Turun yliopisto
University of Turku

PARENT-INFANT CLOSENESS AND FAMILY-CENTERED CARE IN NEONATAL INTENSIVE CARE

Simo Raiskila

TURUN YLIOPISTON JULKAISUJA - ANNALES UNIVERSITATIS TURKUENSIS
Sarja - ser. D osa - tom. 1378 | Medica - Odontologica | Turku 2018

Turun yliopisto
University of Turku

PARENT-INFANT CLOSENESS AND FAMILY-CENTERED CARE IN NEONATAL INTENSIVE CARE

Simo Raiskila

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
Sarja - ser. D osa - tom. 1378 | Medica - Odontologica | Turku 2018

University of Turku

Faculty of Medicine
Department of Clinical Medicine
Paediatrics
Doctoral Programme in Clinical Research
Turku University Hospital
Turku, Finland

Supervised by

Professor Liisa Lehtonen, MD, PhD
Department of Clinical Medicine
Paediatrics
University of Turku
Turku University Hospital
Turku, Finland

Associate Professor Anna Axelin, RN, PhD
Department of Nursing Science
University of Turku
Turku, Finland

Reviewed by

Docent Ulla Sankilampi, MD, PhD
Department of Pediatrics
University of Eastern Finland
Kuopio University Hospital
Kuopio, Finland

Professor Dominique Haumont, MD, emeritus
Department of Neonatology
Free University of Brussels
Saint-Pierre University Hospital
Brussels, Belgium

Opponent

Professor Leif D. Nelin, MD, PhD
Center for Perinatal Research
The Research Institute at Nationwide Children's Hospital
Columbus, Ohio, USA

The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

ISBN 978-951-29-7346-0 (PRINT)
ISBN 978-951-29-7347-7 (PDF)
ISSN 0355-9483 (PRINT)
ISSN 2343-3213 (PDF)
Painosalama Oy – Turku, Finland 2018

To my wife and children

ABSTRACT

Simo Raiskila
Parent-infant closeness and family-centered care in neonatal intensive care

University of Turku, Faculty of Medicine, Department in Clinical Medicine, Paediatrics, Doctoral Programme of Clinical Research, Turku University Hospital, Turku, Finland

Annales Universitatis Turkuensis, Medica-Odontologica, Turku, Finland 2018

Early interaction and closeness with a caregiver are important for the development of newborn infants. Postpartum separation between parent and newborn is still common in the hospital care of premature babies. Parent-infant closeness in neonatal units can be supported by a family-centered care culture, in which hospital care for the newborn is implemented in cooperation with parents. Measuring both parent-infant closeness and family-centered care culture is challenging, and hardly any prospective metrics reported by parents exists in the literature.

The aim of this dissertation was to examine a) first the closeness between the infant and parent, b) second the parents' participation in their infant's care and how each are supported, and c) third how family-centered care practices are implemented in neonatal intensive care units (NICUs). New measures were developed and tested in order to obtain reliable information on the physical closeness between parent and infant and the perceived quality of family-centered care in NICUs.

The results of the present study indicate that it is possible to modify care practices to better support parent-infant closeness and parents' participation in their infant's care without endangering the growth of the premature infant or lengthening hospitalization. In a prospective multi-center study including 11 NICUs in 6 European countries, differences among countries as well as among units within the same country were observed. The most significant factor explaining the observed differences was the possibility for parents to stay overnight in the unit. The new methods developed and validated in the present study can be used in the future, for example in studies exploring the effects of parent-infant closeness on short- and long-term outcomes of the hospitalized newborns. With these new tools, it is also possible to support the implementation of FCC practices.

Keywords: preterm, NICU, Family-centered care

TIIVISTELMÄ

Simo Raiskila
Vanhemman ja lapsen välinen läheisyys ja perhekeskeinen hoito vastasyntyneiden teho-osastohoidossa

Turun Yliopisto, Lääketieteellinen tiedekunta, Kliininen laitos, Lastentautioppi, Turun kliininen tohtoriohjelma, Turun yliopistollinen keskussairaala, Turku, Suomi

Annales Universitatis Turkuensis, Medica-Odontologica, Turku, Suomi 2018

Varhainen vuorovaikutus ja läheisyys ovat tärkeä perusta vastasyntyneen kehitykselle. Vanhemman ja vastasyntyneen välistä läheisyyttä sairaaloissa voidaan tukea perhekeskeisellä hoitokulttuurilla (Family-centered care), jossa vastasyntyneen sairaalahoito toteutetaan yhteistyössä vanhempien kanssa. Läheisyyden ja perhekeskeisen hoitokulttuurin mittaaminen on haastavaa ja kirjallisuudesta ei juuri löydy prospektiivisia vanhempien raportoimia mittareita.

Tämän väitöstutkimuksen tavoitteena oli selvittää, miten vanhemman ja lapsen välistä läheisyyttä ja vanhempien osallistumista keskosen hoitoon tuetaan ja miten perhekeskeisiä hoitokäytäntöjä toteutetaan vastasyntyneiden teho-osastoilla. Tutkimuksessa kehitettiin ja testattiin uusia mittareita, joilla voidaan saada luotettavaa tietoa vanhemman ja lapsen välisestä fyysisestä läheisyydestä ja perhekeskeisen hoidon laadusta vastasyntyneiden teho-osastoilla.

Tutkimuksessa todettiin, että vastasyntyneiden teho-osaston hoitokäytäntöjä voidaan muokata läheisyyttä ja vanhempien osallistumista tukevampaan suuntaan vaarantamatta keskosen kasvua tai pidentämättä sairaalahoitoaikoja. Eurooppalaisessa monikeskustutkimuksessa osoitettiin eroja niin eri maiden välillä kuin myös saman maan sisällä eri yksiköiden välillä. Selkeimmin eroja selittävä tekijä oli vanhempien mahdollisuus yöpyä osastolla. Tutkimuksessa käytetyt prospektiiviset mittarit osoittautuivat helppokäyttöisiksi ja vähän kuormittaviksi, ja pystyivät osoittamaan merkittäviä yksiköiden välisiä eroja. Uusia menetelmiä voidaan tulevaisuudessa hyödyntää esimerkiksi selvitettäessä vanhemman ja lapsen välisen läheisyyden fysiologisia vaikutuksia ja vaikutuksia pitkäaikaiskehitykseen. Kehitettyjen mittareiden avulla voidaan myös tukea perhekeskeisten hoitokäytäntöjen käyttöönottoa.

Avainsanat: keskonen, vastasyntyneiden teho-osasto, perhekeskeinen hoitokulttuuri

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

HPA axis	Hypothalamus–pituitary-adrenal axis
FCC	Family-centered care
SCC	Skin-to-skin contact
VLBW	Very low birth weight
gw	Gestational week
MRI	Magnetic resonance imaging
EEG	Electroencephalography
ERP	Event-related potential
NICU	Neonatal intensive care unit
PMA	Postmenstrual age
CPAP	Continuous positive airway pressure
LOS	Length of stay
NIDCAP	Newborn Individualized Developmental and Assessment Program
SFR	Single-family room
ICS	International Closeness Survey
SCENE	Separation and Closeness Experiences in Neonatal Environment - research group
VR	Variation ratio
CV	Coefficient of variation
ANOVA	One way analysis of variance
SD	Standard deviation
IQ	Intelligence quotient

LIST OF ORIGINAL PUBLICATIONS

I. Raiskila, S., Axelin A., Rapeli, S., Vasko, I., Lehtonen, L. (2014). Trends in care practices reflecting parental involvement in neonatal care. Early Human Development, 90(12), 863–867.

II. Axelin, A., Raiskila S., Lehtonen, L. The Development of User-Friendly Data Collection Tools to Measure Family Centered Care and Parent-Infant Closeness in NICUs. (Submitted)

III. Raiskila, S., Axelin, A., Toome, L., Caballero, S., Tandberg, B. S. Montirosso, R., Normann, E., Hallberg, B., Westrup, B., Ewald, U., Lehtonen, L. (2017). Parents' presence and parent–infant closeness in 11 neonatal intensive care units in six European countries vary between and within the countries. Acta Pediatrica, 106(6), 878–888.

IV. Raiskila, S., Lehtonen, L., Tandberg, B. S., Normann, E., Ewald, U., Caballero, S., Varendi, H., Toome, L., Nordhøv, M., Hallberg, B., Westrup, B., Montirosso, R., Axelin, A. (2016). Parent and nurse perceptions on the quality of family-centred care in 11 European NICUs. Australian Critical Care, 29(4), 201–209.

1 INTRODUCTION

Early interaction and closeness are basic needs and a fundamentally important base for the development of humans and many other animals. The effects and importance of early interaction and early parent-infant closeness have been demonstrated in many studies, including animal studies, studies on basic physiology as well as longitudinal follow-up studies of human infants, especially preterm infants. (Flacking et al. 2012, Feldman 2017) The parent-infant closeness has been shown to improve the physical growth and neurocognitive development, decrease the number of infections, and lower the morbidity and mortality of preterm infants. The increasing closeness and possibility for early interaction with their newborn infant has been shown to reduce the parents' stress and depression. The separation has been associated with retardation of growth and development, increased risk of metabolic diseases, increased psychiatric morbidity and challenges in formation of secure relationships. (Nelson, Fox and Zeanah 2014)

Preterm infants are at high risk of being separated from their parents after birth. Their interaction possibilities are limited, and there are many hospital-made barriers to the formation of early attachment. A great amount of knowledge already exists on the importance of early attachment and how to support it in neonatal care. (Rilling 2013, Benzies et al. 2013) Applying this knowledge to the practice of neonatal care is a time-consuming and challenging process. (Ahlqvist-Björkroth et al. 2017)

Parent-infant closeness consists of both physical and emotional closeness between the parents and the infant. (Flacking et al. 2012) Family-centered care (FCC) is a care approach that supports the parent-infant closeness, and in which the infants' hospital care is executed in mutual relationship with parents. It is challenging to measure both closeness and FCC. Most of the earlier literature about FCC and parent-infant closeness covers mainly care recommendations and retrospective evaluations. There are some prospective studies regarding parent-infant closeness and visits or parents' presence and skin-to-skin contact (SCC), but there is only a little data reported by the parents themselves. FCC has been studied mainly with long questionnaires completed by the staff and/or parents at the end of the hospital care.

In this thesis, the aim was to discover how the parent-infant closeness and parenting, which both are extremely important for the infant's development, are supported and executed in neonatal intensive care units. We developed and tested new tools to acquire broader and more reliable insights especially into parents' impressions of their possibilities for closeness with their infant and participation in their infant's care in neonatal intensive care units.

2 REVIEW OF LITERATURE

2.1 Relevance of parent-infant closeness

2.1.1 Neurobiology of parent-infant closeness and attachment in animal research

Humans are fundamentally social beings, and we have basic needs to belong to a community and interact with other people. The need for social belonging has very early evolutionary roots, as social belonging is critical for survival. (Ulmer-Yaniv et al. 2016) Therefore, hormonal and neurotransmitter mechanisms have developed to draw parents and young infants into close proximity and emotional closeness with each other. Parents also play an important role in their offspring's' stress regulation. (Laurent et al. 2016)

Animal studies have shown that "The onset of function of main sensory systems happens in the same order between different avian and mammalian species." (Alberts and Ronca 1993) A series of studies using Rhesus monkeys was performed in the late 1960s and early 1970s that showed the consequences of separation (Hinde et al. 1971). Separation from the mother led first to anxious behavior, and soon the infants became paralyzed, locomotion and play diminished, and the infants spent a long time only sitting. The effects of separation were visible at 12 months and 30 months of age in these studies, especially in stressful situations. These studies have created the ground for later animal and human studies in this area. The neurobiological mechanisms of closeness, attachment and bonding have been studied mostly with rodents (rats, prairie volae) and primates (Rhesus monkeys, gorillas, marmosets and tamarins).

The primary function of early caregiver recognition and attachment is to ensure the closeness and, thus, the survival of a newborn infant. (Sullivan et al. 2011) It has been shown that newly hatched chicks visually imprint on their mother or a mother-like object, and the exact neural circuit in their brains behind the imprinting has been recognized. (Insel et al. 2001) The same kind of neural circuit has been suggested also for mammalian infants, but it has not yet been identified. The rat pups, as well as the the human infants, receive a burst of norepinephrine in the birth process that causes the rodents to learn their mother's odor and to approach their mothers to nurse. (Sullivan et al. 2011, Bordner et al. 2005) This phenomenon has been tested with other neutral odors instead of the mother's odor with the same result (Hofer 2006) Rat and dog studies have shown that both

nurturing and also painful stimuli from the caregiver support the early attachment immediately after birth (Sullivan et al. 2011). Nevertheless, the quality of attachment has various effects on the infant's cognitive and emotional development (Sullivan et al. 2011).

2.1.1.1 Oxytocin and dopamine

Evolutionarily ancient oxytocin and dopamine systems and their integration are fundamental for the mammal bonding (Love 2014). Oxytocin is a neuropeptide with more than one route of action. Oxytocin is synthesized in the supraoptic and paraventricular nuclei of the hypothalamus. Oxytocin is also excreted from the dendrites of these nerve cells. These dendrites are distributed across a wide area in the brain. Oxytocin is stored during the dendritic excretion in large vesicles from which it is released later upon local stimulus. (Ludwig and Leng 2006) The effect, thus, is long-term and can occur at a long distance from the sites of synthesis. The excretion of oxytocin via peptide feedback into vesicles increases the production of oxytocin, resulting in more oxytocin inside dendrites. This gives rise to a self-sustained, long-term auto regulated function, transferring vesicle-bound oxytocin across the brain. Early sensory functions affect which part of the brain undergoes enhancement of the oxytocin "pathway" and, thus, also affect how the brain reacts in human interaction later in life, leading to the questions of the extent to which local sensory stimuli cause local vesicular excretion of oxytocin, and how much oxytocin is available. (Feldman 2017)

The dopamine system is also an ancient evolutionary system that has remained its functions for 560 million years (Perez-Fernandes et al. 2015). Dopamine is a neurotransmitter, which affects vertebrates' locomotion, learning, eating and feeding, and reward and motivation behavior. Dopamine is connected to circadian rhythm. Dopamine-producing neurons are close to oxytocin receptor neurons in striatum and ventral tegmentum, enabling the oxytocin bursts produced by closeness and caretaking actions to activate the brain's reward processes (Love 2014). This link of closeness to the dopamine-derived reward system leads to motivation and activation to seek new close interactions.

Both systems participate in the regulation of the vital functions of every vertebrate and the vast majority of invertebrates. The typical characteristics for these systems are pulsatile release, patterned actions and seasonal rhythmicity (Feldman 2017). These systems have maintained their evolutionarily ancient mechanisms and functions such as, associative learning, sensory processing, and egg-laying behaviors, in non-vertebrates; modulate male courting behavior in lizards, long-term memory formation and vocal circuitry in fish, flocking behavior in

birds, and reproduction-related behavior in toads; and reproduction, metabolism, homeostasis, and fluid balance in mammals. (Feldman et al. 2016) However, through complicated neural nets and integration mechanisms, both oxytocin and dopamine systems participate and carry out many very different actions and influences including neuromodulation of social behavior, stress regulation, and associative learning in mammals. (Feldman et al. 2016)

Rat studies have shown that oxytocin facilitates the pups' learning when there is social interaction, e.g., the mother's presence is involved, but not in other situations. (Insel et al. 2001) Furthermore, oxytocin antagonist has an opposite effect in social interactions. (Insel et al. 2001) Oxytocin seems to be an important transmitter in the process of forming associations related specifically to the mother. (Insel et al. 2001) Oxytocin is secreted both during breast-feeding and non-noxious cutaneous stimulation (Uvnäs-Moberg et al. 2014). Oxytocin has also effects on mother's pain threshold, sedation, cutaneous vasodilatation and mobilization of nutrients. (Insel et al. 2001, Uvnäs-Moberg 1996). These effects have a positive influence on breast feeding.

A great amount of oxytocin is secreted in pulsatile rereleases in mammals at birth. This secretion of oxytocin from the posterior pituitary is inhibited by the endogenous k-opioids, also produced in the oxytocin producing neurons, to prevent preterm birth during pregnancy. (Feldman 2016) The mother's closeness and caring actions after birth increase the pulsatile secretion of oxytocin. Mouse studies have also shown that a large amount of oxytocin receptors exists in the neocortex after birth. Perinatal and early infancy periods are, therefore, sensitive periods for social development in humans, as well as in other mammals. (Feldman 2015)

While links to the dopamine system increase the motivation for new interaction, oxytocin also regulates the function of the hypothalamus–pituitary-adrenal axis (HPA-axis) to regulate the infant's fear and stress behavior. Many animal studies have investigated the mother's influence on the infant's HPA-axis. Social buffering is the phenomenon where a mother can regulate her infants hormonal stress reactions and behavior in intimidating, stressful and challenging situations (Sullivan and Perry 2015). Social buffering is very similar between mammal species. (Gee et al. 2014; Kikusui et al. 2006). The infant's reactions to different threatening stimuli were composed when the mother was present; for example, an odor-related, electrical shock did not lead to avoidance behavior as it would without the mother (Shionoya et al. 2006). The influence of the mother's presence on the amygdala explains this phenomenon (Sullivan et al. 2015). Rat pups who were predisposed to early separation from their mother in a procedure called neonatal handling developed a pathological fearlessness over time, and they unhesitatingly entered into novel and open areas. (Raineki et al. 2014) This early separation also

decreased the amount of affiliative social behavior, e.g., all grooming and sniffing, and increased non-affiliative behavior, e.g., aggression (Raineki et al. 2014, Todeschin et al. 2009). Rat studies show that early separation increased their appetite for sweets (Silveira et al. 2004) and led to decreased kidney function. The effects of early separation for the functions of monkeys' HPA-axis was still evident at one and one half and three years of age. (Feng et al. 2011)

2.1.1.2 Caregiving and nervous system

The mother or a caregiver has been shown to control the infants' homeostasis with their interactions and caregiving for the infant. Hofer et al's (1994 and 2006) studies have shown how different components of closeness and nurturing, such as warmth, breast milk, tactile stimulation and the mother's odor, affect different parts of the brain and cause different kinds of hormone and other neurotransmitter excretions. Hofer (2006) speculated that long-term disturbances of these regulation mechanisms may lead to permanent changes in brain development. Moreover, these types of changes in brain network and hormone production can be epigenetically regulated, though they might be transmitted to the next generation (Roth et al. 2009).

The foundations of bonding are universal through different mammalian species, although there are differences, as reviewed by Feldman (2017). The mother-offspring bond is non-selective and short in rodents, based on pregnancy hormones and dependent on olfactory cues. The rodent mothers nurse any newborn laid in the nest after the labor. (Rilling et al. 2014). Primates' larger neocortex enables the formation of more selective bonds. (Dunbar et al. 1992). Thus, parenting is typical for primates (Feldman 2017). Primates' bonding is guided by their hormones, but it is not hormone dependent, like rodents' bonding, and olfactory cues and visual perceptions also guide their social bonding (Keverne 2014). Feldman (2017) states that human's relationships are exclusive, association-based, culture-defined, hormone-independent, long-term attachments.

Parent-infant closeness, interaction, and separation influence many parts of the mammalian brain and participate in regulating hormone and other transmitter levels in the body. These changes might be long-term and permanent and can be transmitted to subsequent generations through epigenetic mechanisms such as DNA methylation (Champagne 2008). For example, in female rat pups, it has been suggested that high levels of maternal licking and grooming after birth is associated with decreased estrogen receptor alpha promotor methylation; this leads to increased transcription and increased levels of this estrogen alpha promotor in the medial preoptic area in response to factors like Stat5 (which is most

active in late pregnancy in rats [Cui et al, 2004]), causing increased estrogen sensitivity in late gestation. This also potentially increases the oxytocin receptor binding in the hypothalamus, which can activate mesolimbic dopaminergic neurons that mediate the increase of the licking and grooming of pups (Champagne 2008). Without the methylation of the estrogen alpha promotors, the transcription is less.

2.1.2 Developing brain of an infant

Human brain development begins at the third gestational week (gw) and continues at least through late adolescence and probably throughout the lifespan, but the most critical phase is during fetal life, infancy and early childhood until two to three years of age. The development is genetically programmed but depends also on the stimuli from the environment. The neurons are largely developed by the midgestation. The most important neural pathways in the brain are the thalamocortical and corticothalamic pathways, which transmit sensorimotor information. Thalamocortical pathways relay sensory and motor information from the body's sensory receptors to sensorimotor regions of the neocortex via the thalamus; the corticothalamic pathway transmits information produced in the cortex back to the thalamus. These essential pathways are developed by the 26th gw. (Stiles and Jernigan 2010)

The fetal brain grows 400% during the third semester, which equals the change from the term age to adulthood. A significant change occurs in a very short time period, and the environmental factors are known to play a role in this development. (Stiles and Jernigan 2010) A genetically programmed overproduction of axons, dendrites and synapses, i.e., synaptogenesis, occurs during the first years of life, especially the first two years. (Singer 1995) The myelination of the brain cells also occurs mostly by two to three years of age, although, the peak for synaptogenesis is already around one year of age, especially in the prefrontal cortex. The synaptogenesis continues until late adolescence and early adulthood. (Nelson and Bosquet 2000)

2.1.2.1 Brain of a premature infant

The environmental changes related to prematurity disturb the brain's genetically programmed development, or the corticogenesis. (Ment and Vohr 2008) Ten percent of infants born in gw 24 to 32 had neurodevelopmental impairment at two years of age. (Munck et al. 2010) The imaging studies show that preterm infants

have smaller cortical surface area, lower grey and white matter volumes, and lower volumes of basal ganglions and cerebellum than term controls (Cornell and Boardman 2005, Lodygensky et al 2010).

Using novel MRI techniques, Batalle et al. (2017) investigated the topology of the brain and the influence of the prematurity on brain network organization in infants born between gw 24+2 and 41+1. They found a specific pattern of reduced fractional anisotrophy and neurite density index related to the degree of prematurity at birth. The areas in the brain the prematurity affected the most were short-range connections in the frontal, parietal and occipital regions; frontal and parietal to peri-rolandic and rolandic operculum connections; temporo-parietal connections; connections between the frontal lobe and cingulum; and between the insula and post-central gyrus. These connections are linked to cognitive efficiency in adult studies (Gao et al. 2014), to specific aspects of language including phonology, semantics, and sentence processing (Vigneau et al. 2006); and to social cognition (i.e., the ability to infer others' thoughts and beliefs) (Mars et al 2013). The connection between the frontal lobe and cingulate cortex are also in an important part the brain network regulating the integration of cognition and emotions. (Batalle et al. 2017)

Accordingly, Stephen and Vohr's (2009) review summarizes that being a preterm infant is associated with a wide variety of behavioral and psychological diagnoses and disabilities, particularly showing by school age higher rates of inattention, hyperactivity, anxiety, social withdrawal and psychiatric disorders. Adults born at very low birth weight (VLBW) have scored lower on measures of self-esteem and reported less confidence in their romantic, athletic, school, and job-related abilities in late adulthood (Grunau et al. 2004), and were likely to leave parental home later, and start sexual activity and partnerships later (Kajantie et al. 2008). In a meta-analysis of mental health problems Pyhälä et al. (2017) found that VLBW infants are tend to have more internalizing problems and social avoidance, but less externalizing problems and risk behaviour in adulthood compared to term infants.

