



NICU design



european standards of
care for newborn health

EFGNI european foundation for
the care of newborn infants



Topic Expert Group
NICU-Design

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Topic Expert Group: NICU design

Overview

The design of the neonatal intensive care unit (NICU), which comprises the built environment of a neonatal unit, may influence both short- and long-term outcomes of neonatal care. Evidence-based design can support family-centred care, safe and optimal working conditions for healthcare professionals, and other relevant aspects of good clinical practice. (1) Therefore, planning for a NICU environment needs to integrate scientific evidence and is also an issue of practical and smart technical and design solutions.

The health benefits of continuous parent participation, interaction, and skin-to-skin care are significantly improved if the environmental design allows privacy and protects from visual and auditory stress by respective design of family-rooms. (2,3) Facilitating parent-infant closeness and skin-to-skin care throughout the 24 hours by an optimal design of the neonatal unit represent an underestimated opportunity for improving outcomes for infants. (4) Further elements of NICU design imply spatial division of the necessary facilities and appropriate lighting levels within the NICU that optimise the ability of healthcare professionals to perform care while meeting the health needs of patients and their families. (2) Utilisation of materials preventing elevated noise levels and infection is necessary. (5)

There may be a conflict between patient/family preferences and the preferences of the healthcare professionals, building, and technical department or administration, which needs to be acknowledged already in the planning process. Therefore, NICU planners, hospital administration, NICU staff, and parent representatives should be involved in the planning and building process or the rebuilding process of NICUs.

The Topic Expert Group on NICU design develops standards reflecting several infrastructural and design issues which optimally support the provision of high-quality and family-centred care.

Sources

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Core principles of NICU design to promote family-centred care

Moen A, Hallberg B, Mader S, Ewald U, Sizun J, White R

Target group

Infants, parents, and families

User group

Healthcare professionals, neonatal units, hospitals, health services, and other relevant stakeholders

Statement of standard

Neonatal care is optimised by utilising key design elements to promote the family as primary care givers throughout the stay.

Rationale

The design of the NICU may modulate significantly both short-term and long-term outcomes of neonatal care. (1–4) Family-centred care (5,6) may be achieved independently of NICU design, but the health benefits of daily parent participation, interaction, and skin-to skin care are significantly improved if the environmental design allows privacy and protects from visual and auditory stress. (7–11) Facilitating unrestricted parent-infant closeness and skin-to-skin care represent an underestimated opportunity for improving outcomes for infants. Benefits of family-centred care include reduced pain and stress (12,13), reduced sepsis (1,2,4), improved cardiovascular stability (14,15) and sleep (16,17), together with improved exclusive breastfeeding (1,18), improved parental confidence, interaction and bonding (18–21), which lead to decreased length of stay (4) and readmission rates (22) and improved neurodevelopmental outcomes. (23–25)

The United Nations Convention on the Rights of the Child states that “*The child ... shall have the right from birth to ... be cared for by his or her parents*” (Article 7), and that “*Parties shall ensure that a child shall not be separated from his or her parents against their will*” (Article 9). (26)

The charter of the European Association for Children in Hospital states that “*Children should have the right to have their parents or parent substitute with them at all times*” (Article 2) and that “*Accommodation should be offered to all parents and they should be helped and encouraged to stay*” (Article 3). (27)

Benefits

Short-term benefits

- Facilitated implementation of family-centred and developmental care (2,5,8) (see TEG Infant- & family-centred developmental care)
- Improved parental presence, confidence and parent-infant interaction both pre- and post-discharge (10,11,18–21)
- Reduced rate of late-onset neonatal sepsis (2,28)

