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Individualized developmental care for high risk newborns in the NICU: A practice guideline

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Abstract The newborn infant in the neonatal intensive care unit (NICU) is cared for with highly advanced medical technology, but the incidence of disability and neurodevelopmental problems among survivors remains high and problematic. Preterm birth disrupts the developmental progression of brain structures and affects development of the sensory systems. The Synactive Theory of Development provides a framework to conceptualize the organization of the neurobehavioral capabilities in the early development of the fetus, newborn and young infant. The infant's ability to regulate and control behavior emerges through continued interaction with the environment and is expressed through five systems: autonomic/physiology, motor, state, attention/interaction and self-regulation. In the healthy full term newborn the five subsystems are mature, integrated, synchronized and managed smoothly. The less mature, healthy or sick preterm newborn may be unable or partially able to manage environmental inputs, demonstrating over-reactive responses and poor tolerance from even minimal input. Loss of control and stress responses become frequent unless the environment and caregivers work to read the infants' messages and thresholds for sensitivity and adjust care and handling and the environment based on the infant's behavioral communications. The Newborn Individualized Developmental Care and Assessment Program (NIDCAP) is a comprehensive program which includes a behavioral observation methodology and creation of individual family centered developmental caregiving support of the infant's own developmental goals. The NIDCAP approach seeks to support the infant's stabilization and organization of the autonomic, motor, and state systems at each level of maturation, while minimizing stressful events.

Contents

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1. Introduction

The newborn infant in the neonatal intensive care unit (NICU) is cared for with highly advanced medical care, which has demonstrated remarkably effective success in treating high risk infants and premature illness [1]. However impressive the advanced medical technology, the incidence of disability and neurodevelopmental problems among survivors of neonatal intensive care remains high and problematic [2–6]. In spite of increased survival rates in high risk newborns, the incidence of premature born infants in the United States has risen to 12% of all live births and 18% of African–American births (US Health/Human Services, 2003). Infants who begin life in the NICU have high morbidity issues and a disproportionate need for medical care. Several factors associated with low birth weight impact outcome including severity of illness, chronic lung disease, bronchopulmonary dysplasia, brain injury and retinopathy of prematurity [2]. These factors have been associated with a significant increase in the likelihood of poor neurodevelopment outcome of low birth weight infants. Increasing numbers of fragile and low birth weight infants are represented in the less than 1500 gram newborn population [2]. The incidence of cerebral palsy has not changed over the past 10 years. Moreover, by the age of 8 years, over 50% of very low birth weight preterm children require special educational services and 15% have repeated at least one grade in school [7].

2. Why developmental care?

Neurodevelopmental outcome has become a benchmark in determining the effectiveness of medical neonatal care [2]. In the first developmental outcome studies, the primary focus was on identification of major disabilities including moderate to severe mental retardation, sensorineural hearing loss/blindness, cerebral palsy and epilepsy [1]. Depending on birth weight, high risk newborns have shown up to a 25% incidence of handicapping conditions [1,8]. Due to extended follow-up developmental monitoring, more refined assessment techniques and improved survival rates [2] an increase in neurodevelopmental problems has been identified. These problems include learning disabilities, low average IQ scores, attention deficit hyperactivity disorder, neuropsychological deficits, visual motor integration, executive function, varying temperament difficulties, language delays, emotional problems and regulatory disorders [1,2,6,7,9]. These neurodevelopmental dysfunctions are present in up to 50–70% of very low birth weight premature infants whose developmental outcome will be questionable for years.

More than one half of very low birth weight children will require special education; more than 20% will need self-contained disabilities management [9,10]. The outcome studies to date demonstrate that the effects of premature birth not only are found in neuroimaging studies, but manifest in subtle, but long term deficits in several areas of life function [2,4,10–12]. Such difficulties have been shown to place the low birth weight premature infant at higher risk for child abuse [13,14], regulatory disorders [15] and poor relationships [16,17].