2.1.2.2 The consequences of extreme separation

The consequences of prematurity may be related to the quality of care and parent-infant separation, as suggested by the large body of animal research and also by the research on human children exposed to separation. The effects of separation on human brain development have been studied in the extremely adverse conditions of Romanian orphanages. A randomized controlled trial showed that infants cared in an orphanage compared to those randomized to foster care had

significantly worse results in almost every factor studied: physical growth, motor development, telomere length, stereotypies, cognition, language, psychopathology, brain structure and functioning (MRI, EEG, ERP) and in socioemotional development, including secure attachment. (Nelson et al. 2014) The study suggests that these differences arise from the differences in the quality of care. It is important to point out the ethics of the Romanian orphanage study is thoroughly thought and discussed (Zeanah et al. 2012); the key points are that 1) there was no real option, such as foster care, for the institutions for young children called "Leagans" at the beginning of the project; 2) it was guaranteed that no child randomized to foster care had to go back to institutional care; 3) there were no restriction for the studied children to go to another foster care, than the projects provided, or to be returned to their biological families during or after the study. The results of the study also have had many positive effects on the policies regarding the abandoned children (Zeanah et al. 2012)

The critical elements of care, which were different between the foster homes and orphanage, were sensitivity (child-centered, contingent responses) and positive regard for the child (acceptance, respect, and warmth, including expressions of physical affection). (Johnson et al. 2010) The foster care intervention was more efficient in making progress if the child was able to stay in the same foster care family all the time, as shown by many of the measured factors, including motor-development, psychiatric disorders and brain development and according to EEG measures (Nelson et al. 2014, Humpreys et al. 2015, Vanderwert et al. 2016). Nelson et al. (2007) stated that the younger a child was when placed in foster care, the better the cognitive outcome was at 54 months of age using Wechsler Preschool and Primary Scale of Intelligence—Revised, with a significant threshold at two years of age in foster care placement. (Nelson et al. 2007)

2.1.2.3 Protecting a preterm infant from hospital-made separation

The research data on the neurobehavioral consequences of separation suggest that neonatal care should also be studied from the perspective of exposure to separation and its effects. When the critical elements are identified, preterm care can be developed so that these elements are provided to preterm infants. It can be argued that sensitive, continuous, contingent, and emotionally warm care can best be provided by the infant's parents. Skin-to-skin contact (SSC) in particular is rarely provided by other people.

The early development of tactile sense (Alberts et al. 1993) offers a good reason to suggest that SSC is an important element of parent-infant closeness in preterm infants during their early development. Also, taste is already developed in 16 gw

and olfactory sense between 28 and 35 gw. SSC is a care practice that has been studied intensively and has been shown to have many positive effects for both parents and infants. During SSC, the infant is lying on a parent's bare chest wearing only a diaper or maybe a cap and covered with blanket. SSC has been practiced in many ways from continuous care to shorter periods during the day and from low-resource settings to modern NICUs. Boundy et al. (2016) included all studies with SSC components and any neonatal outcome in their meta-analysis. They discovered that SSC has positive effects on breastfeeding up to four months of age and decreases the risks of neonatal sepsis, hypothermia, hypoglycemia, and hospital readmissions. Newborns receiving SSC had higher oxygen saturation, temperature, and lower pain scores. SSC did not shorten the length of stay (LOS) in the study's whole population, but the LOS was shorter in a subgroup of infants with a birth weight below 1500 g. Infants below 2000 g birth weight also had better head circumference growth (Boundy et al. 2016). Scher et al. (2009) showed that SSC accelerates brain growth.

SSC has been shown to improve infant-parent relationships and parental well-being (Moore et al. 2007). Bigelow et al. (2012) discovered that a group of mothers having SSC with their infants had lower depression scores and cortisol levels compared to a control group. Anderze et al. (2014) found in a qualitative meta-synthesis that SSC, when encouraged, is an empowering and natural part of the journey of becoming a parent in an exceptional environment in the NICU. However, if the care environment did not support SSC, it became an energy taking experience (Anderze et al. 2014). A parent's presence is a prerequisite for SSC and other forms of physical parent-infant closeness.

2.2 Parent participation in the hospital care of preterm infants

2.2.1 History of developmental care and the parent's role and presence in neonatal intensive care

The survival of preterm infants, especially VLBW infants, has increased since the early 20th century (Baker et al. 2000) and even more rapidly after the 1960s as a result of the development of neonatal intensive care. However, preterm infants, and again especially VLBW infants, continue to have more neurodevelopmental impairment compared to term infants (Munck et al. 2012). Improving the infant's neurobehavioral outcome is an essential goal for modern neonatal intensive care (Pascal et al. 2018). The concept of developmental care was first introduced in the mid-1980s to improve the neurobehavioral outcome.

Developmental care is a heterogeneous concept of practices modifying the NICU environment to be more optimal for preterm infants, for example by controlling the external vestibular, auditory, visual, and tactile stimuli, reducing painful procedures, clustering care activities, supporting the infants' flexed positioning, and promoting self-regulation of the infant (Symington and Pinelli 2002). Other components of developmental care may include the promotion of nonnutritive sucking, co-bedding of multiples, skin-to-skin contact, and collaboration with parents to promote bonding (Lester et al. 2011; NANN 2000).

One model to promote developmental care is The Newborn Individualized Developmental Care and Assessment Program, which is based on the synactive theory (Als 1986). It focuses on observing the infant's behavioral cues to adjust the environment and care for each infant's needs. A systematic review of the NIDCAP studies showed controversial results of the positive effects of NIDCAP, although the program was associated with a better daily weight gain and a shorter hospitalization (Ohlsson and Jacobs 2013). The meta-analysis could not show that NIDCAP improved long-term neurodevelopmental outcomes (Ohlsson and Jacobs 2013). However, this does not prove that there is no positive effect on the development, but the studies have been small and are missing long-term follow-ups.

Kennell and Klaus (1976) showed that a mother's presence did not increase the risk of infection. Since then there has been an increasing amount of literature on the positive effects of physical closeness, such as holding, cuddling, massage, and SSC (Anderson 1991; Ludington-Hoe et al. 1994; Moran et al. 1999). Nowadays, there is a large body of evidence pointing to the importance of parent-infant physical closeness and its effects on the physiological stability, growth, and recovery of a preterm infant (Boundy et al. 2015; Flacking et al. 2012).

Until 1996, it was common in Europe to restrict parents' presence by implementing visiting hours and restricting unit routines (Cuttini et al. 1999). Ten years later, the visitation restrictions were abandoned in the majority of European NICUs; however, the number of parental visits varied largely among the units and the countries (Greisen et al. 2009). Moreover, the units' regulations on how the parents were allowed to participate, or how their participation was supported, varied greatly (Pallás-Alonso et al. 2012). A parent's presence can be supported by creating a meaningful role for them in the care of their infant during hospitalization (Alhqvist-Björkroth 2017). Parents can actively care for their infant by providing SCC, taking part in their infant's pain management (Franck et al. 2011), managing the daily care routines of the infant (Flacking et al. 2016), and participating in medical decision-making (Axelin et al. 2018), therefore becoming an integral part of the care team (O'Brian et al. 2018).

2.2.2 Family-centered care

Family-centered care (FCC) is a concept that aims to consider the background and individual needs of the whole family in order to care for the infant in partnership with the parents. FCC has been defined in many ways through many recommendations by organizations and institutions (Dunn et al. 2006). Mikkelsen and Frederiksen (2011), and Shahheidari (2012) performed a concept analysis regarding FCC in neonatal care, but no unambiguous definition exists. Shield et al. (2012) were unable to conduct a Cochrane meta-analysis because of the variation in definitions and different outcome measures. A fundamental aspect is that the infant should never be cared for without considering the whole family (Shields 2015). Table 1 summarizes the general principles of FCC in many recommendations and findings from two concept analyses.

The implementation of FCC in everyday care practices is challenging. Many barriers to implementing any evidence-based practice are reported: lack of time, limited resources or inadequate knowledge, lack of awareness of available research literature, lack of authority to change practices, organizational cultures rewarding routine, nursing as a task-based practice, lack of administrative support, and lack of mentorship (Smith and Donze 2010; Foster et al. 2010). The definition of FCC is still defined in many ways, so it might be difficult to set detailed and accurate goals. The expectations of FCC have been reported to be different between the parents and the nurses. The most distinctive finding in the studies conducted in Sweden and England was that the parents are more self-sufficient in meeting their own needs than staff expect them to be (Shields et al. 2003; Shields et al. 2004). Nurses have reported that the most important part of succeeding in FCC is to develop a relationship with the parents (Trajkovski et al. 2012). New role definitions among health-care professionals are required to involve the parents more in their infant's care (Axelin et al. 2014). This parental empowerment combined with the shift of the nurses' role from performer to advisor might raise issues regarding power, control, and responsibilities (Axelin et al. 2014). This kind of paradigm shift does not happen without considerable effort and perseverance. Also, the informational support from the physician—not only from the nurses—should be reconsidered in order to better support and encourage FCC. Family-centered medical rounds are one promising way of involving and empowering the parents in decision-making (Voos et al. 2011). The whole staff should be educated and motivated in FCC to truly implement the change.

Different family-centered care interventions have shown benefits for infants' development. Providing instructions for parents when observing their infant's behavior and development has improved parent-infant interaction and has reduced maternal anxiety and depression (Meyer et al. 1994; Melnyk et al. 2006). Guid-

ing the parents to interpret their infant's behavioral signals and cues to increase sensitive interaction has improved infant neurobehavior (Montirosso et al. 2012), reduced parenting stress, increased positive child rearing, and improved child development at five years of age in Norway (Kaaresen et al. 2006; Nordhov et al. 2010 a,b). Similar interventions improved child development at nine years of age in a US study (Achenbach et al. 1993). The literature links the positive effects of FCC NICU care to nurses' greater work satisfaction (Voos et al. 2011) and parents' well-being (Spittle et al. 2012), better preparation for parents before their infant's discharge (Solhaug et al., 2010), and decreased length of hospital stay (Gooding et al. 2011; Örtenstrand et al. 2010). However, the heterogeneity of interventions and the definitions of FCC in these studies is both notable and remarkable. It is not always clear what part of the progress is due to FCC since even the definition is still unestablished.

Table 1. General principles and concept analysis of FCC

General principles of FCC in pediatrics in many recommendations synthesized by Kuo et al (2012)	**Information Sharing** **Respect and Honoring Differences:** **Partnership and Collaboration** **Negotiation** **Care in the Context of the Family and Community**
Concept analysis of FCC by Mikkelsen and Frederiksen (2011)	Main aspects of FCC: **Parent autonomy and control** **Negotiation and shared responsibility** **Emotional support for parents**
Concept analysis of FCC focusing directly in NICUs by Ramezani et al (2014)	Concept attributes: **Family's care taking,** i.e., listening and recognizing families' individual needs **Equal family participation,** i.e., families' participation in care planning, decision making and providing care, together with the health-care professionals **Knowledge transformations,** i.e., information sharing between health-care workers and families according to the families' individual learning styles **Maintaining each family's respect and dignity,** i.e., Trust in everyday care between parents and health-care professionals is needed to achieve and maintain the family's respect and dignity.

2.2.3 Single family rooms

The concept of individual rooms for NICU patients had already been proposed in the early 1990s (White 2003). The rationale for building single-family rooms (SFR) has been to provide a calmer and more private environment for the parents and the infant. In SFR, the infant is exposed to less noise and artificial light from the hospital environment. More home-like and peaceful atmosphere for the family supports round-the-clock presence, privacy for pumping and breastfeeding, and SSC. SFRs decreases expose to horizontally spread infections. (White 2011)

The SFR model has been shown to enhance enteral nutrition, breastfeeding, and growth (Lester et al 2016). In addition, there has been less apnea (Domanico et al. 2010) and bronchopulmonary dysplasia (Örtenstrand et al. 2012) and shorter hospital stay in infants cared for in SFR compared to infants cared for in an open-bay unit (Örtenstrand et al. 2012, Lester et al. 2014, Vohr et al. 2017). The care in a SFR was also associated with less maternal stress (Lester et al. 2014) and better work satisfaction among nurses (Lester et al. 2014) and more optimal neurobehavioral function upon discharge (Lester et al. 2014). The parents had three times more interaction with the nursing staff in a SFR unit compared to a traditional architecture with 2 to 4 patients in a room. (Toivonen et al. 2017) Mothers' involvement and the breastmilk provision were shown to be mediators of the benefits of SFR (Lester et al. 2014 and 2016, Vohr et al. 2017). It is likely that parents' presence and active participation have an important role in mediating the benefits of SFR. These factors have not been well documented in literature. Private patient room design without parent's bed in the room has led to negative consequences for the infant. (Pineda et al. 2014). In this case the architecture might have prevented rather than promoted the parents' presence.

Table 2. Surveys for measuring FCC in NICU environment

Surveys for measuring FCC in NICU environment **Surveys for parents**		Items
Authors	Tool	
Hagen IH, Vadset TB, Barstad J, Svindseth MF. (2015)	Neonatal Satisfaction Survey–NSS-13	69
Berns SD, Boyle MD, Popper B, Gooding JS (2007)	USA/DIRECT Inc. national survey	76
Cooper LG, Gooding JS, Gallagher J, Sternesky L, Ledsky R, Berns SD. (2007)	Health Systems Research Inc. (HSR) survey	Not reported
Byers JF, Lowman LB, Francis J, Kaigle L, Lutz NH, Waddell T et al. (2006)	NICU parental satisfaction tool	11
Hurst I (2006)	Parent Satisfaction Survey (PSS)	13
Punthmatharith B, Buddharat U, Kamlangdee T. (2007)	Modified satisfaction questionnaire	75
Tran C, Medhurst A, O'Connell B. (2009)	Modification of nurse-parent support tool (NPST)	42
Domanico R, Davis DK, Coleman F, Davis BO. (2010)	Modified version of nurse–parent support tool (NPST)	31
Bastani F, Abadi TA, Haghani H. (2015)	Not named	18
Capdevila Cogul E, Sanchez Pozo L, Riba Garcıa M, Morina Soler D, Rios Guillermo J, Porta Ribera R, et al (2012)	Satisfaction survey	15
Bruns DA, & Klein S. (2005)	Family-Centered care survey	33
Auslander GK, Netzer D & Arad I (2010)	Parents' expectations and assessments of care	16
Curran A, Brighton J, & Murphy V (1997).	Not named	Not reported
Van Riper M (2001)	The Family-Provider Relationships Instrument–NICU Ryff's measure of psychologic well-being, The General Scale of the Family Assessment Measure.	63 18 50

Surveys for staff		
Asai H (2011)	Japanese Measure of Beliefs about Participation in Family-centered Service (J-MPOC-SP) Japanese Measure of Processes of Care for Service Providers (J-MBP-FCS)	27 28
Benzein E, Johansson P, Årestedt KF, Berg A, & Saveman BI (2008).	Families' importance in nursing care—nurses' attitudes (FINC-NA)	26
Bruce B & Ritchie J (1997)	Family centered care questionnaire (FCCQ)	55
Bruce B, Letourneau N, Ritchie J, Larocque S, Dennis C & Elliot M (2002) Caty S, Larocque S, & Koren I (2000). Letourneau N & Elliot R (1996) Murphy M & Feely G (2007) Petersen M Cohen J & Parsons V (2004)	Family centered care questionnaire – revised (FCCQ-R)	45
Daneman S, Macaluso J & Guzzetta C (2003) Gill, K. M. (1993)	Parent participation attitude scale (PPAS)	24
Meiers S, Tomlinson P, & Peden-McAlpine C (2007)	Family nurse caring belief scale (FNCBS)	27
Benzein E, Johansson P, Årestedt KF, Berg, A & Saveman BI (2008)	Families' importance in nursing care—nurses' attitudes (FINC-NA)	26
Saunders R, Abraham M, Crosby M, Thomas, K, & Edwards W. (2003).	NICU Care Provider Questionnaire	72
Surveys for parents and staff		
Latour JM, Duivenvoorden HJ, Hazelzet JA, van Goudoever JB. (2012)	EMpowerment of PArents in THe Intensive Care-Neonatology (EMPATH-IC-N)	57
Jacono, J., Hicks, G., Antonioni, C., O'Brien, K., & Rasi, M. (1990).	Norris and Grove questionnaire	Not reported
Bruns DA & McCollum DA	PARTNERS Questionnaire	Not reported
Aggarwal S, Chadha P, Kalia S, Richardson S,Winterbottom L, Shields L (2009) Shields, L., & Tanner, A. (2004)	Shields and Tanner questionnaires	20
Neal A, Frost M, Kuhn J, Green A, Gance-Cleveland B & Kersten R (2007)	Institute of Family Centered Care survey	Not reported
Carmen S, Teal S & Guzzetta, CE (2008)	Patient-family-centered care survey	58 for the parents 107 for the staff

Al-Motlag MA, Abuidhail J, Salameh T & Awwas W (2017)	"Parents' "perspectives on FCC aspects in NICUs" and "Parents' satisfaction with the care provided to their neonates" "Nurses' perspectives on FCC aspects in NICUs"	20+11 22
Shimizu A and Mori A (2017)	Measure of Process of Care in the NICU (Neo-MPOC 20) Enabling Practice Scale in the NICU (Neo-EPS) Mother and Infant Questionnaire.	20 24

2.3 Gaps in the literature and rationale for the thesis

A great amount of literature has shown the positive effects of closeness and the negative effects of separation on a neurobiological level and in long term follow up studies of preterm infants (Flacking et al. 2012). The studies have been published for over 70 years, especially during the last 20 years. However, information on the implementation of the evidence in care practices is lacking. A need exists to be able to evaluate the changes and develop the evaluation methods. We need to know and be able to evaluate how early parent-infant closeness and parenting are supported in different NICUs.

Parents' presence and physical closeness with their infants have been studied mainly with the estimation asked from nurses or other staff (for example, Reynolds et al 2013 and Olsson et al 2012) or from the recommendations and unit policies (Mörelius et al. 2012, O'Brien et al. 2013. Only a few research studies exist with prospective data on parents' presence in the units (hours/week), holding or cuddling, or SSC (times per week) reported by the nurses (Reynolds et al. 2013, Gonya et al. 2013, Franck and Spencer 2003, Pineda et al. 2018). Boundy et al. (2016) found in their meta-analysis that only 16 of 124 studies (13%) of the available SSC studies reported the actual amount of SSC. One Swedish study showed that parents are at least as reliable as nurses in reporting the amount of SSC (Blomqvist et al. 2011). Simple measures like parents' presence have been evaluated with patient records and access control systems.

A gold standard or measure to evaluate FCC does not exist. Several surveys have evaluated FCC (Table 2). The common features of these measures are that they are retrospective and performed at one point in time, usually near the discharge from the hospital, and they usually ask a large number of questions (20 to 107). (Dall´Oglio et al. 2018, Butt et al. 2013) Response rates to electronic surveys have occasionally been low, even 25 to 30% (Cook et al. 2000). Moreover, sev-

eral qualitative methods are used, such as semistructured interviews and ethnography, to evaluate FCC.

Altogether, there are large gaps in the information on parent-infant closeness and FCC. Therefore, a need exists to develop easy, internationally feasible, and low-burdening measures that can be used prospectively to collect data on parent-infant closeness and FCC, and potential supporting factors or barriers of closeness and FCC.

3 AIMS OF THE STUDY

The aim of this thesis was to study the quality of family-centered care (FCC) practices supporting and enabling parent-infant physical closeness and parental participation in infant care in different neonatal units. Our research team developed data collection methods especially to capture parents' perspective and to gain new insights.

The specific aims of this study were:

1. to follow the development of care practices supporting and enabling parent closeness and participation in infant care in a neonatal unit. (Study I)
2. to develop new prospective data collection tools to evaluate the implementation of parent-infant closeness FCC. (Study II)
3. to study the amount of physical parent–infant closeness in 11 European NICUs reported by parents and to examine the factors explaining the differences. (Study III)
4. to describe the current perceptions regarding quality of FCC from the perspectives of mothers, fathers and nurses in 11 European NICUs. (Study IV)

4 MATERIALS AND METHODS

4.1 Study designs

This thesis is based on four original publications, which are outlined in Table 3

4.1.1 Participants and setting

Population of study I included all very preterm infants born at less than 32 gestational weeks or at birth weight less than 1500 g in Turku University Hospital. We excluded infants who died or were transferred to other hospitals and or had incomplete or unavailable documentation (in 2001–2002, n=5; 2006–2007, n = 1; 2009–2010, n = 5; and 2011–2012, n= 11). Altogether, 295 patient charts were reviewed, in 2001–2002 (n = 72), 2006–2007 (n = 69), 2009–2010 (n=76), and 2011–2012 (n=78).

Study II was a methodological study to develop and validate tools for studies III and IV. Studies III and IV were designed and executed by the international research group "Separation and Closeness Experiences in the Neonatal Environment" (SCENE). SCENE is a multi-disciplinary group of international professionals that aims to improve parents' and infants' experiences and outcomes of neonatal care. The focus of the SCENE collaboration is to undertake research of how and why parent-infant physical and emotional closeness varies in neonatal units, within and between countries; the short- and long-term effects of closeness and separation on infants, parents and the infant-parent dyad; as well as how to optimize parental and infant health and wellbeing. A key goal of the SCENE collaboration is to identify, construct, implement and evaluate best practice to support physical and emotional parent-infant closeness during neonatal care." (http://www.utu.fi/en/sites/scene/Pages/home.aspx)

Table 3. Study designs in the original publications of the thesis.