Long-term benefits

N/A



Components of the standard

Component	Grading of evidence	Indicator of meeting the standard
For parents and family		
1. Parents and family are informed by healthcare professionals about NICU design and are part of the planning process for NICU design.	B (High quality)	Parent feedback, patient information sheet, training documentation
2. Parents are educated by healthcare professionals about housekeeping rules, patient safety and hygiene, to facilitate their active role in the care of their infant.	B (Moderate quality)	Training documentation
For healthcare professionals and relevant stakeholders		
3. A unit guideline on the organisation of care in developmentally supportive adapted NICU design is adhered to by all responsible stakeholders.	B (High quality)	Guideline
4. Training on the basic emotional, social and psychologic needs of patients, parents and siblings, and of the principles of family-centred care is attended by all responsible healthcare professionals and stakeholders before they are involved in the planning process for a new unit. (see TEG Infant- & family-centred developmental care)	B (High quality)	Training documentation
5. Healthcare professionals are part of the planning process for a NICU design.	B (High quality)	Audit report
For neonatal unit and hospital		
6. A unit guideline on the organisation of care in developmentally supportive adapted NICU design is available and regularly updated.	B (High quality)	Guideline
7. Training on the basic emotional, social and psychologic needs of patients, parents and siblings, and of the principles of family-centred care for everyone participating in the planning process is ensured. (see TEG Infant- & family-centred developmental care)	B (High quality)	Training documentation



8. Family-centred care supportive areas are included during the design process.	B (Moderate quality)	Audit report
9. Patient treatment area: each patient space has at least enough room for a comfortable chair and a hospital bed for parents next to the infant's cot (minimal space 18 m ²) (9,10) taking into account family integrity and privacy; additionally separate parent sleeping facilities including a toilet and shower are sited within the neonatal unit (minimal space 10 m ²).	A (Moderate quality)	Audit report
10. Single occupancy areas: facilities for infants and caregivers are located in the same room (minimum space 24 m ²) (2,9,10), and designed to take into account family integrity and privacy. (9,10)	A (Moderate quality)	Audit report
11. Clinical and monitoring working areas are located in close proximity to patient areas.	B (High quality)	Audit report
12. Areas for eating and socialising for parents, private rooms for parent counselling, and staff rooms out of sight of parents are available on the ward.	B (High quality)	Parent feedback
13. Bereavement space and space to stay with the infant after death is provided within the design.	B (High quality)	Audit report
14. The unit is built to comply with patient safety standards.	B (High quality)	Audit report
For health service		
15. A national guideline for NICU design incorporating the principles of family-centred care is available and regularly updated.	B (High quality)	Guideline
16. Parents and NICU healthcare professionals are involved in guideline development and planning processes	B (High quality)	Guideline



Where to go – further development of care

Further development	Grading of evidence
For parents and family	
<ul style="list-style-type: none">Parents are present in single-family rooms. (2,3,28)	A (Moderate quality)
For healthcare professionals and relevant stakeholders	
N/A	
For neonatal unit	
<ul style="list-style-type: none">Provide single-family rooms and rooms adequately sized for care of multiple births. (2,3,28)	A (Moderate quality)
For hospital	
<ul style="list-style-type: none">Provide single-family rooms and rooms adequately sized for care of multiple births. (2,3,28)	A (Moderate quality)
For health service	
<ul style="list-style-type: none">Incorporate the single-family-room concept in national guidelines.	B (Moderate quality)

Getting started

Initial steps

For parents and family

- Parents and family are verbally informed by healthcare professionals about NICU design, housekeeping rules, patient safety and hygiene.
- Parent representatives are encouraged to express parents' needs regarding NICU design.

For healthcare professionals and relevant stakeholders

- Attend training on basic emotional, social and psychologic needs of patients, parents and siblings, and of the principles of family-centred care to support future changes.

For neonatal unit and hospital

- Develop and implement a guideline on the organisation of care in developmentally supportive adapted NICU design.
- Develop information material on NICU design, housekeeping rules, patient safety and hygiene for parents.
- Involve all relevant stakeholders for the process of NICU design.
- Provide space for a comfortable chair for each parent.
- Guarantee privacy (e.g. by putting up a folding screen).
- Provide adequate and secluded space for pumping of breast milk.
- Identify areas in need of change and improvement and support implementation of and solutions for family-centred care.

For health service

- Develop and implement a national guideline on the organisation of care in developmentally supportive adapted NICU design.
- Develop a policy promoting family-centred care.