3. Early brain development

The impact of the NICU environment on the long term development of the brain has been acknowledged [1,18]. At the time of premature birth, the developing fetal brain is displaced to the NICU during a critical rapid period of brain maturation [19]. Preterm birth disrupts the developmental progression of brain structures [20]. Several critical areas of brain development are affected and include specifically the processes of brain growth, cell migration, synaptogenesis, myelination and brain organization [21].

The preterm sick infant is a misplaced fetus who is developing in an extra-uterine environment at a time when the fetal brain is growing more rapidly than at any other time in the lifespan [19]. The fetal phase of development for the full term infant typically occurs in the mother's womb with complete maternal protection from the environment. The fetus is provided with an ongoing supply of nutrients, regulation of temperature, and several maternal regulating processes [22]. Thus, the premature infant who has been removed from the warm, fluid filled womb prior to the 37th week of gestation, experiences a dramatic "mismatch" with a replacement of the mother's protective nourishing womb by a highly variable NICU environment. Research has documented the vastly different sensory exposures experienced by the infant in the NICU compared to that of a full term healthy newborn taken home immediately after birth. Studies increasingly document that the environment of the NICU itself exposes infants, parents and staff to a constant barrage of negative, variable, non-contingent stimuli [23–25]. The

Table 1
Sequence of the development of sensory systems [28]

1. Touch
2. Kinesthetic/proprioception
3. Vestibular
4. Smell and taste
5. Vision

discrepancy between the maternal experience in the womb and the NICU experience presents the early born infant with significant challenges that influence the infants' physiological, emotional and social development [22,26,27].

4. Sensory systems development

Neonatal sensory development emerges in specific sequence over the course of fetal life (Table 1). During the rapid period of maturation of each sensory system, other sensory stimuli do not advance, and avoid competing with the currently emerging system [28]. Each emerging event takes place in a biologically ordered chain of events. For example the maturation of hearing in the fetus is most intense during the specific time that vision is not developing and is not being stimulated by light. Animal studies have shown [29–31] that if one system is stimulated to occur out of the typical sequence the development of that system will interfere with the development of the currently emerging system (for example, the premature infant experiences ongoing exposure to environmental stimuli in the NICU and develops hearing and vision at the same time, instead of in the intended sequence). In addition interference will also occur to other sensory systems as they try to mature [32]. For example, in animals it has been shown that inappropriate visual activation during the stage of the development of hearing, not only will alter hearing, but will also affect vision [28,33,34]. Thus sensory input introduced to the growing organism before the sequence is ready to be activated, may interfere with that organism's development of perceptual and behavioral development [33].

NICU light has a direct impact on physiological stability and central nervous system organization [34]. Infants in the NICU may experience intense arousal effects from light and noise. Light changes in the NICU are often due to treatment and do not consider for the developing diurnal rhythmic patterns of the infant. It has been suggested that the visual environment of the NICU may alter visual acuity, color vision, problems with visual processing, visual attention, pattern discrimination, visual recognition memory, and visual motor regulation [35,36]. Measurements used to describe light environments include irradiance (kind of light) or illuminance (brightness) and are described in terms of lux (lumens/m^2) [37,38] or foot-candles (ftc). Lux divided by 10 is closely equivalent to foot-candles. The American Academy of Pediatrics in the l970s recommended that light in the NICU should not be brighter than 100 ftc for adequate visualization of NICU patients. Light intensity in the NICU has been measured to show ranges from 192 to 1488 lx (or l9 to 148 ftc) with greater intensity during day rather than night hours [39]. Treatment lamps used in the NICU average up to 350 ftc and bilirubin lights may be as high as 10,000 ftc [34].

Studies to date have reported that infants who experience reduced light levels for some portion of the NICU day shifts demonstrate reduced heart rate, decreased activity, enhanced biologic rhythms, increased sleep and improved feeding and weight gain [35]. Increased infant stability and energy conservation has been demonstrated when environmental stimuli is reduced and monitored [39].