Research aim	Population & Setting	Study design and data collection method	Measured outcomes
Study I: To follow the development of care practices supporting and enabling parent closeness and participation in infant care in a neonatal unit	Very preterm infants <32 gw or <1500 g, Turku Finland, NICU level IIIb 2001–2002, n=72 2006–2007, n=69 2009–2010, n=76 2011–2012, n=78	Retrospective chart review of four cohorts of very preterm infants born in an 11-year period	1. Thermoregulation 2. Nutrition and feeding 3. The beginning and number of SSC* episodes 4. Safety measures
Study II: To develop new prospective data collection tools to evaluate the implementation of parent-infant closeness in FCC	In addition to Study populations III and IV, the families of 162 infants admitted to 5 level II–IIIa NICUs in Finland in 2012–2014	Describing the development of the tools used in studies III and IV through pilot studies. Validation process of the measures.	The reliability of the data collection tools, the number of response days (Kaplan-Meier curves), the impact of modifying the Likert scale on the variation of answers
Study III: To study the amount of physical parent-infant closeness reported by parents and to examine factors explaining the differences in 11 European NICUs	<35 gw infants and their families and nurses 11 NICUs in 6 European countries NICU level II–IIIC 2013–2014 n=328 infants/262 families (208 families with mother and father, 48 with only mother, 6 with only father)	Prospective survey with the Parental Closeness Diary	Parents' physical closeness defined as parents' presence, SSC, and holding (continuous data in 5-min intervals) during the first two weeks of hospitalization.
Study IV: To describe the current perceptions regarding quality of FCC from the perspectives of mothers, fathers, and nurses in 11 European NICUs		Daily prospective survey with one randomly selected text message question out of 8 possible questions on core elements of FCC to the parents and one web question to the nurses after each shift	Parents' presence (% of days) in the unit Parents' perceived quality of FCC Nurses' perception of provided quality of FCC

*SSC=skin-to-skin contact, **FCC= family-centered care

Studies III and IV's population comprised of the parents of infants born below 35 gestational weeks at 11 NICUs in six European countries that participated in the International Closeness Survey by the SCENE Research Group. The participating units were level II to level IIIc units (Barfield et al. 2012) from Finland (Turku), Estonia (Tallinn and Tartu), Sweden (Stockholm: Danderyd and Huddinge; Uppsala), Norway (Bergen, Drammen, and Tromsø), Italy (Como), and Spain (Madrid).

The parents of admitted preterm infants born below 35 gestational weeks and fulfilling the other inclusion criteria were approached to participate until the predetermined number of 30 families per unit was reached or the recruitment had lasted one full year. The number of families was based on the power calculation based on the data from the pilot studies included in Study II. In the first pilot study in Study II the mean parental presence was 7.43 hours/day and the mean SD 2.75. Based on this, to show two hours increase in the duration of the parents' presence with $p<0.05$, power 80%, two independent sample study, 30 families should be recruited in pre and post measures.

The exclusion criteria were that the family did not understand any of the nine study languages –Estonian, English, Finnish, Hungarian, Italian, Norwegian, Russian, Swedish or Spanish; the mother had delivered triplets or higher order, or the infant was likely to die. The nurses working at bedside also participated the study over a three-month period. Figure 1 shows the flow chart of the study populations of studies III and IV

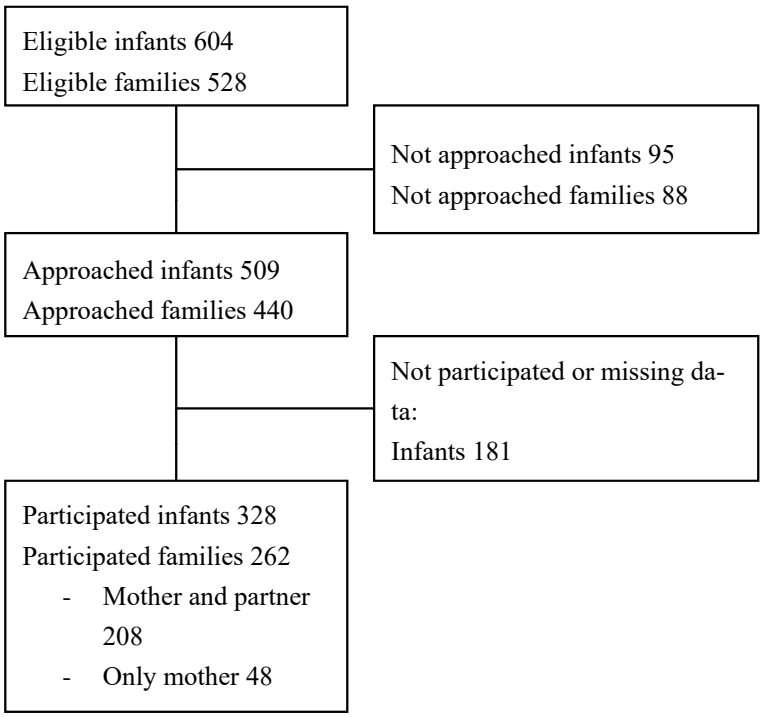

Figure 1. Flow chart of the recruitment process for the International Closeness Survey (Studies III and IV).

The units differed in size, case mix and level of care, as defined by the American Academy of Pediatrics (2004). The units reported the barriers to SSC. The overnight facilities for parents who wanted to stay were also organized differently. The parents were allowed to stay in all of the neonatal units for 24 hours, except for the two pediatric intensive care units (PICUs) in Estonia. The main features of the units are described in the Study III and in Tables 4a and 4b.

Study II describes the developmental process and validations of the measures used in studies III and IV. The population included, in addition to the population from studies III and IV, the Close Collaboration with Parents Training program (Ahlqvist-Björkroth et al. 2017) evaluation study (pilot studies) data from five hospitals in Finland. The first pilot study was performed in the Finnish NICUs of Turku (level IIIb), Oulu (level IIIb), Lahti (level II) and Pori (level II) in June-August 2012. The second pilot study was performed in the NICUs of Oulu and Vaasa (level 2) in June-August 2013 and in the NICUs of Lahti and Pori in June-August 2014. For these pilot studies, all the parents of admitted infants whose estimated length of hospitalization was over five days were recruited; no other specific exclusion criteria were used.

Table 5 presents the descriptive data of the study populations in study IV. There was a statistical difference between the two pilot study populations only in the length of stay (LOS) (mean difference 11.2, 95%CI 3.44 – 18.9, p=0.01) and parity, (18.5% of twins in the first pilot compared to 23.9% of twins in the second pilot, p=0.41, independent samples t-test). No other statistically significant differences were found between the two pilot study populations.

The populations of the two pilot studies were grouped together to compare the whole population of the pilot studies (n=161) to the population of the International Closeness Survey (Study III and IV, n=328 infants). The background characteristics between the pilot studies and International Closeness Survey differed statistically significantly ($p<0.05$) in gestational weeks, birth weight, birth length, birth head circumference, parity, mothers age, and fathers age; but not in length of stay, time from home to hospital, sex, delivery, treatment of the mother's previous child in NICU, whether or not the mother or father were in paid work, or whether the family owned a car.

Table 4a. Characteristics of the units participating the International Closeness Survey (Study III and IV), level of care and admission of infants per year

Country	**Finland**	**Sweden**			**Estonia**						**Italy**	**Spain**	**Norway**		
UNIT	**Turku**	**Uppsala**	**Danderyd**	**Huddinge**	**Tallinn MH**	**Tallinn PICU**	**Tallinn step-down**	**Tartu MH**	**Tartu PICU**	**Tartu stepdown**	**Como**	**Madrid**	**Drammen**	**Bergen**	**Tromsø**
Level of care	IIIB	IIIB	IIIA	IIIA	IIIA	IIIB	II	II	IIIB	II	IIIA	IIIC	IIIA	IIIB	IIIB
Admissions per year (n)	638	414	1031	646	479	150	598	411	135	412	210	935	401	468	326
<37 gestational weeks at birth	240	217	365	325	354	86	140	203	68	120	192	388	176	207	78
<32 gestational weeks at birth	72	104	48	92	75	49	99	10	50	54	51	130	61	63	8
<28 gestational weeks at birth	23	63	4	24	28	30	30	12	15	15	17	52	17	21	8

Table 4b. The the facilitators of family-centered care (FCC) in units participating the International Closeness Survey (Study III and IV),

Country	Finland	Sweden			Estonia						Italy	Spain	Norway		
UNIT	**Turku**	**Uppsala**	**Danderyd**	**Huddinge**	**Tallinn MH**	**Tallinn PICU**	**Tallinn step-down**	**Tartu MH**	**Tartu PICU**	**Tartu stepdown**	**Como**	**Madrid**	**Drammen**	**Bergen**	**Tromsø**
Permanent reclining chair for parent during the 1st week, n(%)	0	0	14 (100)	15 (100)	3 (21.4)	0	10 (100)	0	0	0	8 (55)	50 (100)	17 (100)	16 (76)	6 (80)
Permanent bed for parent during the 1st week n(%)	0	20 (100)	12 (86)	15 (100)	0	0	10 (100)	0	0	0	0	0	17 (100)	0	3(20)
Other beds in the unit for parents	1	20	24	30	14	0	25	0	0	24	0	0	30	0	6
Beds outside the unit for parents	4	4	4	0	0	0	0	0	9	0	6	0	0	8	20
Policy to invite parents to medical rounds	Yes	Yes	Yes	Yes	No	Incon-sistent	Yes	Incon-sistent	Incon-sistent	Incon-sistent	No	No	Yes	Yes	Yes
A family/ single rooms for parents	1	11	12	15	10	0	4–10	6	0	8	2	0	15	3	3
A shower for parents (in the unit)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
A facility to cook or warm up food for parents	Yes	Yes	Yes	Yes	No	?	Yes	Yes	?	Yes	No	No	Yes	Yes	Yes
Parents can stay 24h in the intensive care room	Yes	Yes	Yes	Yes	Yes	No	Yes	?	No	Almost always	Yes	Yes	Yes	Yes	Almost always
Barrier for SSC always/frequently				A	B			B			C	D			

A=ventilator, B= CPAP, umbilical catheter , lack of privacy, unit daily routine, C= Ventilator, phototherapy, D=Ventilator, arteria, umbilical catheter, phototherapy.

Table 5. The infant and parent characteristics and the length of stay in the pilot studies and International Closeness Survey (ICS)

	First pilot		Second pilot		ICS		
Infant characteristics	N	mean(SD)	N	mean(SD)	N	mean(SD)	P-value*
Gestational weeks at birth	90	33.7(4.7)	71	34.7(4.3)	323	31.5(2.9)	<0.001
Birth weight, g	91	2202.6 (1051)	69	2461.5 (1092.3)	323	1555.1 (685.7)	<0.001
Birth length, cm	85	43.7(6.1)	68	44.8(5.4)	322	40.8(4.9)	<0.001
B. head circumference, cm	69	30.2(5.5)	47	31.7(3.7)	318	29.2(3.6)	<0.001
	N	%	N	%	N	%	
Sex (female)	39	42.4	34	47.9	171	52.9	0.11
Delivery (vaginal)	40	43.5	38	53.5	177	55	0.98
Twins	17	18.5	17	23.9	103	32.3	0.01
Family characteristics	N	mean(SD)	N	mean(SD)	N	mean(SD)	
Father's age	90	30.4(9.4)	70	33.3(6.3)	314	34.5(6)	<0.001
Mother's age	92	30.3(6.2)	71	30.6(5.2)	321	32.5(5.4)	<0.001
Time from home (min)	90	59.3(91)	71	59(81)	318	43.4(61)	0.78
	N	%	N	%	N	%	
Previous child in NICU	10	11	12	18.2	43	13.9	0.96
Car, yes	90	97.8	69	97.2	296	93.4	0.05
Siblings, yes	44	47.8	40	57.1	148	45.7	0.38
Mother in paid work	70	80.5	48	68.6	362	77	0.47
Father in paid work	81	89	59	85.5	414	89	0.73
Length of stay (days)	N	mean(SD)	N	mean(SD)	N	mean(SD)	
	87	31.3(28.8)	58	20.1(17.1)	262	31.4(28.5)	0.155

*paired t-test for continuous data and Pearson's chi-square test for categorical data comparing the data from the pilot studies to the International Closeness Survey (ICS)

4.2 Outcomes, explanatory variables and data collection methods

4.2.1 Care practices supporting parent-infant physical closeness and participation in infant care (Study I)

Data for Study I were collected retrospectively from the infants' patient charts. Background factors included gestational weeks at birth, birth weight, and sex. We categorized the outcome factors in three subgroups: 1) thermoregulation expressed as the postmenstrual age (PMA) at the end of incubator and warmer bed care; 2) measures of nutrition and feeding expressed as the proportion of infants

getting enteral and parenteral nutrition on the first day of life, the PMA at full enteral nutrition (i.e., the last day of intravenous fluids), at the beginning of bottle- and breastfeeding, and at full oral feedings (i.e., the last day of nasogastric tube); and 3) physical parent-infant closeness expressed as the PMA and calendar age at the first SSC, and the number of SSC episodes during the first four weeks of life. Safety measures included length of hospital stay, PMA at discharge, and weight gain from birth to discharge. We could not measure the parents' presence retrospectively from the patient records.

4.2.2 Infant and family characteristics (Studies III and IV)

The "Infant and family characteristics" questionnaire collected information about the infants and parents. The infant characteristics included gestational weeks at birth, birth weight, birth length, birth head circumference, sex, mode of delivery, single vs. twins any need for incubator care (not in the pilot studies), and whether there were older siblings. Parent characteristics included mother's and father's age, education, language, socioeconomic status, smoking status (not in the pilot studies), and the distance between the family home and hospital.

4.2.3 Parental closeness diary and its development (Study III)

In Study III the parents provided information on the duration of the presence in the neonatal unit, holding their infant and giving SSC with the Parental Closeness Diary. This data collection tool was developed first in two pilot studies in Finland in years 2012 to 2014. The development process is described below. The initial version of this measurement was developed and tested in pilot studies in Finland in years 2012–2014. The Parental Closeness Diary was developed using iterative design (Gould and Lewis 1985). Deployment feedback provided by parents, staff, and the researchers was integrated into short duration, concurrent implementation, and deployment phases comprising a full development cycle. The collected feedback was analyzed during a periodic research-group meeting and integrated into the continuous development of the tools. Modifications were done after the first pilot study, based on feedback from the parents. This improved Parental Closeness Diary was tested in the second pilot study, and suggestions for further modifications were noted. Before the data collection tools were used in the International Closeness Survey, modifications were done within a Separation and Closeness Experiences in Neonatal Environment (SCENE) research group (www.utu.fi/scene).

4.2.3.1 The content of Parental Closeness Diary

One diary page was dedicated to the time scales of one day similar to what was used in Baby Day Diary (Barr et al. 1988). The time intervals could be marked with an accuracy of five minutes. The initial diary had four different timelines, including mother present, mother SSC, father present, and father SSC. Presence in the unit was defined by being inside the unit, not necessarily all the time in the room with the baby, to avoid the effort caused by marking down short interruptions like bathroom visits or coffee breaks. SSC was defined as the baby lying on the parent's bare chest dressed only in a diaper and maybe a cap. Parents were initially asked to fill in the diaries throughout the time their infant was in a hospital. During data collection, the diaries were stored in a folder at bedside where other families or nurses could not see them.

The Parental Closeness Diary and other measures were reviewed by the SCENE research group before the International Closeness Surveys (Study III) were conducted. The discussions within the SCENE study group pointed out that physical parent-infant contact was mostly holding of an infant instead of SSC in some units. Holding was added in the diary and defined as the baby being in the parent's arms away from the incubator/cot/bed. The final version of the Parental Closeness Diary is presented in Study III.

4.2.3.2 The use of Parental Closeness Diary

In the pilot studies, the functionality of Parental Closeness Diary was evaluated with the Kaplan-Meyer curves, which were drawn to demonstrate the length of parental motivation to fill in the diaries. In the first pilot study, 80% of the families of the hospitalized infants filled in the diaries for up to 14 days, and 50% of the families filled in the diaries for up to 38 days (Figure 2a). In the second pilot study, 67% of the families of the hospitalized infants filled in the diaries for up to 14 days, and 50% of the families filled in the diaries for up to 19 days (Figure 2b). Accordingly, only 14 days of continuous data were collected in the International Closeness Survey to acquire the most comprehensive and, therefore, the most representative data available. Therefore, the parents filled in the diaries at the beginning of Study for 14 days and an extra seven days when the infant was one, two or three months old, if still hospitalized. However, only the data from the first two weeks were used in most of the analyses. Kaplan-Meyer curves were drawn to demonstrate the time period of how long the diaries were filled in. Eighty-three percent of the families of the hospitalized infants filled in the diaries for up to 14 days (Figure 2c).

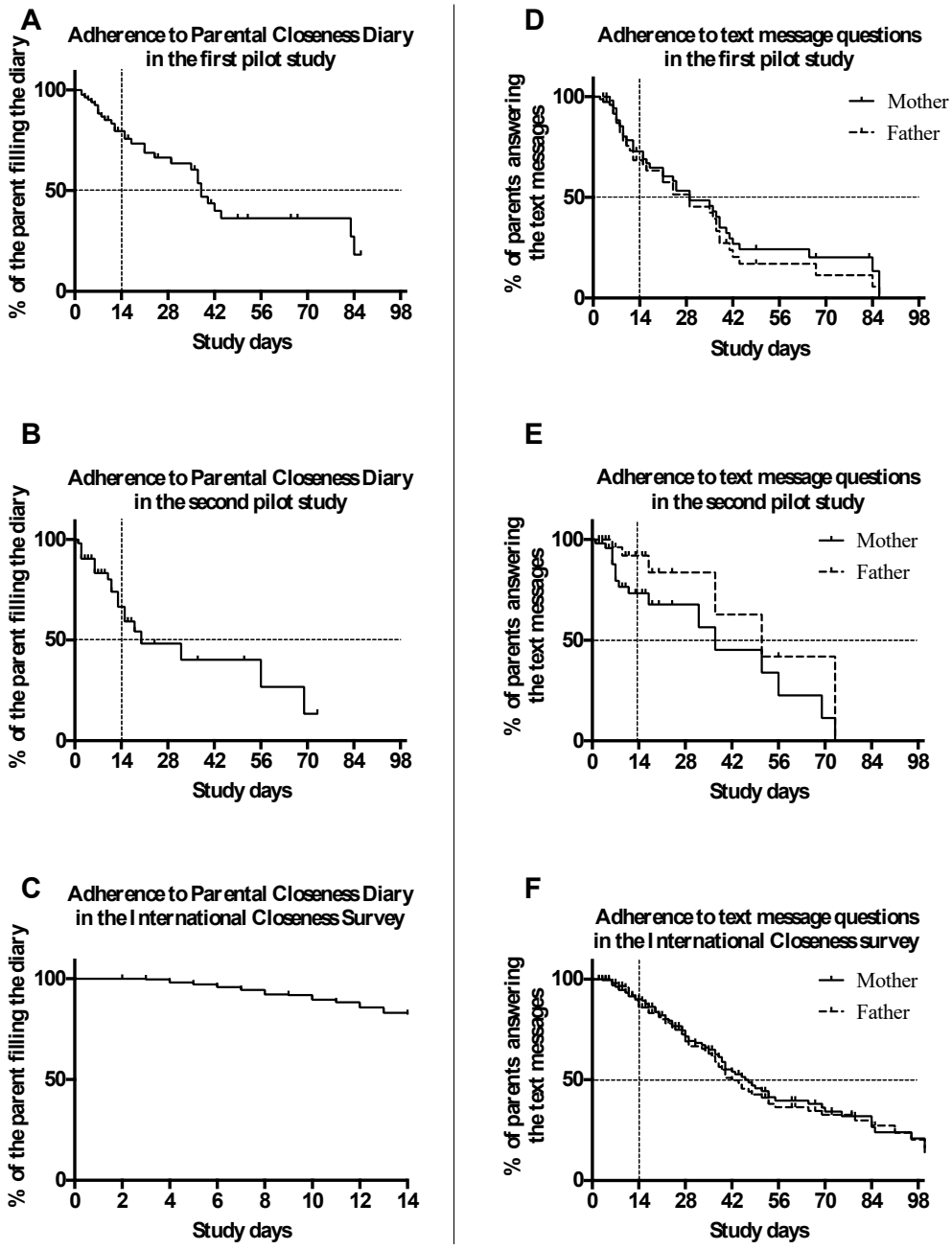

Figure 2a–f. Kaplan-Meyer curves showing how long the parents filled in the Parental Closeness Diary (A–C) and answered text message questions (D–F) in the first pilot study (A, D), second pilot study (B, E) and International Closeness Survey (C, F)

4.2.4 The quality of family-centered care: Parental text messages and nurses' web questions and the development of these tools (Study IV)

The perceived quality of FCC was evaluated with text message questions for the parents and web questions for the nurses in Study IV. Also this data collection tool was developed iteratively as described earlier. There were no previous tools suitable for our purpose for the daily evaluation of parental and nurses' perceptions of the quality of FCC.

4.2.4.1 The development and content validity of the FCC questions

Our aim was to develop a measurement tool to be used prospectively, including only one question per day. The earlier tools included at least 11 questions, and the separate questions were too long to fit easily into a text message (160 characters). The initial questions used in the pilot studies were developed based on FCC literature (Mikkelsen and Frederiksen 2011; Shields et al. 2007; Shields et al. 2004) and the concept of empowerment.

The first six questions were derived from the six aspects that emerge from the literature: parents' willingness to participate and take responsibility (motivation)/staff's motivation to educate and support the parents (Rodwell 1996; Ellis-Stoll and Popkess-Vawter 1998; Skelton 1994; Melnyk et al. 2001); parents' possibilities to become heard/nurses' active listening (Gibson 1999); mutual participation, education, and support (Hakanson and Hawks 1992); individualized knowledge translation and education for parents' needs (Ellis-Stoll and Popkess-Vawter 1998); participation in decision-making/mutual decision-making (Hakanson and Hawks 1992); freedom to make choices, trust, and respect/open communication (Rodwell 1996). The seventh question in the initial questionnaire was about parents' participation in the medical round, which was seen as an important element of FCC.

The questions evolved before the International Closeness Survey in the pilot studies, and thus the text message questions will be presented later in detail. The text messages were automatically sent to the parents recruited to the study. Parents received one question every evening at 9 p.m. regarding that day. After discharge, the parents quit answering the text messages, which ended the automatic questions. The system was piloted in Finland in 2012–2014.

The content validity of the text messages and the nurses' web questions in the International Closeness Survey (Study IV) was improved with an interdisciplinary expert panel of professionals (n=18), including neonatologists, NICU nurses, psychologists, and health and social scientists. The question on parent willingness to participate in infant care was omitted and three new questions were added: 1) how much the parent felt that the staff trusted in the parent in infant care, 2) individualized information, and 3) emotional support. Eight questions for parents and nurses were formed covering the following aspects of FCC after the revision: (1) active listening, (2) parent participation in infant care, (3) individualized guidance given to parents, (4) parent participation in decision-making, (5) parents' trust in staff regarding infant care, (6) parents' feeling that the staff trusted them with infant care, (7) individualized information and (8) emotional support (Table 6).