Description

The standard focuses on the architectural and technical elements necessary to provide family-centred care at the cot side, consistent with the UN convention on the rights of the child. Elements that are not specific to the implementation of these care principles are not covered in this standard but are extensively covered in the standard for neonatal intensive care units by White et al. (29)

The most difficult and challenging aspect of planning a NICU environment centred around the family and newborn infant is the change in culture and mind-set that has to take place among staff and administrators. This process has to start years before the physical planning. It requires leadership with dedication and in-depth understanding and knowledge of the combined scientific and humanistic approach necessary to create a caring environment combining principles of family-centred care with high quality intensive care. It also requires knowledge and a will to work by the principles of shared decision making in healthcare.

Planning for a NICU environment facilitating optimal conditions for infant-parent contact and skin-to-skin care cannot be based only on scientific evidence, although evidence exists. A main source of information and input should come through visitation to units that has gone through the process of redesigning, and discussion with colleagues in these units about strengths and weaknesses of their design is a valuable source of information.

In the planning process, it should be acknowledged that there may be a conflict between the patient and families' preferences and the preferences of the staff, building and technical department or the administration. Such conflicts should be handled with great caution with respect to the patients' perspective, as the voice of the patient may otherwise be too weak to be heard. Free-speaking competent advocates for the patients' interests should be appointed early in the planning process.

As part of the process, and before a full scale major re-design of a unit is taking place, leaders should be aware to the possibilities that minor physical changes or procedures in the existing unit allow introduction of new caring principles. An example may be to allow one or two parent beds to be placed beside the incubator or cot and then let the parents practice skin-to-skin care for as long as they wish with support from the staff. This will demonstrate to the staff that alternative ways of providing care is possible. It may also help the staff to see that most parents are very eager to participate and be present, and through participation are empowered to an extent that changes the traditional roles between staff and parents.

Although NICU healthcare professionals may be very experienced in what they are doing, it should be kept in mind that experience is most valid in the setting where it was gained. When family-centred care is introduced the setting is fundamentally changed. Parents become the best observers of their child, they represent the best continuity of care and they learn skills in caring for their child that may challenge the traditional roles of the staff. Parents are empowered and as their competence increase they may appropriately question treatment decisions or procedures carried out by the staff.

The challenge of the staff adapting to empowered and protective parents, legitimately opposing treatment strategies or decisions from the staff, change the traditional balance in the NICU. It has also been shown to reduce diagnostic testing with all the



pitfalls of over-diagnosis and overtreatment without putting the child at risk of adversities. (2,30)

The challenges of redesigning a NICU focussed on family-centred care is well known and foreseeable. If adequate strategies are not developed and risks handled well ahead of implementation, the risk profile may be high. There are two studies from one single unit that has presented data in conflict with the rest of the published literature. They found increased stress among the staff and poorer neurodevelopmental outcome in infants after introduction of single-family rooms (30, 31). From the first of these two papers it seems that parental visitation rate and participation is very low compared in European NICU's (32), and the unfavourable results may to some extent be explained by limitations and difficulties integrating parents in care. (31)

Single family rooms and NICU design is no goal in itself; it is a tool to fulfil the rights of the child to have its parents present without restrictions and to improve short- and long term medical and neurobehavioral outcome. Good NICU design creates a protective physical environment for the vulnerable sick infant and encourage parents to take an active part in the care and medical treatment for their child.

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Facilitation of skin-to-skin care and parental involvement through the physical environment

Moen A, Hallberg B, Bambang Oetomo S, Ewald U, Fröst P, Ferrari F, Sizun J, White R

Target group

Infants and parents

User group

Healthcare professionals, neonatal units, hospitals, administrators, architects, health services, and payer organisations

Statement of standard

A physical environment that facilitates parent-infant closeness and skin-to-skin care is considered in NICU planning.

Rationale

The design of the neonatal unit is fundamental to facilitate parental presence and involvement in care and for skin-to-skin contact throughout the 24 hours. The standard specifies important aspects in the physical environment of the NICU that facilitate active parental participation and parent empowerment in daily care. Family-centred care, including skin-to-skin contact between infant and parent, is a caring mode for newborn infants that is superior to traditional care in incubators or open beds. (see TEG Infant- & family-centred developmental care) There are ethnographic studies showing that letting parents establish a secluded area around the infants bed gives a feeling of privacy that may increase parental satisfaction and presence, so called safe corners. (1)

Planning for a NICU environment integrates scientific evidence and is also an issue of practical and smart technical and design solutions. One main source of information and input should be through visits to units that have gone through the process of redesigning their unit, and discussion with colleagues about strengths and weaknesses of their design.