These studies represent the current state of the science in NICU lighting and demonstrate that appropriate and safe lighting levels in the NICU have not been established. The Committee for Recommended Environmental Standards in the NICU [40] recommends that until such data are available that baseline levels of ambient light should be monitored in NICUs at the range of 1–60 ftc and staff should be informed about the current concerns of intense stimuli exposure and the effects on newborns and adults. In fact, recent evidence suggests that light levels should be "very dim" for part of a day in the NICU. Recommendations state that moderate light levels should prevail throughout the day. Light levels need to take into account flexible accommodation to meet the developmental range of infant function in the NICU from very immature to recovering postterm infants. Direct ambient light in infant care spaces should be avoided except during procedures [40]. Graven [28] states that premature infants in the NICU need not be exposed to light until reaching term age. Premature infants only need exposure to light to facilitate biologic rhythms [28]. Working to decrease light and sound in the NICU is an important part of providing developmental support and safe caregiving [37,41] (Table 2).

4.1. Visual system

The visual system begins its complex developmental course in fetal life between 30 and 32 weeks of gestation. This

Table 2
Recommendations: light in the NICU

– Avoid direct light of infant care space except for procedures
– Avoid sensory overstimulation in the NICU environment
– Individualize light exposure — provide several choices for light reduction at each bedside through small shields, covers for incubator
– Protect and facilitate REM sleep [28]
– Support quiet alertness and restful sleep
– Support for smooth transition from sleep to wake and vice versa
– Note each infant's level of threshold for light via behavioral signals for disorganization/stress
– Know light equipment lux levels of brightness and adjust to reduce infant exposure (i.e., warming lights during bath time should be directed from back of infant, not side or front facing head on)
– Provide for day/night cycling with protocols for lower lights during night time hours
– Limit intense competing stimuli from other NICU sources and noise

system is fully developed by three years of age. The visual system is the last of the sensory systems to develop and is the most mature sensory system at full term birth. Full term newborns are born with still undeveloped vision. The visual system undergoes significant maturation during the first 4 months postterm. Rapid development of visual neuronal connections and processing occurs between 28 and 34 weeks of gestation [34]. The visual system develops through interaction with the visual environment and exogenous stimuli from the normal environment over the course of three years. Activities of the visual system through its developmental course include the function of reception, perception and recognition of visual images. As the system matures visual input takes on meaning and images interrelate and interconnect in order to complete development [28].

4.2. Auditory system

The auditory system or the infant's hearing system is well underway at term birth. The neurological structures required for hearing development evolve early in utero. Fetal response to sound has been shown to be evident as early as 23 weeks of gestation. The auditory system matures gradually and by full term birth, newborns have experienced listening for at least 10–12 weeks [42]. Sound is produced when a physically vibrating source creates a pressure change in the surrounding medium, called sound waves, which vary in loudness and frequency. The human ear is sensitive to these vibrations which may range from 20 to 20,000 vibrations per second [43]. Loudness of sounds is described by decibels (dB). Normal calm adult conversation ranges in loudness between 45 and 55 dB. If a sound increases 10 dB it actually increases exponentially because sound loudness is quantified in units of decibels (dB) and is a logarithmic scale. Sensitivity to excessive noise begins at 6 months gestation and extends through the newborn period to 2–3 months after birth. Premature infants are more vulnerable to the effects of noise exposure because of their immaturity. Ongoing exposure to alarms, noisy incubators (up to 80 dB) and loud jarring sounds occurring regularly in the NICU environment places premature infants at risk of noise induced hearing loss [44]. NICU infant stress reactions including physiological and behavioral changes have been associated with sound levels in the incubator [32,45].

Table 3
Recommendations: noise in the NICU [40]

- Provision of minimal background noise and sound absorption in infant care spaces
- Sound levels shall not exceed 50 dB and hourly L10 of 55 dB
- Transient sounds should not exceed 70 dB
- Equipment in NICU should have noise levels of <40 dB
- Spaces and adjacent areas to NICU should not amplify sound levels
- Creation of a developmental multidisciplinary team to facilitate staff agreement to reduce and monitor sound reduction in NICU

Even though several recommendations have been published to reduce sound and monitor noise in the NICU, the reduction of consistent sound levels in the NICU continues to be an ongoing issue [37]. Staff regularly works hard at the bedside to adjust sound levels however, until sound absorption is mitigated through NICU redesign, the problem of excessive sound reverberation will persist in the NICU [40,46]. The most successful reduction in sound reduction in the NICU takes place when sound absorbing materials are integrated into architectural unit design [46].