4.2.4.2 The translation process of the FCC questions

The translation process of the official study material is described in Study II as follows:

> "The translation process (- -) followed the ten-step guideline: Preparation, Forward Translation, Reconciliation, Back Translation, Back-Translation Review, Harmonization, Cognitive Debriefing, Review of Cognitive Debriefing, Results and Finalization, Proofreading, and Final Report (Wild et al. 2005). The English versions of data collection tools were forward translated into 7 target languages by the certified translators. The responsible researcher/s in each country reconciled the forward translations to their contexts. After these adapted forward translations were back translated by the second certified translator to English, the cognitive-debriefing group discussed the back translations with each country on Skype." (Study II)

4.2.4.3 The use of text message questions

The parents got one text message question every evening regarding that day. The answer for the questions was initially rated on a 5-point Likert scale (1–5) and in the final version on a 7-point Likert scale (1–7, with higher values being more positive). The answer "0" was provided if the parents had not been in the unit or the nurse had not worked with parents during that particular shift. After the first pilot study in 2012, Kaplan-Meier analysis was made showing that 68% of the

mothers and 62% of the fathers replied to the text message questions up to study day 14; 50% of the mothers of the hospitalized infants replied to text message questions up to 28 days and 50% of the fathers up to 22 days (Figure 2d). Two reminders were added to the protocol to improve the response rate, so the question was resent two days later if the parent had not answered it. In the second pilot study after these modifications, Kaplan-Meier analysis showed that 76% of the mothers and 88% of the fathers replied to the text message questions until study day 14; 50% of the mothers replied to text message questions up to 43 days and 50% of the fathers up to 50 days (Figure 2e).

Parents highlighted that the two reminders were a little confusing, so only one reminder was sent in the final study, the International Closeness Survey. Kaplan-Meier curves were drawn showing that 82.5% of the mothers and 74.2% of the fathers replied to the text message questions up to study day 14; 50% of the mothers replied to text message questions up to 37 days and 50% of the fathers up to 26 days (Figure 2f).

Table 6. Text message questions for the parents and web questions for the nurses regarding the perceived quality of FCC

The textmessage questions for parents Estimate on scale 1-7 or 0 (1=not at all–7=very much, 0=I was not at the unit)	**The Web questions for nurses** Estimate on scale 1-7 or 0 (1=not at all–7=very much, 0=I did dot work with the parents during the work shift)
1: To what extent did the staff listen to you today?	1. To what extent did you listen to parents today?
2: To what extent did you participate in your baby's care today?	2. To what extent did you make it possible for parents to participate in the care of their baby today?
3: To what extent did the guidance provided by the staff meet your needs today?	3. To what extent was the guidance you provided adapted to meet the individual needs of parents' today?
4: To what extent was your opinion considered in decisions made about your baby today?	4. To what extent did you consider parents' opinions in decisions concerning their baby today?
5: To what extent did you trust the staff in the care of your baby today?	5. To what extent did parents trust you in the care of their baby today?
6: To what extent did the staff trust you in the care of your baby today?	6. To what extent did you trust parents in the care of their baby today?
7: To what extent did the information provided by the staff meet your needs today?	7. To what extent was the information you gave adapted to meet the individual needs of parents' today?
8: To what extent did the staff offer you emotional support today?	8. To what extent did you offer parents emotional support today?

4.2.4.4 Nurses' web questions

The nurses working at bedside answered one web question after each shift (Table 6). The nurses' questions corresponded to the parents' questions from the nurses' perspective. The web questionnaire for nurses was distributed for three months during the same period the parents were recruited. Nurses' and parents' questions were not matched, as the aim was to get an overall picture of the unit's care culture. The number of answers peaked at the beginning of the study and settled soon on the level of 50 to 75% of the maximum value in the International Closeness Survey (Study IV) and in the first pilot study. The peak occurred in the middle of the study period in the second pilot study when an intervention was made to improve the response rate. However, the effects of the intervention lasted only for one day. (Figure 3)

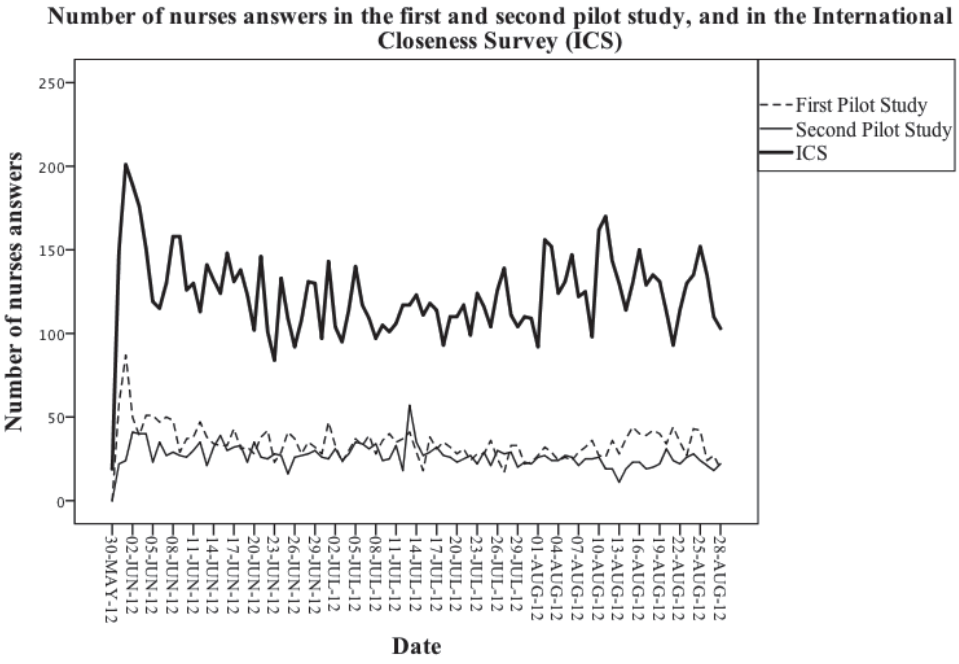

Figure 3. Number of nurses' web question answers per day in two pilot studies and in the International Closeness Survey

4.2.5 The reliability and validation of the measures

4.2.5.1 Patient charts (Study I)

The quality of the hand-written patient chart documentation varied. All documents were carefully reviewed, as similar information could have been written or entered in different places in the documentation sheets or electronic charting system. Part of the patient charts were microfilmed or scanned because of the filing system, which further complicated the data collection. The lowest quality was during the years 2001 to 2002. The data for five randomly selected subjects were re-entered by another person to assess the proportion of data entry errors and interpretation errors. The overall accuracy between the two entries was 71%.

4.2.5.2 The validation of diaries by text-messages (Study IV)

We compared the simultaneous data on the parental presence collected by diaries and daily text messages to both parents during the first pilot study in Turku University Hospital and in the final studies II and III in order to validate the diary data collection process. The text message information was available for 446 diary days for mothers and 349 diary days for fathers in the first pilot study. There were 13 (2.9%) days when mothers and 48 (13.8%) days when fathers had indicated by the text messages that they had been in the neonatal unit, but no diary data were found. In studies III and IV, text message information was available for 393 diary days for mothers and for 309 diary days for fathers. There were 6 (1.5%) days when mothers and 20 (6.5%) days when fathers had indicated by the text messages that they had been in the neonatal unit, but no diary data were found. The change between the pilot study and the actual study was 1.4 percent for the mothers and 7.3 for the fathers.

4.2.5.3 The validation of diaries by nurses' documentation (Study IV)

We compared the simultaneous data collected by parental diaries and nurses' medical chart documentation in Turku University Hospital in the final Study III to validate the diary data about SSC. There were 57 out of 470 days when parents had reported SSC but the nurses had not documented SSC for the day. Conversely, there were 16 out of 470 days when the nurses documented SSC but the par-

ents had not reported SSC in the diary. The raw-agreement was 77%, and the weighted kappa-correlation was 0.63.

4.2.5.4 The effects of Likert scale variations for the variation of parents and nurses responses (Study IV)

The range of possible responses in text messages was from 1 to 5 during the pilot studies and from 1 to 7 during the International Closeness Survey (excluding the response 0 indicating not being present). We calculated the coefficient of variation for the pilot studies combined and for the International Closeness Survey to study the impact of the scale on the variation of responses. The coefficient of variation was CV = (Standard Deviation / Mean) * 100=1.032/4.18*100=24.6% for the pilot studies (Figure 4a) and CV = 1.711/5.65*100 =30.3% for the final study (Figure 4b); there was a statistical difference between the coefficients of variations when tested with Levene F test $p<0.001$.The variation ratio, which is more preferable for categorical data such as the Likert scale, also gives similar results. The variation ratio for the pilot studies was VR=1–(fmode/N)=1–(1529/3023)=0.49 and for the final study VR=1–(3654/8197)= 0.55.

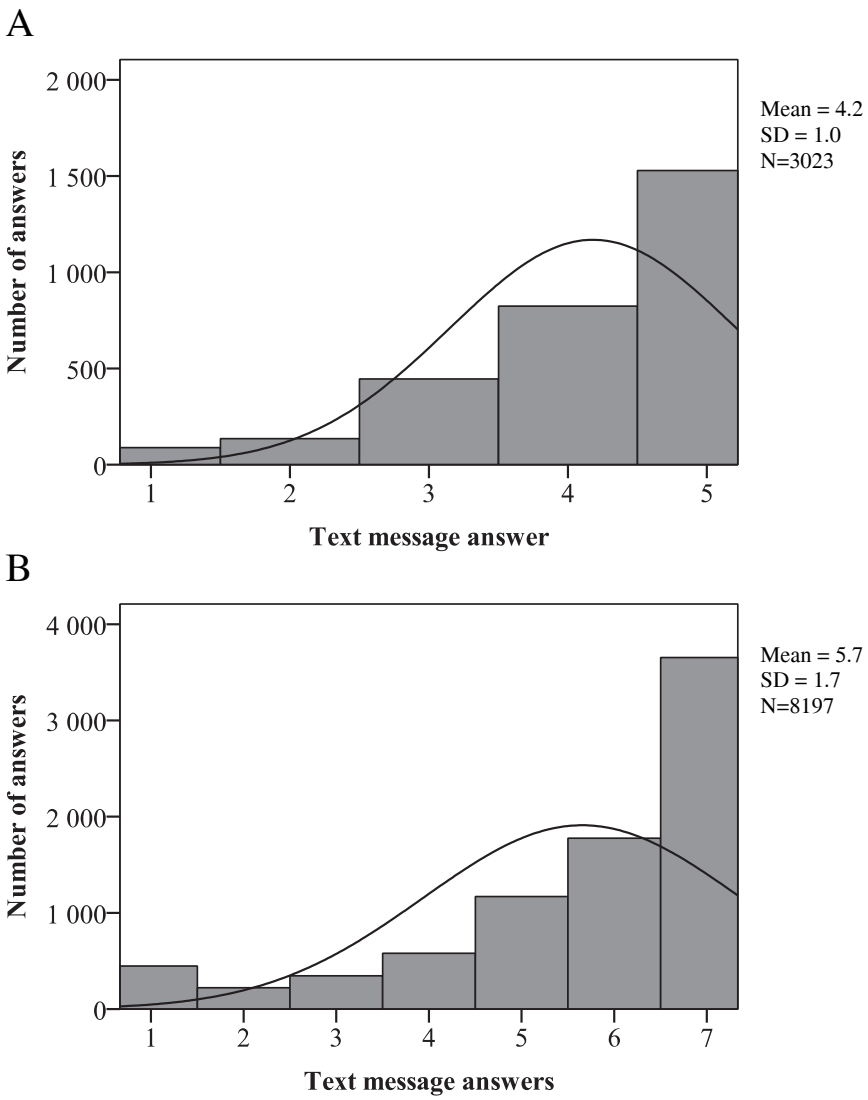

Figure 4a-b. The variation of parents' text message answers in the pilot studies (A) and in the International Closeness Survey (B)

The range of possible responses in the web questions was from 1 to 5 during pilot study 1 and 2 and from 1 to 7 during International Closeness Survey (excluding the response 0 indicating not being present). (Figure 5a and b) We calculated a combined CV for the pilot study 1 and 2 and compared it to that of the International Closeness Survey to see the impact of the scale on the variation of responses. The CV was 1.032/4.18*100= 18.9% for pilot studies 1 and 2 and 1.711/5.65*100= 25.4% for International Closeness Survey ($p<0.001$ Levene

test). VR gives similar results: the VR for pilot study 1 and 2 combined was VR=1–(fmode/N)=1–(1993/4401)=0.55 and for International Closeness Survey VR=1–(3636/9479)=0.62.

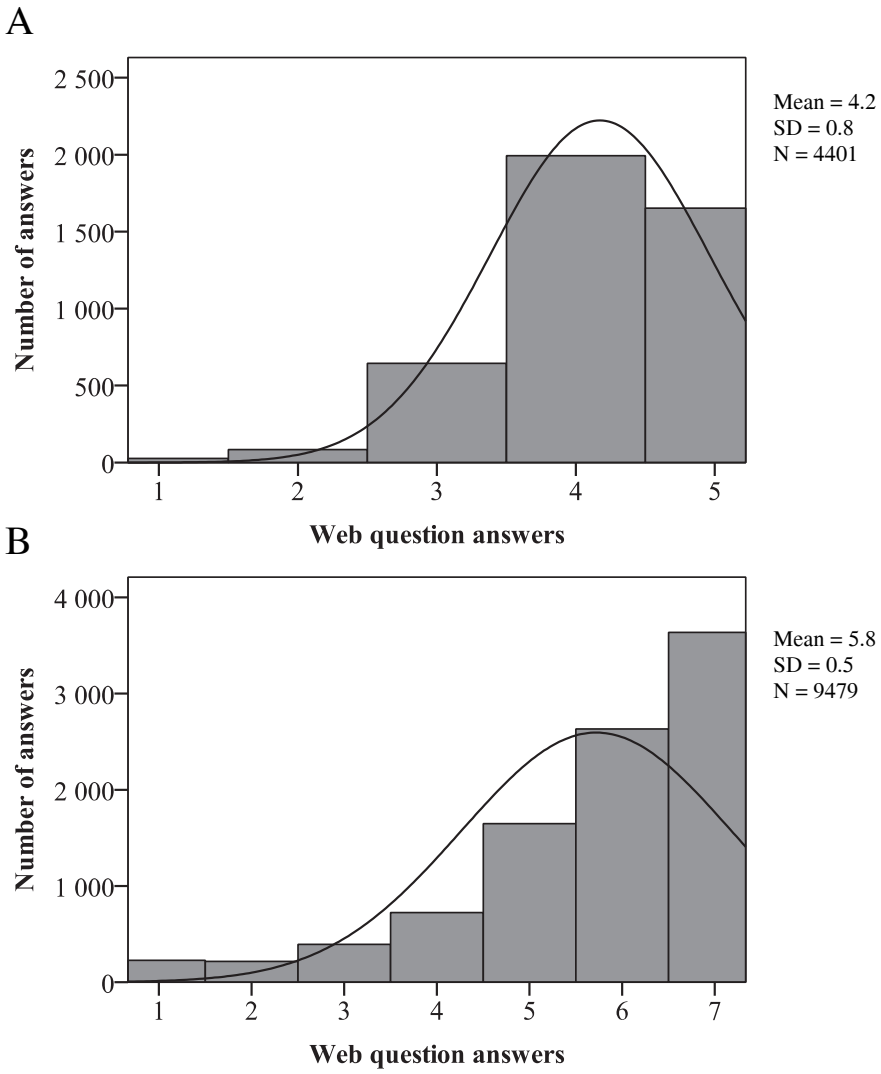

Figure 5a-b. The variation of nurses' web question answers in the pilot studies (A) and in the International Closeness Survey (B).

4.2.6 Statistical analyses

4.2.6.1 Study I

Univariate comparisons between the birth cohorts of Study I were made with one way analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. The associations between the outcome variables and birth cohorts were further studied using analysis of covariance controlling for gender and birth weight. Gestational age subgroup analyses were also performed when the difference between the cohorts was significant. Statistical analyses were done using SPSS v. 20.0 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) and p-values below 0.05 were considered as statistically significant.

4.2.6.2 Study II

We used mostly descriptive data and particularly Kaplan-Meyer –curves in Study II. We calculated the raw agreement and kappa-correlation to validate the Parental Closeness Diaries with the information provided by the nurses to the patients' charts. The effect of changing the 5-item Likert scale to the 7-item Likert scale on the variation of answers was described with variation ratio and the variation of covariances. The statistical differences between the variations of covariences were tested with Levene F test.

4.2.6.3 Study III

The outcome variables, duration of presence, holding and SSC, of the Parental Closeness Diary as daily median and mean values for each unit in Study III. We first calculated the mean value for each infant using the existing data from the first two weeks of diaries and then the mean value of each unit using the mean values of the infants. This strategy was chosen to give every infant the same weight in the final analysis, regardless of the number of days with diary entries during the first two weeks. When we compared the units, the mean values of the two infants were used for twin pairs.

Only background variables (Table 10 a–c) with a univariate connection of $p < 0.10$ were included in the multifactorial analyses because of the large number of

explanatory variables. A paired sample t-test was used to compare the units that offered the opportunity to stay overnight to the other units. A logistic regression analysis was used to study the associations between the parents' presence, holding the infant, SSC and background variables controlling for the unit. Univariate associations between continuous background variables and the neonatal units were studied using linear models. Binary background variables were compared between the neonatal units using logistic regression, and ordinal background variables were compared between the neonatal units using cumulative logic models. Generalized linear models with negative binomial distribution and log link were used to study the association between the response variables, namely the parents' presence, holding the infant and SSC, and predictor variables of the unit and background factors. A paired sample t-test was used to compare the duration of the parental presence, holding and SSC at two time points. Statistical analyses were carried out using SAS for Windows version 9.4 (SAS Institute Inc., Cary, NC, USA). p-Values below 0.05 were considered statistically significant.

4.2.6.4 Study IV

Cross tabulation and logistic regression was used in Study IV to study the difference between the days the mothers and fathers had been present in the unit regarding the data derived from text message questions. Answer "0" was considered as mother or father not being present in the unit on that day and any other number showed that they had been in the unit that day.

Logistic regression analysis was used in Study IV to study whether background characteristics (Table 10 a–c) were associated with participation in the study, controlling for the unit. Logistic regression was also used to compare dichotomous background variables between units. Continuous background variables were compared between units using one-way analysis of variance. The Mantel–Haenzel chi-square test (Mantel and Haenszel 1959) was used to compare the travel time from home between units. Fisher's exact test was used to compare the parents' socioeconomic statuses between the units. Associations between the units' mean scores of the mothers, fathers and nurses were assessed using Pearson's correlation coefficients.

The mean scores of the text message questions, i.e., the quality of perceived FCC, were assessed using mixed-model repeated measures analysis (Littell et al. 1998) with subjects as a random effect. The GEE method (Liang and Zegar 1986) was used to study the proportion of days that the parent was present with a binomial distribution, logit link and exchangeable working correlation. Compari-

sons were made between the units and then between the mothers and the fathers, controlling for the unit. The associations between the parents' background characteristics and mean scores and parents' presence were also studied using the same methods. Questions were used as a further covariate when comparing mean scores.

The mean scores of nurses' web questionnaires were compared between the units using mixed-model repeated measures analysis with random intercept. Statistical analyses were done using SAS for Windows version 9.4. p-Values < .05 were considered statistically significant.

4.2.6.5 Additional data

The scatter plots were drawn to see the relationships between the parents' presence, SSC and holding and the perceived quality of FCC. Mothers' and fathers' measures were used separately.

4.2.7 Ethics

The Study I and the pilot studies for the Study II in Finland were approved by the Ethics Committee of the Hospital District of Southwest Finland in May 2012, and the International Closeness Survey (Study III and IV) was approved in Finland by the Ethics Committee of the Hospital District of Southwest Finland in 2013 and also simultaneously in Sweden, Norway, Estonia, Italy and Spain by the local Ethics Committees. Written informed consent was obtained from each parent before his or her study participation. The hospitals gave overall consent for the nurses' participation in Study IV, which was anonymous, rather than the individual nurses. Each nurse's anonymous reply to the web question was considered as informed consent. Participation was voluntary.

5 RESULTS

5.1 Trends in care practices reflecting parental involvement in neonatal care (Study I)

The study population in Study I comprised of 295 preterm infants born below 32 gestational weeks or birth weight <1500 g, born during an 11-year period, and divided into four cohorts (2001–2002, 2006–2007, 2009–2010, 2011–2012). There was a statistically significant difference in birth weight and gender distribution among the four cohorts, and these were adjusted for in the analyses comparing outcomes (Table 7).

Thermoregulation

Postmenstrual age (PMA) at the end of incubator care was lower in the later cohorts compared to earlier ones. There was a statistically significant difference between the first two cohorts (mean PMA in 2001–2002 vs. 2006–2007, 33.4 [SD 1.36] vs. 32.3 weeks [SD 1.16], $p<0.05$) and between the last two cohorts (mean 32.1 [SD 1.60] vs. 31.6 [SD 1.10], $p<0.05$). The PMA, at the end of warmer bed care, decreased significantly during the study period from 35.5 (SD 2.30) to 34.0 (SD 1.93) in the years 2001–2002 to 2011–2012, respectively ($p<0.001$) (Table 7) (Fig 6).

Nutrition

Feeding during the first 24 hours of life, both parenterally and enterally, became more intensive during the study period. The infants reached full enteral nutrition, i.e., the end of intravenous fluids, earlier in the later three cohorts compared to the first. Breastfeeding began over two weeks earlier and bottle feeding a little less than one week earlier in the last cohort compared to the first cohort, and there was a significant difference in the PMA between the last two cohorts in both breastfeeding and bottle feeding. The infants were at least partially breastfed at the mean PMA of 33.1 (SD 1.89) in the 2011–2012 cohort vs. 34.7 (SD 1.94) in the 2009–2010 cohort, $p<0.05$, and at least partially bottle fed at 33.3 (SD 1.51) vs. 33.9 (SD 1.68), $p<0.05$, respectively. However, full oral feedings, i.e., the termination of both IV-lines and the nasogastric tube, were reached at about the same PMA in every cohort (Table 7).