In the planning process it should be acknowledged that there may be a conflict between patient and family preferences and the preferences of the staff, building, and technical department or administration. Such conflicts should be handled with great caution with respect to the patients' rights and interests. Free-speaking competent advocates for the patients' interests should be appointed early in the process, and their view should be considered to represent the infant's needs and wishes.

Benefits

Short-term benefits

- Increased physical stability of the newborn infant (2–6)
- Reduced mortality and infection rate (7)
- Improved self-regulation and sleep (8,9)
- Decreased newborn infant stress and pain (9–11)
- Improved parental confidence (12,13)



- Early parent-infant interaction (14)
- Reduced length of parent-infant separation (15,16)

Long-term benefits

- Improved cognitive and neurodevelopmental outcome (17–19)
- Improved and prolonged exclusive breastfeeding (8,13)
- Improved speech development (20–22)

Components of the standard

Component	Grading of evidence	Indicator of meeting the standard
For parents and family		
1. Parents and family are informed by healthcare professionals about principles and purpose of the design to facilitate skin-to-skin care and are part of the planning process for NICU design.	B (High quality)	Guideline, parent feedback, patient information sheet
For healthcare professionals		
2. Healthcare professionals are part of the design team.	B (High quality)	Guideline
For neonatal unit		
3. The design ensures that parents and infants are protected from unwanted sensory exposure (noise, light, smell). (16,23–25)	A (Moderate quality) B (High quality)	Guideline
4. Facilities are available to ease transfer from incubator to skin-to-skin care and the use of simultaneous monitoring and respiratory support technologies to allow uninterrupted skin-to-skin care.	B (High quality)	Guideline
5. Hospital beds, which result in longer periods of skin-to-skin care (26), and reclining chairs suitable for mothers that have recently given birth and that allow adjustments of position are available.	A (High quality)	Guideline
For hospital		
6. Physical space and architectural standards in the design facilitate close infant-parent contact throughout the 24 hours, integrating a primary user's perspective and cover delivery room, transfer areas, and NICU.	B (High quality)	Guideline



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| 7. Over-night accommodation facilities for parents in or close to the ward with possibilities for having all meals in the hospital are provided. (26,27) | A (Moderate quality)
B (High quality) | Guideline |
|--|--|-----------|

For health service

- | | | |
|--|------------------|-----------|
| 8. A national guideline for the physical and architectural standards in the NICU including a primary user's perspective allowing close infant-parent contact throughout the 24 hours and entire hospital stay is available. (28) | B (High quality) | Guideline |
|--|------------------|-----------|

Where to go – further development of care

Further development

Grading of evidence

For parents and family
N/A

For healthcare professionals

- Provide technical facilities to start skin-to-skin care in the delivery unit and during transfer to the NICU for stable infants. B (Moderate quality)

For neonatal unit

- Provide single family rooms or adequately sized protected patient treatment areas allowing undisturbed skin-to-skin care. (11) A (High quality)
- Optimise monitoring equipment and use wireless monitoring. B (Moderate quality)
- Provide adequately sized hospital beds for parents with high quality electrically adjustable mattresses. B (Moderate quality)
- Provide separate bathrooms for parents. B (Moderate quality)
- Provide flexible mounting of pumps, CPAP, and ventilators to easy move the patient without disconnecting equipment. B (Moderate quality)
- Provide a suitable area for visiting siblings and a visiting policy allowing siblings into the ward. B (Moderate quality)

For hospital

- Ensure space for both parents caring for the infant skin-to-skin contact throughout the 24 hours. B (Moderate quality)

For health service

N/A

Getting started

Initial steps

For parents and family

- Parents are involved from the earliest steps in the process of re-design/re-arrangement of the NICU in order to ensure that their needs are met.

For healthcare professionals

- Provide parents with a place to sit down beside their infant allowing the infant to be in physical contact with their parents and to hear parents' voice.