Attention to reducing sound levels should be a basic tenant of all developmental programs in the NICU (Table 3). Hearing is not only essential for normal language development, but is important for the development of attention and perception. Difficulties in processing sound and sound interpretation result when sound does not develop appropriately. Attention to tasks, and to visual stimuli, to integration of sound with touch and vision are important and necessary functions. The ability to screen out sound appropriately and to inhibit sound input is an essential auditory system function. Developmental difficulties resulting from sound processing can be seen in distractibility, hyperactivity, inhibited or disorganized responses to sound [46].

5. Neonatal neurobehavioral development

The Synactive Theory of Development [47] provides the framework to conceptualize the organization of the neurobehavioral capabilities in the early development of the fetus, newborn and young infant. The Synactive Theory of Development specifies the degree of differentiation of early infant development [47]. This model is based on the assumption that the infant actively and consistently, through his behavior, communicates his/her thresholds for sensitivity versus competence. The range of infant behaviors becomes evident as the infant matures.

The infant's ability to regulate and control behavior emerges through continued interaction with the environment (whether the womb, NICU, home) and is expressed through five systems: autonomic/physiology, motor, state, attention/interaction and self-regulation [47]. A major tenant of the Synactive Theory states that practitioners do not attend solely to behavior cataloguing of infant behavior, but attend to and appreciate exquisitely the infant's unique individual capacity to manage input from the external world surrounding him/her.

The five subsystems are interdependent and interrelated. For example, physiological stability lays the foundation for motor and state system control. State organization, the management of sleep–wake cycles, creates a component of self-regulatory competence. Concomitantly, the loss of integrity in one system influences the other systems, as they manage environmental demands.

In the healthy full term newborn the five subsystems are mature, integrated, synchronized and managed smoothly. All five systems are managed easily and without stress. The less mature, healthy preterm or sick preterm may be unable or partially able to manage environmental inputs, demonstrating over-reactive responses and poor tolerance from even minimal input. Loss of control and stress responses become frequent unless the environment and caregivers work to read

the infants' messages and thresholds for sensitivity and adjust care and handling and the environment based on the infant's behavioral communications. Thus, Als and Lawhon [22] state that "stimuli that are poorly timed are seen to penetrate and disrupt all subsystems, whereas appropriately timed stimuli appear to maintain and enhance functional integration and support growth".

5.1. Development of self-regulation

The ability to regulate or control one's autonomic, motor and state organization is a requirement of early development [48]. Early self-regulation is accomplished in the mother's body as a fetus, and continues over the course of the first three years of life after birth. Initially, the tasks involve the regulation of physiological function including maintenance of body temperature, regulation of day–night cycles, homeostasis of physiologic function including breathing, heart rate regulation and maintenance of visceral control. Eventually, the infant learns to begin to calm himself and relax even after mild stress. As an infant matures in the context of daily interactive care from consistent primary caregivers, self-regulation becomes the task of learning to control motor behaviors, sleep–wake cycles, attention and interaction [48–50]. Eventually, these capacities merge into emotional regulation.

The process of learning self-regulation in the newborn period and thereafter is deeply embedded in the context of relationships [50,51]. Caregivers and parents become the infant's "co-regulators" and support infants by accurately reading and interpreting the infant's behavioral signals. From infant communicated information, the caregiver facilitates the infant's balance of internal systems. These interactions require caregiver sensitivity, knowledge and energy to provide the infant with mutually satisfying experiences. As the ability to achieve self-regulation progresses beyond infancy, parents and caregivers gradually shift the independent task of self-regulation to the child [51].

The developmental and social agenda of infants from birth include the necessity to engage in social interaction with others, maintain proximity to the caretaker, act on objects and engage in interactions which give pleasure and reciprocity [50–53]. Infants possess sensitivity to intentional behavior in others, demonstrate joy, interest [51], effort and vitality [52]. The human infant appears to be programmed to detect and relate to qualitative differences in caregivers and to elicit from birth an emotional relationship.

