centred developmental care is available and regularly updated.	B (High quality)	Guideline
14. Noise reduction and light adjustment protocols are available. (64,66,72)	A (High quality) B (Moderate quality)	Guideline
15. Facilities to welcome parents continuously in the unit are provided. (61)	A (Moderate quality) B (Moderate quality)	Parent feedback



For hospital		
16. Training on care adapted to a supportive sensory environment and infant- and family-centred developmental care is ensured.	B (Moderate quality)	Training documentation
17. A noise management team is established.	B (Moderate quality)	Audit report
18. During the commissioning of new medical devices an assessment of the environmental and noise impact on the infant is included.	B (Moderate quality)	Audit report
For health service		
19. A national guideline on a sensory supportive environment is available and regularly updated. (73,74)	A (Moderate quality) B (High quality)	Guideline

*Where to go – further development of care*

Further development	Grading of evidence
<b>For parents and family</b>	
<ul style="list-style-type: none"> <li>Parents are supported by healthcare professionals to be the essential providers of sensory stimulations attuned to their infant.</li> </ul>	B (High quality)
<ul style="list-style-type: none"> <li>Other family members are involved as a source of sensory stimulation attuned to the infant when the parents are not available.</li> </ul>	B (Moderate quality)
<b>For healthcare professionals and neonatal units</b>	
<ul style="list-style-type: none"> <li>Develop and evaluate innovative ways to support parent-infant interactions and synchrony.</li> </ul>	A (Low quality)
<ul style="list-style-type: none"> <li>Strengthen the information given to parents about the sensory competencies and needs of their infant (educational course).</li> </ul>	B (Moderate quality)
<b>For hospital</b>	
<ul style="list-style-type: none"> <li>Provide coherent perinatal support for skin-to-skin care and implement couplet care organisation optimising the sensory experience of the infant.</li> </ul>	B (Moderate quality)
<b>For health service</b>	
<ul style="list-style-type: none"> <li>Develop sustainable collaboration with parental organisations to support the provision by parents of a nurturing sensory environment.</li> </ul>	B (Moderate quality)
<ul style="list-style-type: none"> <li>Support, with specific funding, research in the field of sensory system development and in the population of preterm infants.</li> </ul>	B (Moderate quality)



## Getting started

### Initial steps

#### For parents and family

- Parents are verbally informed by healthcare professionals about the development of sensory competencies of preterm infants and about their sensory expectancies.
- Provide skin-to-skin, vocal and touch contacts as early as possible.
- Participate in the feeding of the infant as early as possible.

#### For healthcare professionals

- Attend training on the development of sensory competencies of preterm infants and about their sensory expectancies.
- Protect infants from excessive sound and bright light.
- Evaluate, respect and support the infant's behavioural state.
- Support breastfeeding.
- Support safe skin-to-skin contact by parents as early as possible.

#### For neonatal unit

- Develop and implement a unit guideline on care adapted to a supportive sensory environment and infant- and family-centred developmental care.
- Develop information material about the development of sensory competencies of preterm infants and their sensory expectancies.

#### For hospital

- Support healthcare professionals to participate in training about the development of sensory competencies of preterm infants and their sensory expectancies.
- Provide accommodation for parents as continuously as possible in the hospital.

#### For health service

- Develop and implement a national guideline on care adapted to a supportive sensory environment and infant- and family-centred developmental care.

## Description

### *Sensory environment and brain development*

Although many clinical factors may lead to a higher risk of neurodevelopmental sequelae in very preterm infants, environmental factors during critical periods of brain development also contribute. (1) Epigenetic factors contribute to this “environmental shaping of the developing brain”, as synaptogenesis and selective elimination of synapses during early stages of brain development. (5) The adaptation of the sensory experiences of a preterm infant in the NICU to its sensory expectations and capabilities is the cornerstone of early interventions in infant- and family-centred developmental care. (12) The postnatal environment differs markedly from the environment it should have continued to encounter *in utero*. (3,68,75,76) This exposes the infant to excessive sensory inputs, as well as to sensory deprivation, that can alter well-being and may interfere with brain development and growth. (77,78) For example, the number of painful/stressful procedures during neonatal life impacts brain growth and function (10), and at seven years of age correlates negatively with IQ, is associated with altered brain microstructure (9) and impacts stress sensitive behaviours. (79) Moreover, early sensory experience may have later effects, for example, brief exposure of newborn infants during the early postnatal period to artificial odours while breastfeeding can influence subsequent olfactory preferences until toddlerhood. (80)



### *Sensory sensitivity to the hospital environment*

The provision of a sensory supportive environment is based on knowledge about sensory system development in very preterm infants and its sensitivity to and expectancies derived from the sensory environment. This knowledge guides the implementation of evidence-based and biologically meaningful strategies/interventions for sensory nurturing. The responses of a preterm infant to environmental stimuli can be recorded at physiological, behavioural and cerebral levels. Even an infant born extremely preterm, is sensitive to pain and can integrate at a cortical level a painful heel lance stimulus in pain processing areas from 25 weeks' post-menstrual age. (81) On the other hand, an infant displays fine manual tactile perceptual capacities from 28 weeks of gestation. (82) The chemosensory sensitivity of a preterm infant has been demonstrated through its behavioural responses to odours and tastes. (69,83,84) The cortical responses of preterm infants to nosocomial odours has been recorded as early as 30 weeks post-menstrual age. (67) The developing brain, only few days after birth, can process new artificial odorants in similar cortical areas to those in adults. (85) This provides evidence that human olfaction at birth relies on brain functions that involve all levels of the cortical olfactory system. A very preterm infant is able to react to moderate changes in the artificial auditory environment that can affect its well-being, and its cerebral oxygen saturation. (86,87) They are also particularly sensitive to human voices (15,60,88) and can integrate at a cortical level subtle language differences from 29 weeks post-menstrual age (89), indicating that the immature cortical circuits might process speech even at a stage where cortical organisation in layers is not completed. Finally, although the visual system is the last to develop, a very preterm infant has the capabilities to detect small light level changes in its environment. (90)

### *Modulation of the hospital environment to support neurodevelopment*

Understanding that the environment impacts the experience-dependent brain organisation and realising that the NICU is not the expected and optimal environment for infant development, many strategies have been developed and shown efficient to minimise the exposure to deleterious stimuli coming from the hospital: painful procedures (70), noise (64,72,74), odour from health care products (68), exposure to continuous bright light. (63) A series of recommendations and criteria have been drawn to reduce the impact of the deleterious aspects of the NICU environment (65) and a number of organisations advocate for less invasive practices. (66,73)

Moreover, other strategies support also the access to biologically meaningful stimuli. Experiences of early skin-to-skin contact and of "couplet care" with continuous access and non-separation between the infant and the mother, aim to sustain the ongoing contact between parents and preterm infants, sustaining consistent, and predictable multisensory communication, resulting in more optimal medical and developmental outcomes. Most of these strategies are included in well evaluated and validated developmental care programmes as the NIDCAP programme (12,24,52), Family Nurture Intervention (51,91,92), the COPE (25,47). Other programmes develop similar approaches and scientific evaluations are expected in the near future (93), e.g., for Family Integrated Care and the Close Collaboration with Parents. (94)

Finally, specific sensory interventions may be beneficial but have also an inherent risk of overstimulation, especially if delivered without an individualised approach adjusted to the infant's behaviour. However, this risk could be decreased if the interventions are applied by parents (95), and/or with support of evidenced based developmental care programmes. Their long-term benefits remain to be evaluated. (18,96)





## Source

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