For neonatal unit

- Develop strategies for implementing skin-to-skin contact, bearing in mind the specific outline of the unit.
- Work systematically with healthcare professionals to ensure the re-design/re-arrangement captures critical aspects of the parent-infant relationship and of skin-to-skin care.
- Prioritise parent-infant areas before other unit demands for space.
- Provide over-night accommodation and eating facilities in the hospital or nearby.

For hospital

- If space is limited take all measures to prioritise the physical environment to facilitate parent stay and prolonged skin-to-skin care.

For health service

- Develop and implement a national guideline for the physical and architectural standards in the NICU with a primary user's perspective allowing close infant-parent contact throughout the 24 hours and entire hospital stay.

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General layout of the unit

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Target group

Infants, parents, families, and unit staff

User group

Neonatal units, hospitals, health services, healthcare planners, architects, technical staff, manufacturers, and other relevant stakeholders

Statement of standard

A NICU is designed to support safety and healing through unrestricted parental presence, use of sensory supportive material and optimal working facilities, promoting close collaboration between families and staff in caring for the ill infant.

Rationale

NICU design comprises the built environment of a neonatal unit which aims at evidence-based design supporting family-centred care, safe and optimal working conditions for staff, and other relevant aspects of clinical practice, e.g. appropriate lighting and acoustic environment.

The optimal locus of care for most infants is in a room with their parents. (1) Evidence supports a NICU design with enough single-family rooms to accommodate all families who wish to stay with their infant(s). (1) Single-family rooms lead to better outcomes for the infant and reduced costs when the family is present for extended periods. (2) Single room care can reduce noise, ensure privacy for the infant and their family, is a better environment to prevent infections. (3–6) and may ameliorate or protect the infant from short- and long-term consequences of stress caused by intensive care treatment. (7–9) Parental presence is higher in NICUs providing facilities for overnight stay for the parents. (3,10) A “bed-in-a-unit” architecture for parent-infant closeness in NICUs is therefore important. (10) In settings where families are rarely present and staff resources are strictly limited, the NICU may also contain rooms with more than one patient-bed to accommodate those infants whose families are not present most of the time. (3,10) Also in these settings, enough space and facilities for parental presence and skin-to-skin care is a pre-requisite. (1,11) Each hospital planning team will use their demographics to determine the appropriate mix of beds in multi- and single-family rooms. (11) Other aspects of NICU design which should be taken into account concern lighting and acoustic performance. Appropriate lighting levels within the NICU that optimise the ability of



staff to perform care while meeting the health needs of patients, their families, and their caregivers are required. The build environment should be designed to avoid auditory discomfort and adverse effects on development, and should absorb a high level of background noise (above the hourly Leq 45 dBA threshold). (12) All materials used for patients (including monitoring devices) should be designed to minimise discomfort.

Benefits

Short-term benefits

- Improved medical outcomes (3,13–16)
- Minimised separation between infants and parents (3,10)
- 24/7 skin-to-skin care and improved physiologic stability (17,18)
- Improved comfort and sleep for infants (19–22)
- More attractive environment for prolonged presence for parents (20)
- Encouraged parent involvement from the first day since parents can participate in the infant’s care, both during intensive care and in a family room (consensus)
- Supported physical and mental well-being of newborn infants, their families, and the hospital staff by lighting with appropriate intensity, spectrum, location, and diurnal cycling (23)
- Improved family satisfaction (15,16)
- Enhanced clinician’s abilities to perform direct and indirect patient care tasks accurately while minimising visual difficulties (24)
- Reduced length of hospital stay by cycled lighting (10,25)
- More attractive working environment for healthcare professionals (26)
- Improved nurse satisfaction (15,16)

Long-term benefits

- Improved neuro-development (27)
- Facilitated parent-infant interaction and developmental care (28)

Components of the standard

Component	Grading of evidence	Indicator of meeting the standard
For parents and family		
1. Parents and family are informed by healthcare professionals about principles of the general layout of the unit and are part of the planning process for NICU design.	B (High quality)	Guideline, parent feedback, patient information sheet
2. Structural barriers to family presence and participation in the care of their infant are avoided. (10,19)	A (Moderate quality) B (High quality)	Guideline



For healthcare professionals and relevant stakeholders

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| 3. The monitoring/workstation are designed so that the patient/family or vital parameters can easily be followed by healthcare professionals while maintaining privacy. (29) | A (Low quality) | Guideline |
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For neonatal unit and hospital