5.2. The Newborn Individualized Developmental Care and Assessment Program (NIDCAP)

The Newborn Individualized Developmental Care and Assessment Program (NIDCAP) is a comprehensive program which includes a behavioral observation methodology and creation of individual developmental caregiving support of the infant's own developmental goals [54,55]. By observing the infant throughout routine care (before, during and after) and documenting the infant's behavioral communications, the professional may estimate the immature nervous system's ability to tolerate the environment and caregiving events. Such an assessment provides the opportunity to determine the readiness and appropriateness of environmental and caregiving events for the infant [49].

The observation is a continuous systematic 2 minute time sampling, which identifies and catalogues the autonomic, motor, state and attention behaviors [56] during NICU caregiving. From the information collected the developmentalist interprets and translates the behavioral information into a descriptive narrative which identifies the infant's current goals. The assessment becomes the basis for creation of specific individualized developmental caregiving plans in order to support the infant's developmental agenda. The implementation and education of the individualized careplans is facilitated by an infant developmental specialist. Without compromising medical care delivery, the infant development specialist continually supports the adjustment of the environment and caregiving in the direction of the infant and parents' developmental needs. Specialized training is available from sixteen NIDCAP Training Centers.

The NIDCAP approach is based on the premise that the infant's own behavior provides the necessary information in order to determine the infant's current capabilities. The focus is on what the infant requires to accomplish to achieve neurodevelopmental and behavioral competence [49].

The infant's behavioral language may indicate disorganization (stress) or smooth function (stability) through five subsystems of behavior [56] including autonomic/physiologic, motor system, state system, and attention and interaction, as well as self-regulation behaviors [56]. Sensitivity to these signs of organization or disorganization provides the caregiver with an understanding of each infant's threshold for activity and stimulation. The healthy full term infant easily achieves stability of the systems within the initial days after birth. The regulation of breathing, temperature stability, digestion and cardiac function is established smoothly. Motor stability is seen in the emerging smooth movements, controlled postures and consistent regulation of tone. Sleep and waking cycles are differentiated and a calm, bright alert state appears in the first few days [57]. This stability of the systems manifests in smooth function and reflects intact organization and central nervous system control.

The less mature newborn who spends the first weeks and months in the NICU may demonstrate a less mature level of balance between the systems reflecting central nervous system disorganization [47,56]. The responses of the young sick premature infant may be expressed physiologically rather than behaviorally [25,49]. Very subtle cues in the infant's physiologic patterns may show variations in skin color, fluctuations in heart rate or breathing, presence of startles or tremors [56]. Such reactions may indicate that environmental stimuli of light or noise or even caregiving events such as turning the infant or changing the diaper, may be overwhelming. Deciphering the infant's immediate responses becomes essential to effectively plan individualized developmental caregiving. Moreover, because the function of systems occurs simultaneously, the regulation of autonomic function takes place in conjunction with regulation of motor balance, and organized state management. The process of development requires initial stabilization and integration of the autonomic, motor, state and attention systems, which then allows for emergence of new capacities, which yield an integrated regulated system

evolving toward more sophisticated levels of organization throughout the lifespan [22,56,58,59].

6. Individualized developmental family-centered care in the NICU

6.1. Approach to NIDCAP care in the NICU

The approach to providing individualized developmental care includes fostering neurobehavioral and physiologic organization of the infant's systems of autonomic, motor, state and attention and self-regulation [49]. Strategies to support the achievement of stability and reducing stress must include an ongoing accurate and sensitive assessment of the infant's current developmental capacities taking into account the infant's medical status. An assumption underlying such an approach recognizes that the NICU infant is vulnerable to sensory overload and overstimulation [25,47,49]. Thus, the approach to the provision and implementation of developmental care does not focus on the achievement of developmental milestones, nor does it seek to stimulate the infant to demonstrate skills and performance. Rather, individualized developmental care seeks to support the infant's stabilization and organization of the autonomic, motor, and state systems at each level of maturation and while reducing stress. The NIDCAP approach supports the infant to demonstrate increasing tolerance for stimuli and minimize stressful events, which have the potential to be costly in terms of energy expenditure, caloric utilization and physiological homeostasis [60]. The NIDCAP approach has also shown that a reduction in the need for sedation results when behavioral support is included with pharmacologic intervention [61].