Table 7. Trends in thermoregulation and nutrition in very preterm infants born < 32 gw or <1500g in Turku University Hospital in years 2001–2002, 2006–2007, 2009–2010 and 2011–12,

Background variables	**N**	**Years 2001-2002 (n=72)**	**Years 2006-2007 (n=69)**	**Years 2009-2010 (n=76)**	**Years 2011-2012 (n=78)**	**P-value**
Birth weight (g), mean (SD)	295	1183 (333)	1349 (369)	1292 (383)	1176 (362)	0.01
Male (%)		31 (43%)	41 (59%)	53 (79%)	43 (55%)	0.012
Gestational weeks at birth, mean (SD)		29.4 (2.4)	29.7 (2.1)	29.8 (2.5)	29.0 (2.4)	0.175
Thermoregulation						
End of incubator care ((PMA, weeks), mean (SD)	280	33.4 (1.36)	*32.3 (1.16)	32.1 (1.60)	*31.6 (1.10)	<0.001
End of warmer bed care (PMA, weeks), mean (SD)	264	35.5 (2.30)	34.2 (1.64)	34.3 (2.20)	34.0 (1.93)	<0.001
Nutrition						
Ultra early nutrition	295					
Parenteral nutrition given from the first day of life (n, %)		12 (17.9%)	*56 (83.6%)	61 (82.4%)	*76 (97.4%)	<0.001
Enteral feeding during the first day of life (n, %)		8 (11.1%)	*56 (81.2%)	54 (71.1%)	*75 (96.2%)	<0.001
Full enteral nutrition (PMA, weeks), mean (SD)	286	32.5 (1.78)	*31.6 (2.20)	31.1 (2.21)	30.6 (2.16)	<0.001
Start of bottle feeding (PMA, weeks), mean (SD)	295	34.1 (1.04)	33.7 (1.39)	33.9 (1.68)	*33.3 (1.51)	0.003
Start of breast feeding (PMA, weeks), mean (SD)	228	35.3 (1.34)	34.4 (1.39)	34.7 (1.94)	*33.1 (1.89)	<0.001
< 28 weeks	50	36.2 (1.44)	35.7 (1.76)	35.5 (2.40)	33.1 (2.70)	0.004
28–31 weeks	155	34.8 (1.33)	34.3 (1.16)	34.1 (1.40)	33.0 (1.49)	<0.001
≥32 weeks	23	35.2 (1.06)	34.0 (1.67)	36.5 (0.96)	34.1 (0.66)	0.063
Full oral feeding		36.4 (1.69)	36.1 (1.91)	36.7 (2.63)	36.6 (2.83)	0.367

* Significant difference (p<0.05) between two subsequent cohorts ; PMA, postmenstrual age

The percentage of infants who had their first oral feeding from the breast instead of the bottle increased from 11% in the first cohort to 23% in the last cohort. This change was most pronounced in the subgroup of infants born below 28 gw with an increase from only one infant in first three cohorts to 57.1% of the infants in the last cohort.

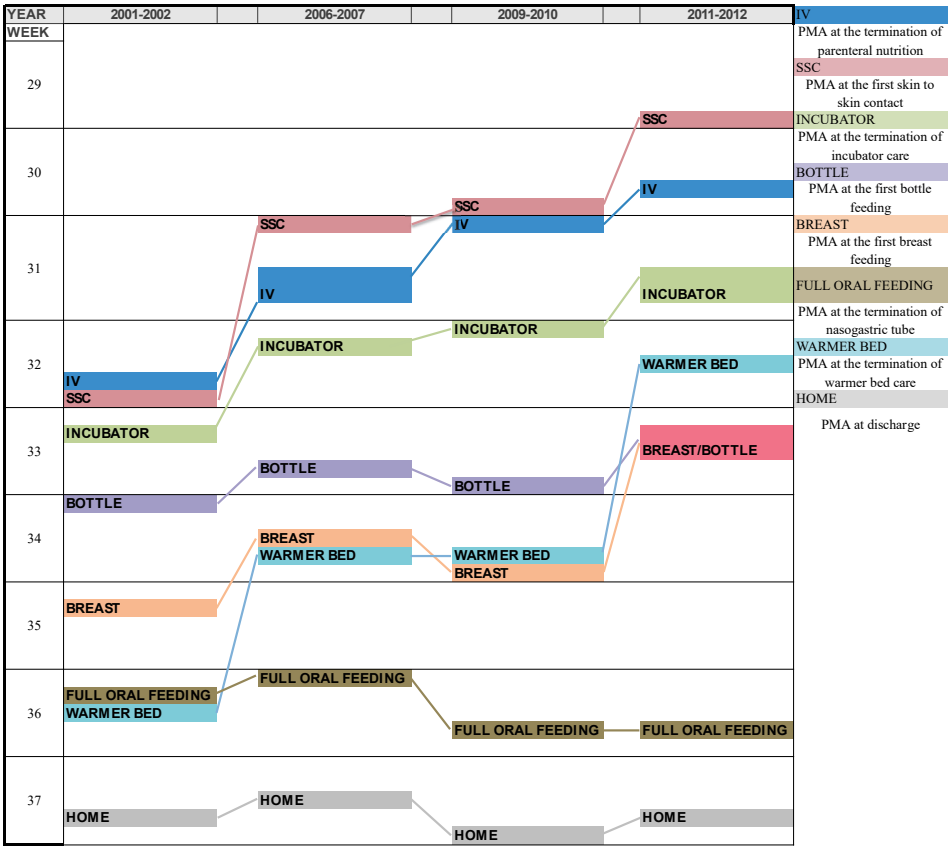

Figure 6. Trends in PMA of very preterm infants reaching milestones reflecting FCC from 2001-2 to 2011-12 in Turku Univeristy Hospital NICU. Data are expressed at mean postmenstrual age (PMA, weeks).

Skin-to-skin contact

The SSC was started three PMA weeks earlier in the whole study population in the 2011–2012 cohort compared to the 2001–2002 cohort (mean PMA 32.8 [SD 1.99] vs. 29.9 [SD 2.34], $p<0.001$) (Table 8). The infants had their first SSC 19 days earlier in the last cohort compared to the first. The most prominent change occurred in infants born below 28 gestational weeks whose PMA at the beginning of SSC decreased from a mean 24.4 to 5.1 and a median of 42.5 days to 4.0

days between the first and the last cohorts (p<0.001) (Table 8). The number of SSC episodes during the first four weeks of life also increased from 5 episodes to 21 episodes between the first and the last cohorts in the whole population (p<0.001).

Table 8. The beginning of skin-to-skin care of very preterm infants <32 gw or <1500g during an 11-year period in Turku University hospital.

	n	Years 2001-2002 (n=72)		Years 2006-2007 (n=69)		Years 2009-2010 (n=76)		Years 2011-2012 (n=78)	P-value
Age at the beginning of SSC (PMA, weeks), mean (SD)	272	32.8 (1.99)	*	31.0 (1.60)		30.9 (2.02)	*	29.9 (2.34)	<0.001
< 28 weeks	74	32.9 (2.84)	*	29.4 (1.47)		28.7 (1.44)	*	27.2 (1.33)	<0.001
28–31 weeks	176	32.3 (1.57)	*	31.5 (1.03)		31.1 (1.15)		30.7 (1.31)	<0.001
≥32 weeks	23	34.0 (0.84)		36.0		34.4 (1.06)		33.6 (0.67)	0.160
Age at the beginning of SSC (calendar age, days), mean (SD)	273	24.4 (19.9)	*	11.4 (9.3)		7.8 (7.2)		5.1 (6.1)	<0.001
< 28 weeks	74	47.2 (20.3)	*	21.4 (12.0)		15.7 (10.3)	*	7.1 (7.9)	<0.001
28–31 weeks	176	17.5 (11.8)	*	8.0 (5.0)		5.5 (3.4)		3.9 (4.8)	<0.001
≥ 32 weeks	23	7.2 (5.4)	*	25.0	*	4.4 (1.6)		5.2 (4.5)	0.001
Age at the beginning of SSC (calendar age, days), median (min; max)	273	20.0 (2;83)		8.0 (2;43)		6.0 (1;35)		3.0 (0;31)	<0.001
< 28 weeks	74	42.5 (12;83)		20.0 (7;43)		11.5 (5;35)		4.0 (1;31)	<0.001
28–31 weeks	176	16.5 (2;46)		7.0 (2;22)		4.5 (1;16)		3.0 (0;31)	<0.001
>32 weeks	23	21.4 (7;43)		25 (25;25)		4,5 (2;7)		4.0 (1;14)	0.001
SSC episodes per first four weeks		5.0	*	10.6	*	15.6	*	20.9	<0.001

* Significant difference (p<0.05) between two subsequent cohorts

The infants gained significantly more weight per week in the last cohort, 159 grams per week, compared to the first cohort, 110 grams per week (p<0.001). No change was observed in the length of stay or in the PMA at the discharge (Table 9).

Table 9. Weight gain, the length of hospital stay and postmensrual age (PMA) at discharge in four cohorts in 11-year period in Turku University hospital

	Years 2001-2002 (n = 72)		Years 2006-2007 (n = 69)	Years 2009-2010 (n = 76)		Years 2011-2012 (n = 78)	P-value
Weight gain (g/week)	110	*	136	147	*	159	<0.001
The length of hospital stay (days)	55.4		57.8	58.8		58.2	0.205
PMA at discharge	37.6		37.4	38.1		37.6	0.195

* Significant difference ($p<0.05$) between two subsequent cohorts

5.2 International Closeness Survey in the SCENE study (Studies III and IV)

The parents of 328 out of 604 eligible preterm infants born below 35 gestational weeks in the 11 NICUs in 6 European countries were included (Figure 1) in studies II and III. Altogether 103 of the 328 infants were twins (52 pairs of twins, one twin died). A total of 262 families with 256 mothers and 214 fathers participated in the International Closeness Survey. The families who were not approached did not differ in regards to the infants' gestational age or traveling time from home to hospital, while a higher birth weight (+100g) increased the possibility for the family not being approached by the researcher (OR 1.05, P = 0.02). There were no differences in the background characteristics of the families who agreed to participate compared to those who declined.

There were significant differences in the demographic background factors between the study populations of the participating 11 NICUs. (Tables 10 a–c) Study population of each NICU differed in gestational age, birth weight, birth length, birth head circumference twins, incubator (yes/no), parents' age and education, mothers' socioeconomic status, time from home to hospital, parents' cohabitation, parents' smoking, and car. There was no statistical difference in the infants' sex, the fathers' socioeconomic status, having siblings, mothers' smoking, owning a car, and whether mothers' native language was different than the official language in the country. (Tables 10a–c)

Table 10a. Characteristics of the preterm infants born < 35 gestational weeks participating in the International Closeness Survey (Study III and IV)

		Finland	Sweden			Estonia		Italy	Spain	Norway			p-value
		Turku	Uppsala	Danderyd	Huddinge	Tallinn	Tartu	Como	Madrid	Drammen	Bergen	Tromsø	
N	n	28	28	25	15	22	14	26	30	27	29	10	
Infant characteristics													
Calendar age at study entry	median (q1–q3)	4 (3–5)	4 (3–5)	5 (4–6)	4 (2–5)	4 (3–5)	2 (1–3)	3 (2–4)	4 (2–5)	2 (4–6)	2 (2–6)	8 (5–12)	<0.001
Gestational weeks at birth	med (q1–q3)	32.0 (29.2–33.9)	28.2 (25.0–31.2)	33.7 (32.4–34.4)	32.6 (31.0–34.5)	33.4 (31.9–34.1)	33.9 (30.7–34.3)	32.1 (31.0–32.9)	31.1 (28.7–32.7)	33.1 (31.0–34.0)	31.2 (28.0–33.6)	31.9 (30.0–34.0)	<0.001
Birth weight (g)	med (q1–q3)	1458 (1065–2087)	1076 (654–1744)	2029 (1748–2234)	1711 (1453–2310)	2044 (1794–2414)	2158 (1440–2246)	1355 (980–1660)	1495 (1090–1780)	1846 (1620–2153)	1655 (1200–2100)	1561 (1242–1905)	<0.001
Birth length (cm)	med (q1–q3)	41 (38.6–44.0)	36.3 (30.5–41.3)	44.0 (41.0–45.0)	40.5 (36.5–46.0)	45.0 (42.0–47.0)	44.8 (41.0–46.0)	40.8 (36.0–43.0)	40.5 (36.0–43.0)	43.0 (39.5–44.0)	41.0 (38.0–45.0)	40.5 (37.5–43)	<0.001
Head circumference at birth (cm)	med (q1–q3)	28.9 (26.4–31.3)	25.4 (22.5–30.0)	31.0 (29.5–32.5)	31.2 (29.0–33.0)	31.0 (29.5–32.0)	31.5 (29.0–32.0)	28.3 (26.5–30.0)	28.3 (26.0–30.5)	30.5 (29.0–31.5)	29.0 (27.0–31.0)	28.7 (27.3–30.0)	<0.001
Sex, female	n (%)	12 (43)	12 (43)	12 (48)	9 (60)	18 (82)	8 (57)	13 (50)	17 (57)	13 (48)	17 (59)	5 (50)	0.43
Delivery, vaginal	n (%)	11 (39)	17 (61)	12 (48)	6 (40)	14 (64)	8 (57)	4 (15)	13 (43)	10 (37)	21 (72)	3 (30)	0.01
Twins	n (%)	10 (36)	3 (11)	1 (4)	5 (33)	4 (18)	3 (21)	8 (31)	10 (33)	4 (15)	1 (3)	1 (10)	0.047
Incubator, yes	n (%)	11 (39)	13 (46)	3 (12)	6 (40)	18 (82)	11 (79)	22 (85)	28 (93)	8 (30)	13 (45)	3 (30)	<0.001

q1=lower quartile, q3= upper quartile

Table 10b. Characteristics of the parents and families of preterm infants born < 35 gestational weeks participating in the International Closeness Survey (Study III and IV)

		Finland	Sweden			Estonia		Italy	Spain	Norway			p-value
		Turku	Uppsala	Danderyd	Huddinge	Tallinn	Tartu	Como	Madrid	Drammen	Bergen	Tromsø	
	n	28	28	25	15	22	14	26	30	27	29	10	
Time from hospital to home <30 min	n (%)	17 (60)	14 (50)	20 (80)	8 (50)	14 (60)	9 (60)	16 (60)	28 (90)	16 (60)	18 (60)	6 (60)	<0.001
Time from hospital to home 30-60 min	n (%)	2 (10)	1 (0)	4 (20)	3 (20)	2 (10)	1 (10)	8 (30)	2 (10)	10 (40)	3 (10)	0 (0)	<0.001
Time from hospital to home >60 min	n (%)	9 (30)	13 (50)	1 (0)	2 (10)	6 (30)	4 (30)	0 (0)	0 (0)	1 (0)	8 (30)	4 (40)	<0.001
Siblings, yes	n (%)	16 (60)	15 (50)	9 (40)	9 (60)	9 (40)	9 (60)	6 (20)	8 (30)	16 (60)	15 (50)	5 (50)	0.06
Mother's prev. child in a NICU	n (%)	6 (20)	5 (20)	2 (10)	2 (10)	2 (10)	2 (10)	1 (0)	2 (10)	3 (10)	3 (10)	2 (20)	0.55
Father's prev. child in a NICU	n (%)	5 (20)	5 (20)	1 (0)	2 (10)	3 (10)	1 (10)	1 (0)	1 (0)	1 (0)	3 (10)	0 (0)	0.57
Car, yes	n (%)	27 (100)	26 (90)	25 (100)	15 (100)	22 (100)	14 (100)	25 (100)	30 (100)	27 (100)	29 (100)	9 (90)	0.23
Parents living together, yes	n (%)	24 (90)	27 (100)	25 (100)	15 (100)	22 (100)	12 (90)	25 (100)	26 (90)	26 (100)	29 (100)	8 (80)	0.02
Mother smoking, yes	n (%)	0 (0)	0 (0)	1 (0)	2 (10)	1 (0)	1 (10)	2 (10)	8 (30)	0 (0)	0 (0)	2 (20)	0.08
Father smoking, yes	n (%)	7 (30)	0 (0)	4 (20)	2 (10)	7 (30)	9 (60)	9 (30)	15 (50)	4 (10)	4 (10)	1 (10)	0.002
Mother's language non-native	n (%)	4 (10)	0 (0)	3 (10)	3 (20)	0 (0)	0 (0)	0 (0)	0 (0)	3 (10)	5 (20)	0 (0)	0.31
Father's language non-native	n (%)	3 (10)	1 (0)	4 (20)	5 (30)	1 (0)	0 (0)	0 (0)	1 (0)	7 (30)	2 (10)	0 (0)	0.06

Table 10c. Education and socioeconomic status of the parents of preterm infants born < 35 gestational weeks participating in the International Closeness Survey (Study III and IV)

		Finland	Sweden			Estonia		Italy	Spain	Norway			
		Turku	Uppsala	Danderyd	Huddinge	Tallinn	Tartu	Como	Madrid	Drammen	Bergen	Tromsø	p-value
	n	28	28	25	15	22	14	26	30	27	29	10	
Mother's education university	n (%)	2 (10)	15 (50)	17 (70)	8 (50)	13 (60)	6 (40)	10 (40)	10 (30)	21 (80)	7 (20)	5 (50)	<0.001
Father's education university	n (%)	3 (10)	13 (50)	15 (60)	3 (20)	9 (40)	2 (10)	3 (10)	7 (20)	17 (60)	11 (40)	2 (20)	<0.001
Mother's socioeconomic status													0.002
Paid work	n (%)	16 (60)	22 (80)	19 (80)	13 (90)	13 (60)	11 (80)	23 (90)	22 (70)	25 (90)	26 (90)	9 (90)	
Home-maker	n (%)	1 (0)	0 (0)	0 (0)	0 (0)	5 (20)	3 (20)	2 (10)	6 (20)	0 (0)	0 (0)	0 (0)	
Unemployed	n (%)	4 (10)	1 (0)	1 (0)	0 (0)	2 (10)	0 (0)	0 (0)	2 (10)	1 (0)	1 (0)	0 (0)	
Student	n (%)	4 (10)	1 (0)	1 (0)	1 (10)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (10)	1 (10)	
Other	n (%)	2 (10)	2 (10)	4 (20)	1 (10)	1 (0)	0 (0)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	
Father's socioeconomic status													0.10
Paid work	n (%)	23 (80)	22 (80)	22 (90)	14 (90)	21 (100)	13 (90)	21 (80)	24 (80)	25 (90)	28 (100)	8 (80)	
Unemployed	n (%)	2 (10)	0 (0)	0 (0)	1 (10)	1 (0)	0 (0)	0 (0)	3 (10)	1 (0)	0 (0)	0 (0)	
Student	n (%)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	1 (10)	
Other	n (%)	1 (0)	3 (10)	3 (10)	0 (0)	0 (0)	1 (10)	4 (20)	1 (0)	0 (0)	0 (0)	0 (0)	

5.2.1 Parents' presence in 11 European NICUs (III and IV)

We looked in the text-message answers for how many days the mothers and fathers had reported being in the unit in Study IV. Mothers' presence in the unit was more likely than the fathers' (92.7% of the study days (mothers) vs. 77.9% of the study days (fathers), OR 4.0 [95% CI 3.0–5.4], p<0.001). The parents' presence varied widely between the units: mothers were present the most in Madrid, Spain, in 98.1% of the study days and the least in Tartu, Estonia, in 78.9% of the study days, respectively (p<0.001). The fathers were present most often in Danderyd, Sweden, in 96.1% of the study days and the least in Tartu, Estonia, in 52.2% of the days, respectively (p <0.001). (Table 11)

The parents reported the length of their presence at the unit daily during the first two weeks in Study III (Figure 7a). The parents' presence varied widely between the units. The longest mean duration of parental presence was reported in Huddinge, Sweden (22.4 (SD 1.6) hours per day) and the shortest duration was seen in Como, Italy (median 3.4 (SD 1.5) hours) (p<0.001).

We compared the six units with the possibility for the parents' to stay overnight to the five other units and found out that the parents daily presence was a mean of 14.2 hours (19.7 hours, SD 5.3 vs. 5.5 hours, SD 2.6, p<0.001) longer in these "bed-in-a-unit" –units (Fig. 7a). On average, the parents were present at the NICU over seven hours also between 10 p.m. and 7 a.m. in five of those six bed-in-a-unit units (Fig. 7b).

5.2.2 Duration of parents holding or having SSC with their infant (III)

The duration of the time the parents were holding their infant varied between the units. The longest length of holding was observed in Drammen, Norway (mean of 3.2 hours per day (SD 2.7) and the shortest length of holding was seen in Uppsala, Sweden (0.1 (SD 0.26) hours) (p<0.001). In the units providing parents the opportunity to stay overnight, the mean duration of holding was 1.81 hours (SD 2.08) compared to 1.49 hours (SD 1.84) in the other units (p = 0.15) (Fig. 7c).

Table 11. Proportion of the study days when the mothers and fathers were present in the NICU.

Unit	Mother		Father	
	Number of received text message aswers	Present* at the NICU	Number of received text messages answers	Present* at the NICU
Turku, Finland	609	92.5 %	507	71.4 %
Uppsala, Sweden	772	89.9 %	719	78.3 %
Danderyd, Sweden	248	97.6 %	243	96.1 %
Huddinge, Sweden	160	96.3 %	125	94.0 %
Tallinn, Estonia	355	90.1 %	171	57.3 %
Tartu, Estonia	242	78.9 %	134	52.2 %
Como, Italy	779	92.9 %	660	77.9 %
Madrid, Spain	643	98.1 %	340	88.8 %
Drammen, Norway	405	91.1 %	351	72.7 %
Bergen, Norway	576	95.5 %	516	80.4 %
Tromso, Norway	256	92.6 %	197	77.2 %

** Percentage is derived from those days that the parents replied to text message questions*

The amount of SSC varied widely between the units. The longest duration was a mean of 8.9 hours per day (SD 6.09) hours per day in Uppsala, Sweden, and the shortest was mean of 0.3 (SD 0.3) hours per day in Tartu, Estonia ($p < 0.001$ hours). The units providing parents the opportunity to stay overnight had an average duration of SSC mean 4.00 hours, SD 4.51, compared to the other units with mean of 1.74 hours, SD 1.54 per day, $p<0.001$) (Fig. 7d).