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| 4. The principles of the general layout and facilities within a NICU are agreed between planners, hospital, NICU staff, and parent representatives before commencing the planning process. | B (Moderate quality) | Guideline |
| 5. The NICU is located in close proximity to the obstetric department to facilitate ease of transportation to the NICU. (30) | A (Moderate quality) | Audit report |

Space for infant, family and staff

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|--|--|-------------------------------|
| 6. Multiple-bed rooms have a minimal space of 18 m ² per patient (10,19,31–33); single-family rooms have a minimal space of 24 m ² , taking into account family integrity and privacy and providing at least enough room for (10,13,32): <ul style="list-style-type: none">• At least one comfortable and reclining chair (1)• Hospital bed• Lockable wardrobe• Easy access to rest-rooms and bathroom• Technical equipment• Ability for multiple care staff staying in the room at the same time | A (Moderate quality)
B (Moderate quality) | Guideline,
parent feedback |
| 7. The stationary medical equipment is arranged and mounted with flexibility to allow easy transfer of the patient from incubator/cot to parents' chest for skin-to-skin care. | A (Low quality) | Guideline |
| 8. An additional separate parent sleeping facility including easy access to rest-rooms and shower are located close to the neonatal unit. | B (Moderate quality) | Guideline,
parent feedback |
| 9. Family facilities including kitchen, laundry room, socialising lounge, and | A (Moderate quality)
B (Moderate quality) | Guideline,
parent feedback |



playroom for siblings close to the unit are available. (1)

10. A barrier-free room with window for expression is available within the NICU, providing: <ul style="list-style-type: none">• Sinks with equipment (soap, towel and disinfectant dispenser)• Comfortable chairs• Tables (see TEG Care procedures and TEG Nutrition)	B (Moderate quality)	Guideline, parent feedback
11. Access to a human milk bank is ensured and a milk preparation room is integrated into the NICU.	B (Moderate quality)	Guideline
12. Bereavement space with window and space to stay with the infant after death, including a cooling facility, is provided in a culturally and spiritually appropriate design.	B (High quality)	Guideline, parent feedback
13. The spatial organisation of the NICU is decentralised with distributed support spaces, medication, disinfection, and storage etc.	B (Moderate quality)	Guideline
14. Free opening dimension to patient room varies between 1600 mm-2000 mm depending on the turning radius of a caregiver's bed and corridor width.	B (Moderate quality)	Guideline
15. Private rooms for parent counselling are available on the ward.	B (High quality)	Guideline
16. Acoustically separate rooms for professional, administrative and personal needs providing privacy and reducing noise in the NICU.	B (Moderate quality)	Guideline, healthcare professional feedback
17. Wall colors radiating comfort and homeliness are used adapted to cultural values.	B (High quality)	Guideline
Lighting		
18. Lighting within a NICU are agreed between planners, hospital, NICU staff, and parent representatives before commencing the planning process,	B (High quality)	Guideline



including the following principles: (see description)

- Ambient lighting levels in infant spaces are adjustable
- Separate procedure lighting is mounted at each infant bed
- Illumination of support areas conforms to published specifications. (33)

19. Light sources have an appropriate color spectrum and are positioned in a way that will minimise glare, shadowing, and flicker. (35)	A (Moderate quality) B (Moderate quality)	Guideline
20. Switching and dimming options are provided to allow adjustment of lighting levels for utility, comfort, and circadian stimulus. (35)	A (Moderate quality) B (Moderate quality)	Guideline
21. Parents have ready access to daylight without having to leave the NICU. (1,32,36,37)	A (High quality)	Guideline

Acoustic environment

22. Sound-absorbing materials are used for building or renovating NICUs, e.g. wall and ceiling finishes; floor surface; furnishing; doors; windows. (32,38,39)	A (High quality)	Guideline
23. Appropriate ventilation, humidification, air conditioning and heating system with high-efficiency particle air (HEPA) filtration taking into account noise levels, is provided. (40)	A (High quality)	Guideline

Patient safety

24. In patient rooms, sinks with equipment (soap, towel, and disinfectant dispenser) and space for gloves, disposable apron/smock, visors and surface disinfectants are available. The sink is placed visibly by staff walking routes and with barrier-free access. In addition, equipment for hand disinfection are available at points of care. (32,41,42)	A (Moderate quality) B (Moderate quality)	Guideline
25. An antechamber/airlock (isolation room) is provided in at least one single-family room. It is equipped with a sink, facilities for hand disinfection, respiratory	B (Moderate quality)	Guideline



protection, apron and surface
disinfectants and cabinet/shelf for
nearby storage of textiles.