The developmental approach views sensory input as an important and necessary parameter in fostering central nervous system development. Sensory input must be appropriate and individualized to the infant's physiological and neurobehavioral tolerance as the infant achieves increasing stabilization. Each caregiver, whether medical staff or parent needs to recognize that for the ill, unstable or fragile infant the best form of sensory input, may be no input at all, necessitating a plan of reduction of surrounding stimuli. Ongoing observations, including the formal, systematic NIDCAP assessment provide essential information, help caregivers recognize early signs of sensory overload and initiate appropriate care strategies to avoid overstimulation and support balance [37]. A thorough and accurate assessment and translation of the NICU infant's communications behaviorally, furnishes the developmentalist with the information necessary to recommend a construction of the caregiving environment to adapt the NICU to the infant's needs.

Figure 1 Appropriate positioning aides support flexed positions.

Figure 2 Handling is slow and based on infant's cues.

The infant's care involves numerous medical procedures and handling events carried out by many medical professionals in the course of a NICU stay. Provision of consistency in caregiving at all levels and across shifts supports the infant to be regularly "heard" and promotes energy saving interventions for the infant.

One of these caregiving practices involves primary nursing, which provides continuity of caregivers. The consistent primary nurse who comes to know along with parents, the unique and intimate interactions of the infant can effectively utilize the infant's behavioral messages in consistent individualized care delivery. To be even more effective, a primary care team including a primary physician, respiratory therapist, social worker, and an infant developmental specialist may enhance the provision of consistent care. NIDCAP research studies have shown that this component of care delivery is a significant and essential part of individualized developmental care implementation [18,22,62–64].

6.2. The interpretation of behavior

In order to determine the infant's current developmental needs, the developmental nurse or professional must review the infant's medical and family history, as well as the infant's current medical status. Questions to ask include:

1. What are the infant's physiological communications?
2. How does he tell us he is tired, exhausted?
3. What is he trying to do to help himself?
4. What is this baby's behavior saying in terms of what he wants to accomplish?

Care in this mode becomes infant-centered and not caregiver-centered. The caregiver, seeing and acknowledging the behavior of the infant, then supports the infant in order to provide care to facilitate the infant's self-calming, always watchful of any signs of stress that may need to be managed. Attention to the infant's thresholds and need for rest or stopping handling altogether is essential.

6.3. The role of the infant development specialist (IDS)

Provision of consistent individualized developmental care requires the support and collaboration of all professionals in the NICU, who with parents, provide the delivery of care practiced in consultation with professional developmental disciplines. The developmental professional provides individual NIDCAP assessment and creates a written plan of suggestions, which invite bedside caregivers to review, consider and discuss specific aspects of care based on the infant's communicated developmental needs.

Areas for review include positioning the infant, handling, and support during diapering, bathing and turning, to name a few. Additional suggestions may include preparation for handling, support throughout medical procedures and caregiving events, and for management of the infant's recovery after the caregiving in order to facilitate the infant's returning to stable relaxation (Figs. 1 and 2).

Parents are active members of the primary care team and participate as members of the health care team including posting notes in the chart, presence at daily rounds, having access to their infant at all times and participation in decision making. Research has shown repeatedly that highly trained NIDCAP reliable developmental professionals are essential to improve developmental and medical outcome for NICU infants and enhance confidence and reduce stress for parents [18,22,62,63].