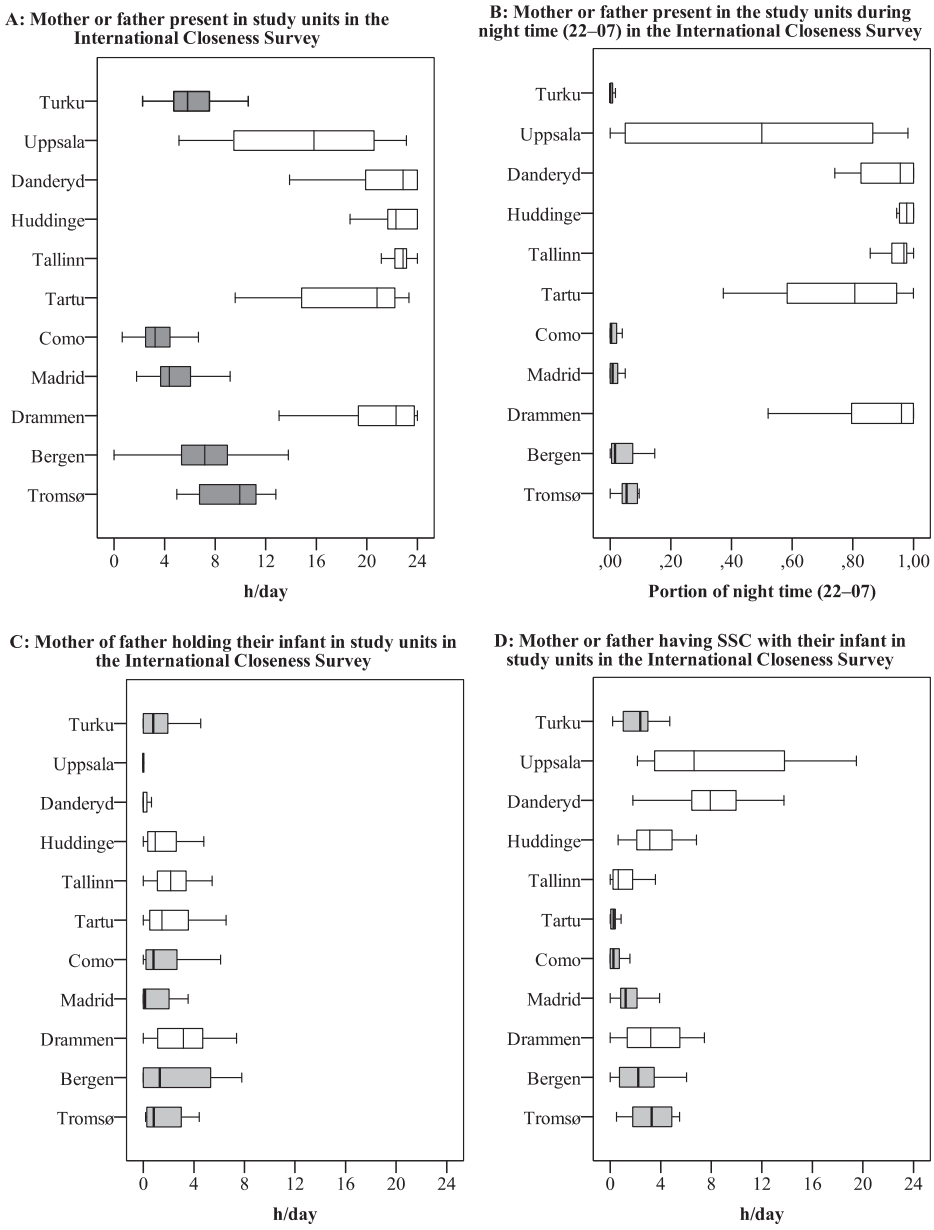

Figure 7a–d. Mother's or father's presence (A), Percentage of the night time (10pm to 7 am) hours, Holding (C) and SSC (D) at the 11 NICUs in 6 European countries during the first two weeks of their infant's life. The units with the opportunity for parents to stay overnight are indicated as white box-plots.

5.2.3 The time trends in parent-infant closeness

With the one-week of Parental Closeness Diary data from 81 infants at one month of age, we were able to analyze the time trends of parents' presence and physical parent-infant closeness between the first 14 days at the beginning and 7 days at one month of infant's age. Overall, the parents' presence increased with a mean of 77 minutes, SD 307 minutes, p=0.03 and holding increased with a mean of 115 minutes, SD 134 minutes, p<00.1, respectively. In contrast, the duration of SSC decreased with a mean of 34 minutes, SD 130 minutes, p = 0.02, respectively.

5.2.4 Parent perceptions of the quality of FCC in 11 European NICUs (IV)

In the daily SMS enquiry with 1 randomly selected question out of 8 possible questions on quality of FCC the mothers gave slightly higher scores, with a scale from 1 to 7, compared to the fathers. The mothers' mean score was 5.8 (SD 0.47, 95% CI 5.7–5.9), and the fathers' mean score was 5.7 (SD 0.51, CI 5.6-5.9) (p<0.001, parameter estimate from the mixed model analysis) The parents' perceptions of the quality of FCC had significant variation between the units. The highest mean score for mothers was observed in Drammen, Norway and lowest in Como, Italy (6.4 (SD 1.0) 4.9, (SD 2.0), respectively (p<0.001). The fathers' mean score ranged from 6.3, (SD 1.2) in Turku, Finland to 4.6 (SD 2.3) in Tartu, Estonia (p arvo) (Table 12).

Looking at the eight different questions covering the aspects of FCC, question on "Mutual trust between parents and the staff," (question 5 and 6) was ranked among the highest three scores in 10 out of 11 units by the mothers and in all units by the fathers. "Participation in infant care" (question 2) was ranked among the lowest three scores by the fathers in 10 units. "Emotional support" (question 8) was ranked among the lowest three scores in 11 units by the mothers and in 7 units by the fathers. "Participation in decision-making" (question 4) was ranked among the lowest three scores in 9 units by the mothers and in 7 units by the fathers. However, in one unit—Uppsala, Sweden—the parents regarded this aspect of FCC, "Participation in decision-making," as the strength of the unit.

Table 12. The perceived quality of FCC based on text message questions for the parents and web questions for the nurses at eleven NICUs in the International Closeness Survey

	Text messages				Web questions	
	Mothers		Fathers		Nurses	
Unit	number of text message answers from 1 to 7	Mean (SD)	number of text message answers from 1 to 7	Mean (SD)	number of text message answers from 1 to 7	Mean (SD)
Turku, Finland	563	6.26 (1.19)	355	6.26 (1.19)	705	5.82 (1.27)
Uppsala, Sweden	694	5.98 (1.52)	563	6.03 (1.38)	1360	5.7 (1.39)
Danderyd, Sweden	242	6.16 (1.14)	243	5.76 (1.29)	689	6.12 (1,19)
Huddinge, Sweden	154	6.15 (1.36)	125	6.02 (1.41)	258	6.25 (1.02)
Tallinn, Estonia	369	6.41 (1.00)	255	6.07 (1.17)	881	5.6 (1.5)
Tartu, Estonia	550	5.82 (1.50)	415	5.83 (1.48)	494	5.27 (1.53)
Como, Italy	237	5.63 (1.51)	152	5.88 (1.54)	540	5.08 (1.67)
Madrid, Spain	320	5.53 (1.68)	98	5.66 (1.69)	1834	5.59 (1.72)
Drammen, Norway	191	5.08 (1.93)	70	4.64 (2.33)	1162	5.84 (1.21)
Bergen, Norway	724	4.94 (1.96)	514	4.80 (1.97)	907	5.94 (1.34)
Tromso, Norway	631	5.78 (1.57)	302	5.47 (1.74)	649	3.02 (1.74)

5.2.5 Nurses' perceptions on the quality of FCC in 11 European NICUS

Altogether, the nurses gave 11,132 responses regarding their perceptions of the quality of FCC they had provided during their shift. The mean response rate of the nurses was 55% (range 39% to 87%). The mean score in the whole nurse population was 5.7 (SD 0.35). The nurses gave the highest mean scores in Huddinge, Sweden (6.35, SD 1.02) and the lowest scores in Como, Italy (5.08, SD 1.67), ($p<0.001$). (Table 12) The item "Emotional support" was rated most often

(9 out of 11 units) with the lowest three scores among all the items of FCC. The highest-rated aspect was "Parents' trust in nurses," as it was among the highest three scores in 10 out of 11 units.

5.2.6 The relationships between the perceived quality of FCC and parent-infant closeness indicators

The scatter plots of the relationships between the perceived FCC and presence, holding and SSC were drawn showing mothers and fathers separately (Fig 8 a-d)

5.2.7 The associations between parent/family background characteristics and the durations of parents' presence, SSC, and holding

In the multifactorial analyses to elucidate factors associated with parental presence, we found that mothers' younger age, mothers' higher education, and whether the parents were living together were associated with a higher amount of parents' presence. Mothers' higher education and having a singleton baby associated with a longer duration of SSC. The median duration of SSC for the singletons was 2.3 hours (ranging from 0 to 19.5) and for the twins 1.2 hours (ranging from 0 to 8.4), ($p<0.001$). In contrast, holding the baby was not associated with being a singleton. A longer duration of holding was associated with higher gestational age at birth. Neither having other children nor the distance between the hospital and the parents' home explained any differences in presence, holding, or SSC.

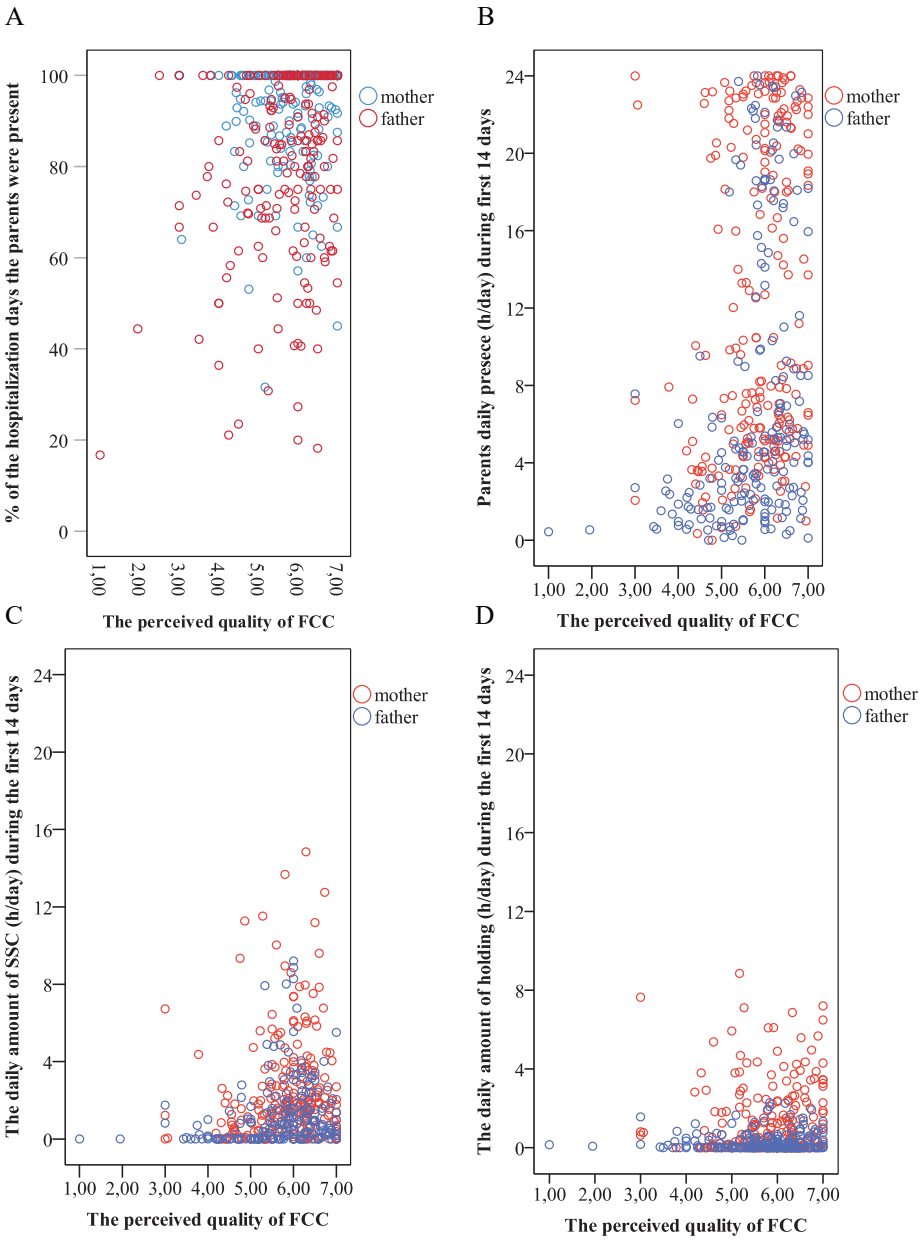

Figure 8 a-d. Relationships between the perceived quality of FCC and the length of parents' daily presence (B), SSC (C), and holding (D) during the first two weeks; and the relationship between the percentage of the hospitalization days the parents were present and the perceived quality of FCC (A).

5.2.8 The association between the parents/family background characteristics and the perceived quality of FCC

The parents' presence in the NICU or the perceived quality of FCC were not associated with gestational age at birth, plurality, parents' education, having a previous child in the NICU, or socioeconomic or cohabiting status in multivariate analyses in Study IV. The fathers had been present less frequently (OR 0.68 [CI 0.49–0.95]) and rated the perceived quality of FCC to be lower (b = 0.46 [CI 0.8–0.09], p =0.01) if the infant was female. Fathers were present often if the travel time from their home to the hospital was below 30 min. compared to those with travel times longer than 60 min (OR 2.00 [CI 1.28–3.13], p = 0.002). Siblings in the family had no effect on the mothers' presence in the unit or with the mothers' ratings of the perceived quality of FCC, but the fathers were present more often in the unit if there were no siblings in the family (OR 1.55 [CI 1.13–2.14], p = 0.01). Non-smoking mothers gave higher scores on perceived quality of FCC than mothers who smoked, (b=0.80 [CI 0.29-1.30], p=0.002).

5.2.9 The association with the amount of parents presence and perceived quality of FCC with the possibility to stay overnight in the unit

The mothers had been present more often at the NICUs that offered opportunities to stay overnight (Tallinn, Tartu, Drammen, Uppsala, Danderyd and Huddinge) compared to the other units (OR 1.70 [CI 1.09–2.64], p = 0.03). Conversely, the opportunity to stay overnight in the unit had no effect on the fathers' presence or the parents' rating of the perceived quality of FCC.

Summaries of the main results

- The care practices in the Turku University Hospital developed over the years (2001–2012) to better support parent-infant closeness without impairing the infant's growth or lengthening the hospitalization.
- There were large differences in the parents' presence and in the amount of SSC between the 11 European NICUs. There were differences between the countries but also between the units within the same country.
- A major factor influencing the physical parent-infant closeness was the parents' ability to stay overnight at the NICU.
- The parents gave high ratings for the quality of FCC in all study units.
- The parents and the nurses agreed on the successful and challenging aspects of FCC in their units.
- The simple and low-burdening tools used in this study provided meaningful and useful information on parent-infant closeness and FCC.

6 DISCUSSION

6.1 Goal

This thesis provides important information on how the care practices at a single NICU have evolved by time in a way that they support more parent-infant closeness and on how the parent-infant closeness, parents' participation and FCC practices were executed in different European NICUs. This information was derived with new simple and low-burdening tools, which were developed as part of the process. Parent-infant closeness and early attachment are an important foundation for the development of a newborn infant. Preterm infants are especially at risk of having long periods of separation from their parents due to the hospitals' care practices and care culture. Family-centered care practices have been shown to improve preterm infant development but very little quantitative measures have existed.

6.2 Trends in care practices in one hospital

We showed clear trends in care practices over time to the direction that supported better the parent-infant closeness. These trends could be shown by reviewing systematically all charts of very preterm infants admitted to the unit during four two-year-periods between 2001 and 2012 in the NICU in Turku University Hospital. Previously, long-term trends in NICU care practices regarding e.g., lighting, noise levels, speech, music, temperature, and exposure to chemicals have been identified (Santos et al 2015 [review]) We chose to evaluate multiple care practices that could pose a barrier to parent-infant closeness as well as were available in the retrospective assessment of the patient charts. The changes seemed to evolve in a sequence so that some changes formed a basis for the next changes. For example, we could observe that the first change was a more active daily increase in enteral given milk volumes leading to shorter use of IV fluids and IV lines. Another early change was to transfer the infant sooner from an incubator to an open warmer table. As IV lines and care in an incubator may be seen as barriers for skin-to-skin care, these changes potentially facilitated skin-to-skin care, which then created a natural place for early breastfeeding.

There was a fourfold increase in the number of SSC episodes during the 11-year time period. SSC began at three weeks younger PMA in the last cohort compared to the first cohort. Even more pronounced difference was seen in the most immature preterm infants born below 28 gw who were allowed for SSC over five

weeks earlier in the last cohort in 2001 to 2002 compared to the last cohort in 2011 to 2012. Our data indicates that SSC became a routine practice during the first week of life in the most immature infants, ie. infants <28 gw, only during the last period 2011-12 when 50% of the infants received SSC during the first four days of life. SSC has been proved to be safe already during the first week of life also in infants born at 22 to 27 gestational weeks (Karlsson V et al. 2012). A large variability has been observed in SSC practices in the Nordic countries (Olsson et al 2012). The number of SSC episodes in 2001 to 2002 in the NICU of Turku University Hospital was comparable to the number reported in the St. Louis Children's Hospital in Missouri, USA, in 2007 to 2010 (Reynolds et al. 2013). The numbers of SSC episodes in 2011 to 2012 were at the same level as in the Nationwide Children's Hospital in Ohio, USA, in 2010 to 2011 (Gonya and Nelin 2013) where the parents reported the SSC episodes themselves.

This study showed a steady decrease in the duration of incubator care starting already after the first time period in 2001–2002. One reason for this change may have been the parents' own wish to be closer to their infant. Ågren (2014) states that normal indoor air humidity (40-50%) is sufficient already from the second postnatal week for infants born below 28 gestational weeks and after the first day in infants born after 28 gestational weeks. After this, it is possible to provide care on a warmer bed with a heated mattress. (Ågren 2014)

The last change in the sequence was the decrease in the age at the beginning of breastfeeding. The care practices changed so that it became possible to start oral feeding practices by breastfeeding rather that bottle-feeding. This paradigm shift was preceded by an increase in the duration of SCC. It is logical that the opportunities to start breastfeeding will be better utilized when the infant is SSC with the mother. It has been shown that preterm infants are more stable when they are fed from breast compared to bottle (Bier et al. 1996) Therefore, it may be optimal to start feeding from breast instead of bottle. Breastfeeding has indisputable benefits compared to bottle-feeding and it is an essential element in FCC practices such as kangaroo mother care (Conde-Agudelo & Díaz-Rossello 2016). Breastmilk itself has been shown to bring additional benefits for long-term developmental prognosis as each 100 ml/kg breast milk at 4 weeks of age increased intelligence quotient (IQ) in very preterm infants by 3 points (Vohr et al. 2017). In a Danish cohort (Maastrup et al. 2014), the initiation of breastfeeding occurred in the PMA of 31.8 weeks in the infants born below 28 gestational weeks and in the PMA of 32.0 weeks in infants born at 28–31 gestational weeks. In our study, breastfeeding was initiated at 33.1 PMA in these gestational age groups. The bottle-feeding began 4 weeks earlier in our last cohort compared to the Danish study. (Maastrup et al. 2014)

We showed an improved weight gain over the study period in very preterm infants. This could be a result of either increased SSC or the changes in nutrition. Although SSC has not been shown to increase weight gain (Boundy et al. 2016), there is a multicenter cluster randomized controlled trial showing that parents' increased presence and participation does promote weight gain (O'Brian et al. 2018, O'Brian et al. 2013). Better weight might be due to more rapid increase in enteral nutrition even if the duration of parental nutrition simultaneously shortened significantly. Shorter duration of parenteral nutrition can decrease infections, infant pain, and parental stress (Miles et al. 1993, Frank et al. 2005).

Our study showed that the changes in care practices promoting parent-infant closeness did not prolong hospital stay. It is notable that the infants were sooner out of the incubator and started oral feeding earlier without affecting the length of stay. We did not, however, show a shorter hospital stay either. This might be explained by the fact that the length of hospital stay in the study NICU was shorter than average compared to the national (Korvenranta et al. 2007) and international (Vermont Oxford Network) comparison populations.

6.3 Prospective European multicenter study

In our European multicenter study the amount of parents' presence, SSC and holding varied largely between the units and countries. In several NICUs and countries, some infants had their parents present almost 24 hours per day. The 24 hours presence has been the aim in the single-family room NICU design (Örtenstrand 2010). The lowest amount of parents' daily presence were observed in the NICUs in Southern Europe with an average of three to four hours of presence per day comparable to previous prospective studies in UK and USA (Franck and Spencer 2003, Reynolds et al. 2013). However, the results are not directly comparable because only the mothers' presence was measured in the earlier reports.

None of the units in this European survey had regulations that restricted parental presence and would explain the differences between the units. the largest amount of presence and physical closeness occurred in the northern Europe, parallel to earlier Europe-wide studies (Greisen et al. 2009, Pallás-Alonso et al. 2012), Although the social secure system and parental leaves have a clear influence, there were observed differences between the units within the country in Norway, which has a highly developed social secure system. Also in Finland, the parents have relatively long parental leaves but the amount of parents' presence was low compared to the neighboring countries at the time of the study. The units without opportunity for parents to stay overnight had fewer parents' presence despite par-

ents' social benefits. The parents' presence was the longest in the units with a possibility for the parents to stay overnight in their infant's room. In our data the distance from home to hospital or whether the parents had previous children did not explain the differences in the parents' presence or in the parent-infant closeness contrary to earlier studies (Franck and Spencer 2003, Giacoia et al. 1985). Interestingly, younger mothers spent more time in the unit than older mothers in this study, in contrast to earlier findings (Brown et al. 1989).

In our study, the average amount of SSC is comparable to the earlier literature as the length of daily SSC ranges from 0.48 hours per day (Gonya and Nelin 2013) to 5.17 hours per day (Blomqvist et al. 2011). Some parents in our study recorded almost 20 hours of average daily SSC time, which can be considered continuous SSC and therefore part of the Kangaroo mother care, as defined by the World Health Organization (2015). Parents' higher education seemed to associate with higher amount of SSC between the parent and the infant.

The possibility for parents to stay overnight in the unit partly explained the amount of SSC. However, there was one unit with the opportunity for the parents to stay overnight but with reported low amount of SSC. It is likely that providing a bed for a parent is necessary in supporting long periods of SSC, but is not enough without care culture that supports parent-infant closeness and especially SSC.

The amount of holding was low in all study units during the first two weeks. However, the proportion of holding increased markedly with the increasing age of the infant, which has also been shown in earlier literature (Reynolds et al 2013). This is likely to be explained by the fact that other parent-infant interaction, including eye contact, smile and interactive vocalization become more important in addition to physical closeness with the developing skills of the infant.

6.4 The perceptions on the quality of FCC

The parents generally gave positive ratings for the quality of FCC and for their own opportunities to participate. It can be seen very positive that both the nurses and the parents rated the 'mutual trust' between the parents and the staff high. Mikkelsen et al. (2011) described mutual trust as the foundation for the collaborative care and partnership. Our results suggest that there is a gap between the parents' and nurses' view about parents' participation in decision-making. The parents gave less positive ratings about their possibility to be part of the decision-making in their infant's care compared to the nurses. This important aspect in care has not been studied much even if it has been suggested that there is a need

to develop parents' participation in decision-making (Weis et al. 2015). Furthermore, the parents experienced a sense of closeness when they were able to make decisions about the care of their infant (Treherne et al. 2017). In addition to parents' participation, the emotional support provided by the staff was found to be a challenging aspect of FCC in our data as reported earlier (Franck et al. 2003, Feeley et al. 2013, Johnson et al. 2008). This result shows that the whole staff needs new skills to provide better emotional support for the parents. The educational programs of FCC should consider incorporating these skills in the training (Ahlqvist-Björkroth et al. 2017).