26. In single-family room units, a high-level central monitoring system including a hand-held distributed alarm management system is implemented.	B (High quality)	Guideline
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Materials

27. The whole NICU (e.g. wall and ceiling finishes; floor surface; furnishing; doors; windows) is designed so that it is: <ul style="list-style-type: none">• Easy to clean• Can withstand cleaning and disinfection• Germ resistant• Free of harmful substances	B (High quality)	Guideline
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For health service

28. A national guideline on the space and layout requirements for a new NICU is available and regularly updated.	B (High quality)	Guideline
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Where to go – further development of care

Further development	Grading of evidence
For parents and family	
<ul style="list-style-type: none">• Couplet Care: the post-partum mother and the infant are cared for in the same room after birth.	B (Moderate quality)
<ul style="list-style-type: none">• Electronic links with their infant and healthcare professionals are provided for parents when they are unable to be at the bedside.	B (Moderate quality)
For healthcare professionals	
N/A	
For neonatal unit	
<ul style="list-style-type: none">• Closely monitor developments in research on NICU design and operation and incorporate new evidence into existing structures whenever feasible.	B (Moderate quality)
<ul style="list-style-type: none">• Closely monitor new developments on unobtrusive and wireless monitoring, paying respect to avoid pain and stress caused by adhesive electrodes.	B (Moderate quality)
For hospital	
<ul style="list-style-type: none">• Monitor design standards of the NICU not being inferior to similar care areas in a hospital for infants/children and adults.	B (Moderate quality)
<ul style="list-style-type: none">• Provide readily-accessible, protected outside garden, balcony, or atrium for families and staff to use without leaving the hospital grounds⁷.	B (Moderate quality)
For health service	
<ul style="list-style-type: none">• Plan design standards and resources covering the care needs of all newborn infants needing intensive care in the administrative uptake area, limiting unnecessary transfers to other levels/hospitals of pregnant women or their infant.	B (Moderate quality)

Getting started

Initial steps
For parents and family
<ul style="list-style-type: none">• Parents are involved from the earliest steps in the process of re-design/re-arrangement of the NICU in order to ensure that their needs are met.• Furniture that supports family presence (foldable beds, chairs for skin-to-skin care and breastfeeding) is provided.• Interior design is used to promote comfort and stress reduction.• A room for parents to relax and to prepare food and drinks is provided.• Parents are encouraged to form a support group that identifies shortcomings of the current NICU and advocates for change-in-place wherever possible.
For healthcare professionals
<ul style="list-style-type: none">• Be aware of new concepts of NICU design through site visits, literature review, and conference presentations to begin thinking beyond the current situation and imagine the NICU of the future to be able to create a design that is not obsolete soon after completion.



- Protect newborn infants from bright, direct lighting by use of an incubator cover and by shielding the eyes during a procedure.
- Assure diurnal cycled lighting by exposure to 250-600 lux light levels during the day, <100 lux at night.

For neonatal unit

- Provide hygiene-alcohol dispensers at point of use.
- Evaluate and improve the acoustic environment, if needed.

For hospital

- Secure close and safe transportation paths to and from obstetric department.
- Improve signage for orientation of parents and families.
- Benchmark and visit units that have already gone through a re(building) process.
- Use sound-absorbing materials for renovating or building NICUs.
- Improve acoustics with absorbing material in ceiling, on walls etc.

For health service

- Develop and implement a national guideline on the space, layout, lighting, and acoustic requirements for a new NICU.

Description

Space for infant, family and staff

Depending on the NICU department size, it is important how to organise support spaces, medication, disinfection, storage, parent's kitchen etc. By decentralising the department so that the necessary resources are added within delimited units, personnel thus not need to walk unnecessarily long distances.