The role of the infant development specialist (IDS) in the NICU has been well described [65]. Typically the position in the NICU is provided by a highly trained, experienced infant developmentalist. The position requires one full time equivalent per 30 bed NICU and may be filled by an experienced advanced graduate degree professional who is knowledgeable in the atypical, normal and neonatal development. The developmental professional also must be experienced in understanding the NICU culture, staffing issues, medical conditions and course of patients, as well as the social dynamics of parents. The IDS provides the NICU and family with specialized developmental assessment of the infant's neurodevelopment and creates and implements the individualized developmental recommendations with family input and staff coordination. The IDS supports the NICU personnel and family to maintain a developmental perspective throughout all care delivery. This includes review and documentation of the infant's 24 hour daily cycle and review of infant sleep–wake patterns, timing of all procedures and caregiving events. The IDS is responsible for communication of the developmental information and careful planning with staff to implement the developmental recommendations. Partnering with medical staff to work "through" the nurse and/or parent is essential. The delivery of developmental intervention suggestions may be more successfully implemented when intervention strategies are discussed and evaluated at the bedside with staff and parents. Suggestions are made with attention to appropriate and sensitive evaluation of the infant's state and readiness for developmental handling. Suggestions become part of all care and handling for the primary caregivers, the nurse and the parent, and are delivered through the hands of these caregivers.

A primary goal for the NICU staff and IDS/Team is fostering of a positive parent–infant relationship with mutual responsiveness in their interactions with their infant. The infant in the NICU should be viewed as an active participant in the parent–infant interaction [66,67] (Fig. 3). The first weeks and months of an infant's life during their NICU stay, can lay a foundation of positive feelings or of ambivalence and

Table 4
Key elements for implementation of individualized developmental family-centered care

1. The parent is the primary caregiver and needs support to begin to establish a mutually satisfying relationship with their infant in the NICU. NICUs support parent–infant relationships through recognition of parents as members of the health care team with provision of consistent parental involvement in caregiving,
2. The presence and active involvement of at least one funded NIDCAP reliable infant developmental specialist who:
   a. provides consistency of developmental support to medical staff, family and the infant,
   b. conducts regular NIDCAP observations and bedside/staff/parent teaching; articulates and adjusts the NICU to the developmental needs of the infant including facilitation of sensitive, flexible direct caregiving, modifications and provision of appropriate bedding, positioning and facilitation of state organization, attention, sleep and alertness, and
   c. articulates the tenants of individualized developmental care and implementation into a systems wide approach and guide the developmental program with sustainable leadership.
3. Creation of a calm NICU environment with adjustable low levels of light, minimal low levels of sound, sound absorption and a calm ambience. Such an environment also includes space for the families needs and meets the developmental needs of individual infants. NICU practices allow and respect the privacy of parents and their infants.
4. Provision of sensitive care and handling based on an accurate reading of infant behavioral signals and respect for the message that the infant communicates, along with recognition that the infant actively participates in all aspects of care delivery.

Figure 3 A key goal is facilitation of parent-infant interaction.

negativity, which has consequence for nurturing stability of the parent–infant relationship. This important relationship is biologically and psychologically essential for the infants' survival and development.

Infant reactions to being touched may yield a series of startles and limb extensions followed by flailing, arching and uncontrollable squirming, which becomes an ongoing continuous movement. The infant may experience an unbreakable cycle of costly energy expenditure, which cannot be detected until the infant either stops breathing or drops his oxygen level or heart rate [41]. The infant then is using energy he desperately needs to maintain his physiological stability. This high reactivity interferes with his growth and may prevent recovery [49,68]. Another reactive issue for the premature infant may be seen in a pattern of lethargic, depressed responses by an infant who cannot respond to environment or handling stimuli [47,56]. This infant may be unresponsive and lie in the bed, limp and flaccid, unable to put any energy into responding to his/her nurse or parent. He may develop minimal ranges of responsiveness [49]. This infant is uncommunicative. He appears depressed to his caregivers and is unable to respond to their efforts to interact with him/her.

Many low birth weight premature newborns in the NICU demonstrate these response patterns during their most stressful and sickest days in the NICU. They continue to react with intense sensitivity to their environment and to handling. As the infant continues to recover, with the supports in place and sensitive caregivers, who understand his signals for slowness, gentleness and quiet, the stressful behaviors begin to disappear and are replaced by a more modulated level of responsiveness. Infants may demonstrate more energy after care, and less irritability and may eventually begin some brief interactions [69].