The fathers were almost equally positive about the quality of FCC as the mothers in our study. This differs from the previous studies, summarized in a metaethnographic synthesis (Sisson et al. 2015), which report that fathers commonly feel like outsiders in the NICU and that their special needs are not acknowledged in a predominately female environment. It is not clear why the results seem to be better in our study data compared to the earlier literature. We know that at least in six units the fathers had good facilities for example for overnight stays. The good facilities have been speculated to be one important factor affecting fathers' presence and participation in their infants care (Lindberg et al. 2007). However, the fathers rated the quality of FCC also high in other units too in our study. The units participated in the study by their own interest and had already been interested in developing FCC practices. Therefore, it might be that the staff in the units has already taken steps to pay attention to fathers' needs and better support fathers' participation. These potential ways to notice and support fathers in NICU environment might be the same as suggested in the earlier literature: the staff might be recognizing the father's individual needs better, the nurses could encourage fathers to take part in everyday caregiving activities, and they could help the fathers to understand the infants' cues to get to know their infant (Feeley et al. 2013, Johnson et al. 2008, Provenzi et al. 2016). It might also be that in our study units they are encouraged to participate immediately after infant's birth, when they might the only parent available due to mother's medical condition (Provenzi et al. 2016, Lindberg et al. 2007). In any case it would be worth exploring what are the potentially better practices in these hospitals leading to high fathers' satisfactions. Benchmarking to the hospital with the highest scores from the fathers could give us useful information. Although the fathers' overall rating of the quality of FCC was high among the study units, the fathers reported less participation in infant care compared to the mothers, consistently with other studies (Franck et al. 2003), which emphasize the need for the development of FCC practices in order to meet the needs of the both parents.

The responses by the nurses reflected well the ratings by the parents when measured prospectively and daily. This method ties the ratings to the concrete daily

events, which may be important to the reliability and sensitivity of the ratings. Therefore, this approach seems to be more sensitive than the global measures, in which nurses may rate their general support better than parents do. (Franck et al. 2013). On the other hand, this good match was fund in a group of hospitals with high level of FCC. It can be assumed that with lower quality FCC care, the reflective skills of the staff are also lower and they may see less of the challenges. This is valuable information as it might be sufficient to measure FCC from either parents or nurses' perspective to get a good overall picture. The high consistency between the parents and the nurses might be explained by the prospective nature of our assessment tool, as it requested responses about the quality of FCC in each individual work shift.

Text messages enabled the evaluation of parents' presence in the NICU on a daily basis, previous literature referred to this with the term visitation. Compared to the diary that offered more information on the length of presence at the beginning of the treatment period, the text messages enabled us to monitor days when the parents stayed at the NICU throughout the treatment period. Parents in this study reported presence almost every day, on the contrary to many previous studies in the USA (Reynolds et al. 2013) and in Europe (Latva et al. 2009). In our study, in accordance with previous literature (Garten et al. 2011), the mothers were present at the NICU on more days than the fathers. The lesser presence of the fathers has been explained by the traditional role of the father as the family's guardian and "primary wage earner" in many societies (Pohlman et al. 2005, Arockiasamyet al. 2008). The phenomenon is explained by the mother's role as breast feeder, for example.

6.5 The parents' ability to stay overnight and SFR model

In our study, the main factor influencing physical closeness was the parents' ability to stay overnight at the NICU. This European survey identified five different architectural models that supported parents' presence in the NICUs. There were many modifications in the way parents' bed(s) could be situated related to the infant's bed: it could be in the same space close to the infant; it could be separated by a sliding wall which could be fully opened; or it could be in a room adjacent to the infant's care space. There was also a model in which mothers had a separate room for their accommodation inside the NICU. It is therefore important that a detailed description of the unit's architecture is given in studies about SFR. Furthermore, in addition to the architecture of the single-family room, it is also of importance to report parental participation and presence when evaluating the effect of the SFR model.

6.6 Strength and limitations

The use of patient medical records is a traditional way of gathering information that poses no strain on the study persons. Limitations and challenges are related to the nature and extent of information the staff can be assumed to fill in the records. The study was retrospective and we were not able to gather all the data we would have like to have, such as the parents' presence. In addition, going through patient records afterwards is laborious. The challenge for the future is to create an electronic patient record system that can genuinely reduce the workload and speed up recording. However, basic measures can adequately describe even a topic as abstract as this – the trends in practises associated with FCC. According to our observations, patient records do not confer detailed information on the duration of closeness. Earlier literature on the length of parental presence and kangaroo care, reported by staff, could only be found in few studies. It is also known that such information on presence and kangaroo care reported by parents themselves is as or more reliable than that reported by staff. (Blomqvist et al 2011). It was obvious that the parents' own experience on the support and opportunities for participation they received could not be conveyed from patient records.

The simple parent-infant closeness diary used in the study provided daily prospective data on presence at the unit, SSC and holding care, reported by the parents themselves. It is clear that there are countless levels of physical closeness such as eye contact, touching, caressing, holding, bathing and SSC. We chose SSC for the primary measure, because it has been studied the most and shown to be beneficial. SSC is one of the first ways the parents can participate in their baby's care, and it has been proven safe even for the most premature infants (Karlsson et al 2012). SSC is almost never fragmentary, which makes it a more reliable measure. The reliability of measuring, for example, hand touching/caressing, etc., might prove challenging, even though these interventions are also meaningful for the parents and have been shown effective in pain management, for example (Axelin et al 2006). Initially, holding was included as an alternative for SSC, since not all the participating units had implemented SSC in their care practices, and its percentage was shown to increase as the newborn grows. We were unable to see any effect of holding during the first two weeks of treatment in our study. One must remember that closeness is not only physical, and the emotional side needs measuring as well.

The study employed daily text-message questions to measure the experienced outcome of FCC. This enabled us to gain prospective data, which can be deemed more reliable than the more usual survey at the end of the treatment period, when the answers may be influenced by the child's recovery and, thus, give an overly optimistic result. We did not send all of the questions to all parents every day to

reduce parental strain, but we sent different questions to different parents, enabling the" sampling" of opinions and perceptions regarding the units FCC care culture every day.

The focus of this study was the parents' physical closeness with their infant and their perception of the quality of FCC. With the outcomes measured in this study, it is not possible to fully evaluate the other potential factors affecting preterm infants' development, such as other principles and strategies of early developmental care. One interesting and important way to improve mother-infant closeness in preterm infants is the concept of Couplet Care, where the mothers and infants are treated in the same place after birth (Westrup 2014). This question could also have been studied as part of the "parent-infant characteristics questionnaire" in our study.

The study's methods provided important information on parental presence and physical closeness, the parents' experiences on family-centered care practices and an insight as to which direction aiming at FCC guides the development of care practices such as nutrition and thermal regulation methods. The measures and study methods posed minimal strain on the patients and their parents. This study provided new information on presence and physical closeness reported by parents themselves. Compared to earlier measures, clear benefits can be seen in that mothers and fathers are equally studied and that there are few-to-none previous studies with similar prospective daily collected data sets reported by parents themselves.

6.7 Future perspective

We have created simple tools to measure family-centered care practices and physical closeness, enabling their future use in not only comparing units but also monitoring changes in time and the effect of quality improvement interventions. The light user interface of the measures also enables follow-up monitoring with minimal resources.

The next level for developing measures will be to utilize digital opportunities, such as mobile applications and automatic tracking systems, to further diminish parental strain. Electronic patient record systems also have enormous potential to be utilized by, e.g., Big Data methods. The measures can and should be combined in the future with outcome measures such as hormonal or other biomarkers, surveys and markers to illustrate the newborn's development and the family's well-being.

7 CONCLUSIONS AND CLINICAL IMPLICATIONS

This research demonstrated that it is both safe and possible to change the care practices at neonatal intensive care units to better support the parent-infant closeness as well as parents' participation. Demolishing iatrogenic or hospital-made barriers, leading to, for example, shorter duration of IV lines and decreased time in the incubator, resulted in increased closeness and earlier breastfeeding, but that had no negative impact on the growth of premature infants or the duration of hospitalization.

In our European multi-center study, we collected extensive materials consisting of prospective data reported by the parents, concerning the physical parent-infant closeness at neonatal intensive care units. The most significant background variable that supported closeness was the parents' possibility to stay overnight at the unit. Both the parents and the nurses in the studied units rated the parents' participation possibilities and the quality of FCC as high; in addition, the nurses were also able to identify the same challenges in the realization of family-centered care as those reported by the parents.

This study enabled the creation and testing of indicators that can directly measure the physical presence of parents and their closeness with their infant at neonatal intensive care units, as well as the parents' experiences of their possibilities to participate in and influence the care of their premature infant. There are very little similar prospective data directly reported by the parents in the previous literature. The indicators enabled us to research whether there were differences in parents' participation and presence between the units. The results can later be utilized in further research when studying the impact of closeness to the infant's hormonal indicators, development and interactions, as well as its effect on the duration and cost efficiency of treatment. The indicators can also be used to evaluate the effects of interventions aimed at changing treatment practices. Additionally, the indicators used in this research can be used to observe the strengths and weaknesses of family-centered care practices in each unit. This information can be utilized for quality improvement purposes.

ACKNOWLEDGEMENTS

This study was carried out at the Department of Pediatrics in Turku University hospital, at the University of Turku, and in 15 NICUs in 6 European countries as a part of the International Closeness Survey by the SCENE research group.

First, I would like to express my deepest gratitude to my supervisors, Professor Liisa Lehtonen and Associate Professor Anna Axelin, for their experienced and endless support and patience. Liisa, your immense knowledge and enthusiasm for neonatal hospital care and research are astonishing. I admire your exactness and thoroughness in addition to your effectiveness. As a supervisor, you have been demanding and encouraging. Anna, you inspire me with you ideas and work ethic. As a supervisor, you have been always available and online, and you have always pushed me to think further and deeper. Thank you both for the inspiring and enjoyable conferences and meetings around the world; they have not been boring.

Aside from my supervisors, I would like to thank the official reviewers of this thesis: Professor Dominique Haumont and Docent Ulla Sankilampi. Thank you for your insightful comments and vast outlook on the research area. Your comments and critiques improved this thesis.

I am honored and grateful that Professor Leif D. Nelin agreed to be the opponent of this thesis.

My sincere thanks also goes to the whole international research group, SCENE, and to the entire staff in each NICU that participated in the studies in Finland, Sweden, Norway, Estonia, Italy, and Spain. Also, I thank those who helped us gather the study data. Without your work and help, the study would have been impossible to perform. Special thanks goes to all co-writers of the articles: Liisa, Anna, Saara, Ina, Liis, Heili, Uwe, Erik, Björn, Boubou, Atle, Bente, Marianne, Sylvia, and Rosario. Special gratitude goes to statistician Jaakko Matomäki.

I would like to thank the following foundations and institutions for their crucial financial support: the Foundation for Paediatric Research; the Turku University Hospital Foundation; the EVP funding from the South-West Finland and Pirkanmaa Hospital Districts; and the University of Turku

I want to thank my parents and my in-laws for always encouraging me and helping us with the children.

Dear Lilja, Kerttu, and Miira, you are the most important people in my life. Lilja and Kerttu, you both have taught me how to stay awake at night and work while carrying you in a tie-up sling. At the same time, your unending joy and love is enchanting. Dear Miira, thank you for being such a wonderful wife and mother. Thank you for believing in me, pushing me forward, and helping and supporting me in every possible way.

REFERENCES

Aggarwal S, Chadha P, Kalia S, Richardson S, Winterbottom L, Shields L. Perceptions of family-centred care: A UK pilot study of the Shields and Tanner questionnaires. Neonatal Paediatr Child Health Nurs 2009;12(2):25-29.

Ahlqvist-Björkroth S, Boukydis Z, Axelin AM, Lehtonen L. Close Collaboration with Parents™ intervention to improve parents' psychological well–being and child development: Description of the intervention and study protocol. Behav Brain Res. 2017; 15;325(Pt B):303–310.

Alberts JR, Ronca AE. Fetal experience revealed by rats: psychobiological insights. Early Hum Dev. 1993 Dec 31;35(3):153–66.

Als H. A synactive model of neonatal behavioral organization: framework for the assessment and support of the neurobehavioral development of the premature infant and his parents in the environment of the neonatal intensive care unit. Phys Occup Ther Pediatr. 1986;6:3–55

Al-Motlaq MA, Abuidhail J, Salameh T, Awwad W. Development and validation of an instrument to assess the implementation of family-centred care in traditional open bay Neonatal Intensive Care Units. Early Child Dev Care 2017;187(1):168-177.

Anderson GC. Current knowledge about skin-to-skin (kangaroo) care for preterm infants. J Perinatol. 1991;11(3):216–226.

Anderzén-Carlsson A, Lamy ZC, Tingvall M, Eriksson M. Parental experiences of providing skin-to-skin care to their newborn infant - Part 2: A qualitative meta-synthesis. Int J Qual Stud Health Well-being 2014;9.

Auslander GK, Netzer D, Arad I. Parents' satisfaction with care in the neonatal intensive care unit: The role of sociocultural factors. Child Health Care 2003;32(1):17-36.

Arockiasamy V, Holsti L, Albersheim S. Fathers' experiences in the neona- tal intensive care unit: a search for control. Pediatrics 2008;121(2):e215–22.

Asai H. Predictors of nurses' family-centered care practises in the neonatal intensive care unit. Jpn J Nurs Sci 2011;8(1):57-65.

Axelin A, Salanterä S, Lehtonen L. 'Facilitated tucking by parents' in pain management of preterm infants-a randomized crossover trial. Early Hum Dev 2006;82(4):241-247.

Axelin A, Ahlqvist-Björkroth S, Kauppila W, Boukydis Z, Lehtonen L. Nurses' perspectives on the close collaboration with parents training program in the NICU. MCN Am J Mater Child Nurs 2014;39(4):260-268.

Axelin A, Outinen J, Lainema K, Lehtonen L, Franck LS.Neonatologists can impede or support parents' participation in decision-making during medical rounds in neonatal intensive care units. Acta Paediatr. 2018 May 3, Epub ahead of print

Baker JP. The incubator and the medical discovery of the premature infant. J Perinatol. 2000; 20(5):321-328.

Barnett CR, Leiderman PH, Grobstein R, Klaus M. Neonatal separation: the maternal side of interactional deprivation. Pediatrics 1970;45(2):197-205.

Barfield WD, Papile L-, Baley JE, Benitz W, Cummings J, Carlo WA, et al. Levels of neonatal care. Pediatrics 2012;130(3):587-597.

Barr RG, Kramer MS, Boisjoly C, McVey-White L, Pless IB. Parental diary of infant cry and fuss behaviour. Arch Dis Child 1988;63(4):380-387.

Bastani F, Abadi TA, Haghani H. Effect of family-centered care on improving parenta satisfaction and reducing readmission among premature infants: a randomized controlled trial. J Clin Diagn Res 2015; 9: sc04–8.

Batalle D, Hughes EJ, Zhang H, Tournier J-, Tusor N, Aljabar P, et al. Early development of structural networks and the impact of prematurity on brain connectivity. Neuroimage 2017;149:379-392.

Benzein E, Johansson P, Årestedt KF, Berg A, Saveman B-. Families' importance in nursing care: Nurses' attitudes - An instrument development. J Fam Nurs 2008;14(1):97-117.

Benzies KM Magill-Evans JE, Hayden KH, Ballantyne M. Key components of early intervention programs for preterm infants and their parents: a systematic review and meta-analysis BMC Pregnancy and Childbirth 2013;13(Suppl 1):S10

Berns SD, Boyle MD, Popper B, Gooding JS, Preemie Health Coalition. Results of the premature birth national need-gap study. J Perinatol 2007; 27 (Suppl 2): S38–44.

Blaymore Bier JA, Ferguson AE, Morales Y, Liebling JA, Oh W, Vohr BR. Breastfeeding infants who were extremely low birth weight. Pediatrics 1997;100(6).

Blomqvist YT, Rubertsson C, Nyqvist KH. Parent-infant skin-to-skin contact; How do parent records compare to nurse records? Acta Paediatr 2011; 100:773–775.

Boundy EO, Dastjerdi R, Spiegelman D, Fawzi WW, Missmer SA, Lieberman E, et al. Kangaroo mother care and neonatal outcomes: A meta-analysis. Pediatrics 2016;137(1).

Bordner KA, Spear NE. Olfactory learning in the one-day old rat: reinforcing effects of isoproterenol. Neurobiol Learn Mem. 2005;86(1):19–27.

Brown LP, York R, Jacobsen B, Gennaro S, Brooten D. Very low birth-weight infants: parental visiting and telephoning during initial infant hospitalization. Nurs Res 1989; 38:233–6.

Bruns DA, McCollum JA. Partnerships between mothers and professionals in the NICU: caregiving, information exchange, and relationships. Neonatal Netw 2002;21(7):15-23.

Bruns DA, Klein S. An evaluation of family-centered care in a level III NICU. Infants Young Child 2005;18(3):222-233.

Brunssen SH, Miles MS. Sources of environmental stress experienced by mothers of hospitalized medically fragile infants. Neonatal Netw 1996; 15: 88–9.

Butt ML, McGrath JM, Samra HA, Gupta R. An integrative review of parent satisfaction with care provided in the neonatal intensive care unit. J Obstet Gynecol Neonatal Nurs 2013;42:105–20.

Byers JF, Lowman LB, Francis J, Kaigle L, Lutz NH, Waddell T,

et al. A quasi-experimental trial on individualized, developmentally supportive family-centered care. J Obstet Gynecol Neonatal Nurs 2006; 35: 105–15.

Capdevila Cogul E, Sa nchez Pozo n L, Riba Garc ıa M, Morin~a Soler D, R ıos Guillermo J, Porta Ribera R, et al. Assessment of parental satisfaction in a neonatal unit. An Pediatr (Barc) 2012; 77: 12–21.

Carmen S, Teal S, Guzzetta CE. Development, testing, and national evaluation of a pediatric patient-family-centered care benchmarking survey. Holistic Nurs Pract 2008;22(2):61-74.

Champagne, FA. Epigenetic mechanisms and the trans- generational effects of maternal care. Front. Neuroendocrinol. 2008;29:386–397

Conde-Agudelo A, Díaz-Rossello José L. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database Syst Rev 2014; 4: CD002771.

Cook C, Health F, Thompson RL. A Meta-analysis of Response Rates in Web- or Internet-Based Surveys. Educational and Psychological Measurement 2000;60(6):821–836

Cooper LG, Gooding JS, Gallagher J, Sternesky L, Ledsky R, Berns SD. Impact of a family-centered care initiative on NICU care, staff and families. J Perinatol 2007; 27 (Suppl 2): S32–7.

Cuttini M, Rebagliato M, Bortoli P, Hansen G, de Leeuw R, Lenoir S, et al. Parental visiting, communication, and participation in ethical decisions: a comparison of neonatal unit policies in Europe. Arch Dis Child Fetal Neonatal Ed 1999; 81: F84–91.

Curran A, Brighton J & Murphy V. Psychoemotional care of parents of children in a neonatal intensive care unit: Results of a questionnaire. Journal of Neonatal Nursing, 1997;3(1):25–29.

Dall'Oglio I, Mascolo R, Gawronski O, Tiozzo E, Portanova A, Ragni A, et al. A systematic review of instruments for assessing parent satisfaction with family-centred care in neonatal intensive care units. Acta Paediatr Int J Paediatr 2018;107(3):391-402.

Davis L, Mohay H, Edwards H. Mothers' involvement in caring for their premature infants: An historical overview. J Adv Nurs 2003;42(6):578-586.

Domanico R, Davis DK, Coleman F, Davis BO. Documenting the NICU design dilemma: parent and staff perceptions of open ward versus single family room units. J Perinatol 2010; 30: 343–51

Dunbar RIM. Neocortex size as a constraint on group size in primates. J Hum Evol 1992;22(6):469–493.

Dunn MS, Reilly MC, Johnston AM, Hoopes Jr. RD, Abraham MR. Development and dissemination of potentially better practices for the provision of family-centered care in neonatology: The family-centered care map. Pediatrics 2006;118(SUPPL. 2):S95-S107.

Ellis-Stoll C & Pokess-Vawter S. A concept analysis on the process of empowerment. Advances of Nursing Science 1998; 2, 62-68.

Feeley N, Sherrard K, Waitzer E, Boisvert L. The father at the bedside: patterns of involvement in the NICU. J Perinat Neonatal Nurs 2013;27(1):72–80.

Feldman R, Eidelman AI, Sirota L, Weller A. Comparison of skin-to-skin (kangaroo) and traditional care: parenting outcomes and preterm infant development. Pediatrics. 2002 Jul;110(1 Pt 1):16-26.

Feldman R. Sensitive periods in human social development: New insights from research on oxytocin, synchrony, and high-risk parenting. Dev Psychopathol. 2015;27(2):369–95

Feldman R, Monakhov M, Pratt M, Ebstein RP. Oxytocin Pathway Genes: Evolutionary Ancient System Impacting on Human Affiliation, Sociality, and Psychopathology. Biol Psychiatry. 2016;79(3):174–84.

Feldman R. The neurobiology of mammalian parenting and the biosocial context of human caregiving. Horm Behav. 2016;77:3–17.

Feldman R. The Neurobiology of Human Attachments. Trends Cogn Sci. 2017;21:80–99.

Feng X, Wang L, Yang S, Qin D, Wang J, Li C, Lv L, Ma Y, Hu X. Maternal separation produces lasting changes in cortisol and behavior in rhesus monkeys. Proc Natl Acad Sci U S A. 2011;108(34):14312–14317.

Flacking R, Lehtonen L, Thomson G, Axelin A, Ahlqvist S, Moran VH, Ewald U, Dykes F; Separation and Closeness Experiences in the Neonatal Environment (SCENE) group. Closeness and separation in neonatal intensive care. Acta Paediatr. 2012;101(10):1032–1037

Flacking R, Thomson G, Axelin A. Pathways to emotional closeness in neonatal units - a cross-national qualitative study. BMC Pregnancy Childbirth. 2016 Jul 19;16(1):170.

Foster M, Whitehead L, Maybee P. Parents' and health professionals' perceptions of family centred care for children in hospital, in developed and developing countries: A review of the literature. Int J Nurs Stud 2010;47(9):1184-1193.

Franck LS, Spencer C. Parent visiting and participation in infant caregiving activities in a neonatal unit. Birth 2003; 30:31–35.

Franck LS, Cox S, Allen A, Winter I. Measuring neonatal intensive care unit-related parental stress. J Adv Nurs 2005;49(6):608-615.

Franck LS, Oulton K, Nderitu S, Lim M, Fang S, Kaiser A.Parent involvement in pain management for NICU infants: a randomized controlled trial. Pediatrics. 2011;128(3):510-8

Franck LS, Axelin A. Parents', nurses' and physicians' views of NICU parent sup- port. Acta Paediatr 2013;102(6):590–6.

Gao J, Cheung RTF, Chan Y-, Chu L-, Mak HKF, Lee TMC. The relevance of short-range fibers to cognitive efficiency and brain activation in aging and dementia. PLoS ONE 2014;9(4).