The bed/cot are placed so that the patient/parent can see who enters the room. This can support the feeling of control.

Placing the patient in single rooms reduces the spread of infection between patients. Single patient rooms with anteroom can prevent droplet infection, contact infection and airborne infection between patients. Single rooms with airlock can prevent airborne infections. The lock should be such that air is prevented from passing between patient room and corridor and conversely so that the room can serve as both isolations of and from infectious patients. The lock must be dense.

It also contains easily adjustable workstations, tables and chairs. Materials and medicines, that are often used for patient care, are easily accessible from the patient/parent room and/or workstation.

It is important to have good view into the patient/parent room towards the patient. But the patient's/parent's privacy needs to be protected when the wall is transparent into the room.

A significant number of studies suggest that the ability to view nature from the built environment has a positive impact. It helps to reduce stress, promote more positive emotions and support recovery. The ability to look towards nature in the NICU can affect staff performance and increase their well-being. Informal, spontaneous meetings with nature views act as a positive diversion and stress reduction.

Humidity and temperature are important for the perception of the environment in the department and thereby affect patients. Undesirable or unpleasant odours can



increase the stress levels of patients/family. This can be reduced by good ventilation and access to fresh air from the outside.

Lighting

The following principles regarding lighting should be taken into account in NICU planning:

- Ambient lighting levels in infant spaces are adjustable through a range of at least 10 to no more than 600 lux. A color rendering index of no less than 80 and a gamut area of no less than 80 and no greater than 100 is available. Unnecessary ultraviolet or infrared radiation is avoided by the use of appropriate lamps, lens or filters. (11) Lighting fixtures are easily cleaned.
- Separate procedure lighting is mounted at each infant bed. The luminaire is capable of providing no less than 2000 lux and is framed so that no more than 2% of the light output of the luminaire extends beyond its illumination field. This lighting is adjustable so that lighting at less than maximal levels can be provided.
- Illumination of support areas within the NICU, including the charting areas, medication preparation area, the reception desk and handwashing areas is conformed to published specifications. (34)
- Ready access to daylight and nature without having to leave the NICU is ensured: At least one source of natural daylight is visible from an infant space or room, either from an exterior window or exterior clerestory located at each infant space or in each room, or from an exterior window or exterior clerestory in the staff work area adjacent to the infant space or room. Exterior window(s) located at an infant space or room are glazed with insulating glass to minimise heat gain or loss, and situated at least 0.6 m away from any part of an infant's bed to minimise radiant heat gain or loss. All external windows are equipped with shading devices that are neutral color to minimise color distortion from transmitted light.

Acoustic environment

The impact of sound reduction on short term medical outcomes, on sleep patterns at three months of age, on staff performance and on parents' satisfaction with the care needs to be evaluated in large and well-designed trials. (43) However, such trials are difficult to conduct for practical and ethical reasons. Thus, recommendations are based on the precautionary principle, as is common in environmental science. (44)

The US standards on NICU design (11) recommend that in newborn infant rooms, the sound level shall not exceed an hourly equivalent sound level (Leq) of 45 dBA, sounds should not exceed 50 dBA more than 10% of the time (L10) with transient maximum sounds (Lmax) below 65 dBA. In staff work areas and family areas, and staff lounge areas, the sound level should not exceed an hourly Leq of 50 dB, an hourly L10 of 55 dB, or with transient sounds (Lmax) not over 70 dB.

Strategies to reach these recommended levels have not been studied in depth. Using high-performance sound-absorbing materials to build or renovate the NICU has been suggested. (32,39) Single rooms seem to be quieter than open-bay rooms except for respiratory support equipment. (45,46) The continuous use of sound-monitoring equipment leads to reduction in the sound level for 2 months, but no longer. (47) Changing the behaviour of staff members and the culture of the NICU team is



complex. Implementing a “quiet hour” could be a feasible first step. (22)
Developmental care training could have an impact on the NICU environment.
Providing an adequate acoustic environment to hospitalised newborn infants is not only based on protecting them from the deleterious effect of noise but also to offer them a nurturing environment enabling the access to biologically meaningful sensory stimuli (see TEG Infant & family-centred developmental care)

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