In this way, increased awareness of management of environmental stress, agitation, overstimulation and instability have led to changes in caregiving in NICUs. Staff now provides protective nurturing environments with increased understanding of the behavioral and developmental needs of NICU patients.

7. Guidelines for implementation of individualized family-centered developmental care in the NICU (Table 4)

Implementation of individualized family-centered developmental care includes a multidisciplinary and collaborative approach (Table 4). NICU management and hospital administration, along with medical, social and developmental professionals establish working relationships with professional NIDCAP trainers who are certified by the NIDCAP Federation International (NFI), the international governing board of the NIDCAP Model (see http://www.nidcap.org/centers.html for NIDCAP Training Centers).

7.1. Individualized family-centered developmental care and the NICU system

The NICU is a system unto itself, but it is also part of a larger entity – the hospital. Understanding systems wide processes is helpful in order to recognize the changes, attitudes and adaptations that have occurred due to individualized developmental care (NIDCAP). The implementation of NIDCAP in the NICU encompasses changes in values, increased collaboration, incorporation of behavioral science knowledge, and adaptations which could lead to improvement in the life and culture for professionals and patients in the NICU system [70]. The implementation of a focus on relationship-based care induces a change in values within the NICU, marked by realization that personal growth and development is important. In addition, developmental practitioners work to support many disciplines within the NICU and focus to integrate the differences in those disciplines, while valuing the similarities of each. The primary focus for all becomes care of the infant and family. Effectiveness in achieving this goal is paramount in spite of dramatic changes occurring in medicine, nursing, and hospital administration. NICUs are part of the overall goal of the hospital organization which strives to meet financial goals, improve care for patients, and meet the goals of their corporate leaders.

Individualized developmental care is a method of care which is changing how the hospital organization addresses patient needs, and it is changing care directly at the bedside. It has been part of the impetus for direction in remodeling and restructuring the environments of NICUs throughout the world. Increased respect and sensitivity has become an integral value in the NICU, and in spite of the technology, care is changing toward an awareness of the tiny infant at the center of it all.

A NICU, which has implemented the NIDCAP approach, provides a primary team of physicians, nurses, social workers, and infant developmental specialists identified within the first 24 h after birth. This team of NICU professionals will become a primary team for each infant and family throughout their course in the NICU. An individualized plan of care will be developed by this team of professionals who work together and with the family to implement the developmental family-centered care-plan [22]. The infant development specialist becomes a resource and facilitator reviewing the infant's unique developmental needs and consistently supporting the staff and family through changes and adjustments in caregiving at each stage of NICU care. The multidisciplinary professional team of developmental specialists will support the NICU in advancing the implementation of developmental care throughout the NICU. Such a focus could include planning and presenting individual case presentations in developmental rounds, creating working committees to carry out specific unit developmental projects, adjusting and modifying the environment, and/or developing a parent advisory or support group.

Individualized developmental care for NICU infants has as its goal the preservation of energy for the infant, fostering self-regulation, prevention of agitation and stabilization of the physiological system. Strategies to enhance infant regulation of autonomic, motor, and state function are based on careful behavioral observation throughout care and handling and individualized to the age and clinical condition of the infant. Support may be specific to the fragile infant who needs protection from environmental stimuli, as well as for the recovering infant who needs facilitation for appropriate social interaction. Ongoing observation of the infant's responsiveness to handling and the environment is a continuous focus. Activities which disturb or disrupt the infant's balance, as

evidenced by avoidance or stressful patterns of behaviors should be avoided and stopped.

It is now recognized that implementation of the NIDCAP approach involves much more than offering reduced light and noise and provision of a positioning aide for infants. The complete adoption of the NIDCAP methodology supports a NICU to undergo a paradigm cultural shift. A NIDCAP NICU provides an experience for infants and families, which, along with advanced medical care, offers flexible sensitive caregiving based on the infant's behavior as a guiding principle. Such care ensures a unique caregiving experience for the infant and family and creates the opportunity for significant improved outcome.

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