Garten L, Maass E, Schmalisch G, Bührer C. O father, where art thou? Parental NICU visiting patterns during the first 28 days of life of very

low-birth-weight infants. J Perinat Neonatal Nurs 2011;25(4):342–8.

Gee DG, Gabard-Durnam L, Telzer EH, Humphreys KL, Goff B, Shapiro M, Flannery J, Lumian DS, Fareri DS, Caldera C, Tottenham N. Maternal buffering of human amygdala-prefrontal circuitry during childhood but not during adolescence. Psychol Sci. 2014;25(11):2067–78.

Giacoia GP, Rutledge D, West K. Factors affecting visitation of sick newborns. Clin Pediatr 1985; 24:259–62.

Gibson C. Facilitating critical reflection in mothers of chronically ill children. Journal of Clinical Nursing 1999; 8, 305-312.

Gonya J, Nelin LD. Factors associated with maternal visitation and participation in skin-to-skin care in an all referral level IIIc NICU. Acta Paediatr 2013; 102:53–6.

Gooding JS, Cooper LG, Blaine AI, Franck LS, Howse JL, Berns SD. Family support and family-centered care in the neonatal intensive care unit: origins, advances, impact. Semin Perinatol 2011;35(1):20–8.

Greisen G, Mirante N, Haumont D, Pierrat V, Pallás-Alonso CR, Warren I, et al. Parents, siblings and grandparents in the Neonatal Intensive Care Unit A survey of policies in eight European countries. Acta Paediatr Int J Paediatr 2009;98(11):1744-1750.

Grunau RE, Whitfield MF, Fay TB. Psychosocial and academic characteristics of extremely low birth weight (< or 5800 g) adolescents who are free of major impairment compared with term-born control subjects. Pediatrics 2004;114(6):e725–32.

Hagen IH, Vadset TB, Barstad J, Svindseth MF. Development and validation of Neonatal Satisfaction Survey - NSS-13. Scand J Caring Sci 2015; 29: 395–406.

Hawks J. Empowerment in nursing education: concept analysis and application to philosophy, learning and instruction. Journal of Advaced Nursing 1992; 7, 609-618.

Hurst I. One size does not fit all: parents' evaluations of a support program in a newborn intensive care nursery. J Perinat Neonatal Nurs 2006; 20: 252–61.

Insel TR, Gingrich BS, Young LJ. Oxytocin: who needs it? Prog Brain Res. 2001;133:59–66.

Jacono J, Hicks G, Antonioni C, O'Brien K, Rasi M. Comparison of perceived needs of family members between registered nurses and family members of critically ill patients in intensive care and neonatal intensive care units. Heart Lung J Crit Care 1990;19(1):72-78.

Johnson AN. Kangaroo holding beyond the NICU. Pediatr Nurs 2005;31(1):53-56.

JohnsonAN. Engaging fathers in the NICU: taking down the barriers to the baby. J Perinat Neonatal Nurs 2008;22(4):302–6.

Johnson DE, Guthrie D, Smyke AT, Koga SF, Fox NA, Zeanah CH, et al. Growth and associations between auxology, caregiving environment, and cognition in socially deprived Romanian children randomized to foster vs ongoing institutional care. Arch Pediatr Adolesc Med 2010;164(6):507-516.

Karlsson V, Heinemann AB, Sjörs G, Nykvist KH, Ågren J. Early skin-to-skin care in extremely preterm infants: Thermal balance and care environment. J Pediatr 2012; 161:422–6.

Keverne, EB. Significance of epigenetics for understanding brain development, brain evolution and behaviour. Neuroscience 2014;264:207–217

Kikusui T, Winslow JT, Mori Y. Social buffering: relief from stress and anxiety. Philos Trans R Soc Lond B Biol Sci. 2006 29;361(1476):2215–28.

Klaus MH & Kennell, JH. 1976. *Maternal-infant bonding.* St. Louis: Mosby.

Korja R, Maunu J, Kirjavainen J, Savonlahti E, Haataja L, Lapinleimu H, et al. Mother-infant interaction is influenced by the amount of holding in preterm infants. Early Hum Dev 2008;84(4):257-267.

Korvenranta E, Lehtonen L, Rautava L, Häkkinen U, Andersson S, Gissler M, et al. Impact of very preterm birth on health care costs at five years of age. Pediatrics 2010;125(5):e1109-e1114.

Latva R. Preterm birth and hospitalisation. Experiences of mother and child. Tampere: Tampere Univ Press; 2009. p. 594.

Laurent HK, Harold GT, Leve L, Shelton KH, Van Goozen SH. Understanding the unfolding of stress regulation in infants. Dev Psychopathol. 2016;28(4pt2):1431–1440

Larroque B, Ancel P-Y, Marret S, et al. Neurodevelopmental disabilities and special care of 5-year-old children born before 33 weeks of gestation (the EPIPAGE study): a longitudinal cohort study. Lancet 2008;371:813–820.

Latour JM, Duivenvoorden HJ, Hazelzet JA, van Goudoever JB. Development and validation of a neonatal intensive care parent satisfaction instrument. Pediatr Crit Care Med 2012; 13: 554–9.

Lester BM, Miller RJ, Hawes K, et al. Infant Neurobehavioral Development. Seminars in perinatology. 2011;35(1):8-19

Lester BM, Hawes K, Abar B, Sullivan M, Miller R, Bigsby R, et al. Single-family room care and neurobehavioral and medical outcomes in preterm infants. Pedi- atrics 2014;134(October (4)):754–760.

Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models Biometrika 1986;73:13–22.

Lindberg B, Axelsson K, Öhrling K. The birth of premature infants: expe- riences from the fathers' perspective. J Neonatal Nurs 2007;13(4): 142–149.

Littell RC, Henry PR, Ammerman CB. Statistical analysis of repeated measures data using SAS procedures. J Anim Sci 1998;76:1216–31.

Love TM. Oxytocin, motivation and the role of dopamine. Pharmacol Biochem Behav. 2014;119:49–60.

Ludington-Hoe SM, Thompson C, Swinth J, Hadeed AJ, Anderson GC. Kangaroo care: research results, and practice implications and guidelines. Neonatal Netw 1994;13(1):19-27.

Ludwig M, Leng G. Dendritic peptide release and peptide-dependent behaviours. Nat Rev Neurosci. 2006;7(2):126–36.

Maastrup R, Hansen BM, Kronborg H, Bojesen SN, Hallum K, Frandsen A, et al. Breastfeeding progression in preterm infants is influenced by factors in infants, mothers and clinical practice: The results of a national cohort study with high breastfeeding initiation rates. PLoS ONE 2014;9(9).

Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospec- tive studies of disease. J Natl Cancer Inst 1959;22:719–748.

Mars RB, Sallet J, Neubert F-, Rushworth MFS. Connectivity profiles reveal the relationship between brain areas for social cognition in human and monkey temporoparietal cortex. Proc Natl Acad Sci U S A 2013;110(26):10806-10811.

Melnyk BM, Alpert-Gillis L, Feinstain NF, Fairbanks E, Scultz-Czarniak J, Hust D, Sherman L, LeMoine C, Moldenhauer Z, Small L, Bender N, Sinkin RA. Improving cognitive development of low-birth-weight premature infants with the COPE program: a pilot study of the benefit of early NICU intervention with mothers. Research in Nursing and Health 2001; 24, 373-389.

Ment LR, Vohr BR. Preterm birth and the developing brain. Lancet Neurol 2008;7(5):378–379.

Mikkelsen G, Frederiksen K. Family-centred care of children in hospital – a concept analysis. J Adv Nurs 2011;67(5):1152–62.

Miles MS, Funk SG, Carlson J. Parental Stressor Scale: neonatal intensive care unit. Nurs Res. 1993; 42, 148-52.

Moore ER, Anderson GC, Bergman N. Early skin-to-skin contact for mothers and their healthy newborn infants. Cochrane Database Syst Rev. 2007 Jul 18;(3):CD003519.

Moran M, Radzyminski SG, Higgins KR, Dowling DA, Miller MJ, Anderson GC. Maternal kangaroo (skin-to-skin) care in the NICU beginning 4 hours postbirth. MCN Am J Matern Child Nurs. 1999;24(2):74-79.

Munck P, Haataja L, Maunu J, Parkkola R, Rikalainen H, Lapinleimu H, Lehtonen L & the PIPARI Study Group: Cognitive outcome at 2 years of age in Finnish infants with very

low birth weight born between 2001 and 2006. Acta Peadiatrica 2010; 99: 359-66.

Mörelius E, Theodorsson E, Nelson N. Salivary cortisol and mood and pain profiles during skin-to-skin care for an unselected group of mothers and infants in neonatal intensive care. *Pediatrics*. 2005;116(5):1105–1113

National Association of Neonatal Nurses (NANN): Infant and Family-Centered Care: Guidelines for Practice. Des Moines, IA: NANN; 2000

Neal A, Frost M, Kuhn J, Green A, Gance-Cleveland B, Kersten R. Family centered care within an infant-toddler unit. Pediatr Nurs 2007;33(6):481-485.

Nelson CA, Fox NA, Zeanah CH. 2014. Romania's abandoned children: deprivation, brain development, and the struggle for recovery. Harvard University Press: Cambridge, USA

Nelson CA, Bosquet M. Neurobiology of fetal and infant development: implications for infant mental health. In book: Zeanah CH ed., Handbook of infant mental health. New York: The Guilford Press 2000, s. 37–55.

Nelson CA, Zeanah CH, Fox NA, Marshall PJ, Smyke AT, Guthrie D. Science. 2007;318(5858):1937-40.

O'Brien K, Bracht M , Macdonell K, McBride T ,Robson K, O'Leary L,et al. A pilot cohort analytic study of family integrated care in a Canadian neonatal intensive care unit. BMC Pregnancy Childbirth 2013;13(Suppl. 1):S12.

Olsson E, Andersen RD, Axelin A, Jonsdottir RB, Maastrup R, Eriksson M. Skin-to- skin care in neonatal intensive care units in the Nordic countries: a survey of attitudes and practices. Acta Paediatr 2012; 101:1140–1146.

Ohlsson A, Jacobs SE. NIDCAP: a systematic review and meta-analyses of randomized controlled trials. Pediatrics. 2013;131(3).

Organization WH. WHO Recommendations on Interventions to Improve Preterm Birth Outcomes. Geneva: World Health Organization, 2015. Available from: https://www-ncbi-nlm-nih-gov.ezproxy.utu.fi/books/NBK321160/

Pascal A, Govaert P, Oostra A, Naulaers G, Ortibus E, Van den Broeck C.

Neurodevelopmental outcome in very preterm and very-low-birthweight infants born over the past decade: a meta-analytic review. Dev Med Child Neurol. 2018;60(4):342-355.

Pallás-Alonso CR, Losacco V, Maraschini A, Greisen G, Pierrat V, Warren I, et al. Parental involvement and kangaroo care in European neonatal intensive care units: A policy survey in eight countries. Pediatr Crit Care Med 2012;13(5):568-577.

Pérez-Fernández J, Megías M, Pombal MA. Expression of a Novel D4 Dopamine Receptor in the Lamprey Brain. Evolutionary Considerations about Dopamine Receptors. Frontiers in Neuroanatomy. 2015;9:165.

Pineda RG, Neil J, Dierker D, et al. Alterations in brain structure and neurodevelopmental outcome in preterm infants hospitalized in different neonatal intensive care unit envi- ronments. J Pediatr. 2014;164(1):52–60.e52

Pineda R, Bender J, Hall B, Shabosky L, Annecca A, Smith J. Parent participation in the neonatal intensive care unit: Predictors and relationships to neurobehavior and developmental outcomes. Early Hum Dev 2018;117:32-38.

Pohlman S. The primacy of work and fathering preterm infants: findings from an interpretive phenomenological study. Adv Neonatal Care 2005;5(4):204–16.

Provenzi L, Barello S, Fumagalli M, Graffigna G, Sirgiovanni I, Savarese M, et al. Comparison of maternal and paternal experiences of becoming parents of a very preterm infant. J Obstet Gynecol Neonatal Nurs 2016;45(4): 528–41.

Punthmatharith B, Buddharat U, Kamlangdee T. Comparisons of needs, need responses, and need response satisfaction of mothers of infants in neonatal intensive care units. J Pediatr Nurs 2007; 22: 498–506.

Rodwell C. An analysis of the concept of empowerment. Journal of Advanced Nursing 1996, 23, 305-313.

Ulmer-Yaniv A, Avitsur R, Kanat-Maymon Y, Schneiderman I, Zagoory-Sharon O, Feldman

R. Affiliation, reward, and immune biomarkers coalesce to support social synchrony during periods of bond formation in humans. Brain Behav Immun. 2016;56:130–139.

Uvnäs-Moberg K. Neuroendocrinology of the mother-child interaction. Trends Endocrinol Metab. 1996 May-Jun;7(4):126–131.

Uvnäs-Moberg K, Handlin L, Petersson M. Self-soothing behaviors with particular reference to oxytocin release induced by non-noxious sensory stimulation. Frontiers in Psychology. 2014;5:1529.

Hinde A, Spencer-Booth Y. Towards understanding individual differences in rhesus mother-infant interaction. Animal Behaviour 1971;19(1):165–173

Hofer MA. Early relationships as regulators of infant physiology and behavior. Acta Paediatr Int J Paediatr 1994;83:9–18.

Hofer MA. Psychobiological Roots of Early Attachment. Current Directions in Psychological Science. 2006; 15(2):84–88

Humphreys KL, Gleason MM, Drury SS, Miron D, Nelson CA, Fox NA, et al. Effects of institutional rearing and foster care on psychopathology at age 12 years in Romania: Follow-up of an open, randomised controlled trial. Lancet Psychiatry 2015;2(7):625-634.

Rilling JK. Comparative primate neuroimaging: insights into human brain evolution. Trends Cogn. Sci. 2013;18:46–55

Rilling JK, Young LJ. The biology of mammalian parenting and its effect on offspring social development. Science. 201;345(6198):771–776.

Raineki C, Lucion AB, Weinberg J. Neonatal handling: an overview of the positive and negative effects. Dev Psychobiol. 2014;56(8):1613–25.

Reynolds LC, Duncan MM, Smith GC, Mathur A, Neil J, Inder T, et al. Parental presence and holding in the neonatal intensive care unit and associations with early neurobehavior. J Perinatol 2013;33(8):636–41.

Roth TL, Lubin FD, Funk AJ, Sweatt JD. Lasting Epigenetic Influence of Early-Life Adversity on the BDNF Gene. Biol Psychiatry 2009;65(9):760–769.

Santos J, Pearce SE, Stroustrup A. Impact of hospital-based environmental exposures on neurodevelopmental outcomes of preterm infants. Curr Opin Pediatr 2015;27(2):254-260.

Saunders RP, Abraham MR, Crosby MJ, Thomas K, Edwards WH. Evaluation and development of potentially better practices for improving family-centered care in neonatal intensive care units. Pediatrics 2003;111(4 Pt 2):e437-449.

Scher MS, Ludington-Hoe S, Kaffashi F, Johnson MW, Holditch-Davis D, Loparo KA. Neurophysiologic assessment of brain maturation after an 8-week trial of skin-to-skin contact on preterm infants. Clin Neurophysiol 2009;120(10):1812-1818.

Shahheidari M, Homer C. Impact of the design of Neonatal Intensive Care Units on neonates, staff, and families: A systematic literature review. J Perinat Neonatal Nurs 2012; 26:260–6.

Shields L, Kristensson-Hallström I, O'Callaghan M. An examination of the needs of parents of hospitalized children: Comparing parents' and staff's perceptions. Scand J Caring Sci 2003;17(2):176-184.

Shields L, Hunter J, Hall J. Parents' and staff's perceptions of parental needs during a child's admission to hospital: An English perspective. J Child Heal Care 2004;8(1):9-33.

Shields L, Tanner A. Pilot study of a tool to investigate perceptions of family-centered care in different care settings. Pediatr Nurs 2004;30(3):189-197.

Shields L, Pratt J, Davis LM, Hunter J. Family-centred care for children in hospital. Cochrane Database Syst Rev 2007(1).

Shields L, Zhou H, Pratt J, Taylor M, Hunter J, Pascoe E. Family-centred care for hospitalised children aged 0-12 years. Cochrane Database Syst Rev 2012;10.

Shields L. What is ”Family-centred care”?. Eur J Pers Cent Healthc. 2015;3(2):139–144

Shimizu A, Mori A. Maternal perceptions of family-centred support and their associations with

the mother-nurse relationship in the neonatal intensive care unit. J Clin Nurs 2018.

Shionoya K, Moriceau S, Lunday L, Miner C, Roth TL, Sullivan RM. Development switch in neural circuitry underlying odor-malaise learning. Learn Mem. 2006;13:801–808.

Silveira PP, Portella AK, Clemente Z, Bassani E, Tabajara AS, Gamaro GD, Dantas G, Torres IL, Lucion AB, Dalmaz C. Neonatal handling alters feeding behavior of adult rats. Physiol Behav. 2004;80(5):739–45.

Silveira PP, Portella AK, Crema L, Correa M, Nieto FB, Diehl L, Lucion AB, Dalmaz C. Both infantile stimulation and exposure to sweet food lead to an increased sweet food ingestion in adult life. Physiol Behav. 2008;93(4-5):877–82.

Singer W. Development and plasticity of cortical processing architectures. Science 1995;270:758–764.)

Sisson H, Jones C, Williams R, Lachanudis L. Metaethnographic synthesis of fathers' experiences of the neonatal intensive care unit environment dur- ing hospitalization of their premature infants. J Obstet Gynecol Neonatal Nurs 2015;44(July–August (4)):471–80.

Smith JR, Donze A. Assessing environmental readiness: First steps in developing an evidence-based practice implementation culture. J Perinat Neonatal Nurs 2010;24(1):61-71.

Solhaug M, Bjørk IT, Sandtrø HP. Staff perception one year after implementation of the the newborn individualized developmental care and assessment program (NIDCAP). J Pediatr Nurs. 2010;25(2):89-97.

Spittle A, Orton J, Anderson P, Boyd P, Doyle LW, Early developmental intervention programmes post-hospital discharge to prevent motor and cognitive impairments in preterm infants, Cochrane Database Syst. Rev. 2012;12

Stephens BE, Vohr BR. Neurodevelopmental outcome of the premature infant. Pediatr Clin North Am. 2009;56(3):631-46

Stiles J & Jernigan TL. The Basics of Brain Development. Neuropsychol Rev 2010;20:327–348

Sullivan R, Perry R, Sloan A, Kleinhaus K, Burtchen N. Infant bonding and attachment to the caregiver: insights from basic and clinical science. Clin Perinatol. 2011;38(4):643–655.

Sullivan R, Perry R. Mechanisms and functional implications of social buffering in infants: Lessons from animal models. Soc Neurosci. 2015;10(5):500–511.

Symington A, Pinelli JM. Distilling the evidence on developmental care: a systematic review. Adv Neonatal Care. 2002; 2(4):198-221.

Thomas LM. The changing role of parents in neonatal care: a historical review. Neonatal Netw, 2008; 27(2):91-100.

Todeschin AS, WinkelmannDuarte EC, Jacob MH, Aranda BC, Jacobs S, Fernandes MC, Ribeiro MF, Sanvitto GL, Lucion AB. Effects of neonatal handling on social memory, social interaction, and number of oxytocin and vasopressin neurons in rats. Horm Behav. 2009;56(1):93–100.

Toivonen M, Lehtonen L, Löyttyniemi E, Axelin A. Effects of single-family rooms on nurse-parent and nurse-infant interaction in neonatal intensive care unit. Early Hum Dev 2017;106-107:59-62.

Trajkovski S, Schmied V, Vickers M, Jackson D. Neonatal nurses' perspectives of family-centred care: A qualitative study. J Clin Nurs 2012;21(17-18):2477-2487.

Tran C, Medhurst A, O'Connell B. Support needs of parents of sick and/or preterm infants admitted to a neonatal unit. NPCHN 2009; 12: 12–7.

Treherne SC, Feeley N, Charbonneau L, Axelin A. Parents' Perspectives of Closeness and Separation With Their Preterm Infants in the NICU. JOGNN J Obstet Gynecol Neonatal Nurs 2017;46(5):737-747.

Vanderwert RE, Zeanah CH, Fox NA, Nelson CA. Normalization of EEG activity among previously institutionalized children placed into foster care: A 12-year follow-up of the Bucharest Early Intervention Project. Dev Cognitive Neurosci 2016;17:68-75.

Van Riper M. Family-provider relationships and well-being in families with preterm infants in

the NICU. Heart Lung J Acute Crit Care 2001;30(1):74-84.

Vigneau M, Beaucousin V, Hervé PY, Duffau H, Crivello F, Houdé O, et al. Meta-analyzing left hemisphere language areas: Phonology, semantics, and sentence processing. Neuroimage 2006;30(4):1414-1432.

Vohr B, McGowan E, McKinley L, Tucker R, Keszler L, Alksninis B. Differential Effects of the Single-Family Room Neonatal Intensive Care Unit on 18- to 24-Month Bayley Scores of Preterm Infants. J Pediatr 2017;185:42-48.e1.

Voos KC, Ross G, Ward MJ, Yohay AL, Osorio SN, Perlman JM. Effects of implementing family-centered rounds (FCRs) in a neonatal intensive care unit (NICU). J Matern Fetal Neonatal Med. 201;24(11):1403-1406.

Weis J, Zoffmann V, Egerod I. Enhancing person-centred communication in NICU: a comparative thematic analysis. Nurs Crit Care 2015;20(6):287–98.

Westrup B. Family-centered developmentally supportive care. NeoReviews 2014; 15: e325–35.

White RD. Individual rooms in the NICU — An evolving concept. J Perinatol 2003;23:S22-S24.

White RD. Designing Environments for Developmental Care. Clin Perinatol 2011;38(4):745-749.

Zeanah CH, Fox NA, Nelson CA. Case Study in Ethics of Research: The Bucharest Early Intervention Project. The Journal of nervous and mental disease. 2012;200(3):243-247

Ågren J. The Thermal Environment of the Intensive Care Nursery. 2014. *In: Neonatal-Perinatal Medicine 10th Edition /* [ed] Martin R, Fanaroff A, Walsh M, Philadelphia: Saunders Elsevier, 2014

ÖrtenstrandA, Westrup B, Broström EB ,Sarman I, Akerström S, Brune T, et al. The Stockholm Neonatal Family Centered Care Study: effects on length of stay and infant morbidity. Pediatrics 2010; 125: e278–85.

Annales Universitatis Turkuensis

Turun yliopisto
University of Turku

Painosalama Oy, Turku, Finland 2018

ISBN 978-951-29-7346-0 (PRINT)
ISBN 978-951-29-7347-7 (PDF)
ISSN 0355-9483 (PRINT) | ISSN 2343-3213 (PDF)