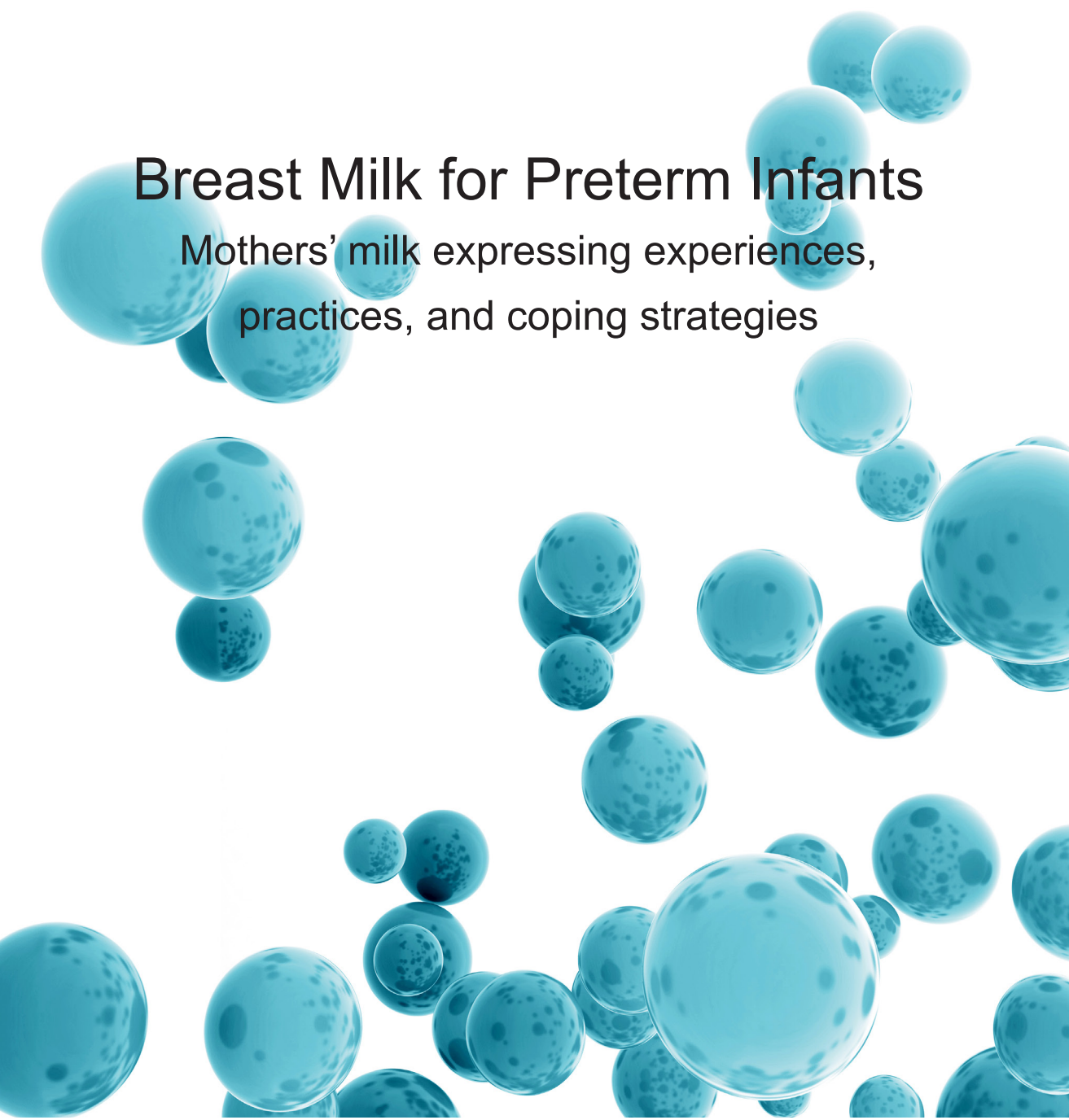


RIIKKA IKONEN

Breast Milk for Preterm Infants

Mothers' milk expressing experiences,
practices, and coping strategies





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ACADEMIC DISSERTATION

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UNIVERSITY OF TAMPERE

RIIKKA IKONEN

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For Petri, Katriina, and Aleksi

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On the first day of year 2018,

Riikka Ikonen

ABSTRACT

Offering breast milk to preterm infants is one of the most important tasks for the mothers during the hospitalization in neonatal intensive care unit (NICU). Breast milk significantly decreases mortality and morbidity of preterm infants, and expressing breast milk enables mothers to become an essential part of the NICU team. The aim of the study's first phase was to describe mothers' experiences and coping strategies related to milk expression. In the second phase, the aim was to evaluate the psychometric properties of the developed Coping with Milk Expressing for Preterm Infant (CMEPI) scale, and to explore the associations of mothers' and infants' characteristics, milk expression practice, use of breast milk in NICU, expression-related stress, use of coping strategies, and managing with expressing.

First, in the qualitative phase, preterm infants' mothers' experiences of breast milk expressing were studied through an integrative review ($n = 23$ studies) using thematic analysis and through descriptive qualitative study ($n = 130$ mothers' narratives) using inductive content analysis. The concept of coping was identified as a central concept during the analysis. Therefore the analysis proceeded to identify mothers' expression-related coping strategies through secondary analysis of both datasets using deductive content analysis. The transactional theory of stress and coping was used as a theoretical framework.

The results suggested that expressing was an important way to contribute to the care, execute motherhood, and maintain connection with their infants for the mothers. Expressing was also seen as an obligatory task to achieve breastfeeding. Mothers confront several obstacles in expression, such as exhaustion, frustration, practical problems, mother-infant separation and insufficiency of milk supply. According to the qualitative findings, the increased expression-related stress and poor management of expressing were barriers to adequate expression frequency. Several emotion- and problem-focused expression-related coping strategies were found.

During the second, quantitative, phase, the coping strategies were operationalized into the CMEPI scale. The psychometric properties of the CMEPI scale were examined using data from NICU-hospitalized and NICU-graduated preterm infants' mothers ($n = 174$). Furthermore, NICU-hospitalized preterm infants' mothers' ($n = 129$) sociodemographic characteristics, expression practices and expression-related stress, coping strategies, and managing with expression were measured using bivariate statistical tests and multivariate modelling.

The CMEPI scale showed acceptable validity and reliability for a newly developed scale. The scale consisted of five sub-scales: Alienating, Activity and Learning, Mastering, Facilitation and Delimitation, and Positive Thinking. Socio-demographic characteristics, expression-related stress or perceived management was not associated with expression frequency. Expressing was measured to be only moderately stressful for the mothers in the early phase of lactation. Expression-related stress, previous NICU experience and infant's chronological age were predictors of use of coping strategies. The coping strategies significantly mediated the relationship between expression-related stress and managing.

The results suggest that, opposite to qualitative findings, subjective managing and expression frequency are unrelated issues. Supporting mothers' coping strategies by counseling may not have an influence on expressing frequency, but can be an opportunity to support mothers' managing with expression.

Key words: Infant, premature; Breast milk expression; Intensive care, neonatal; Coping strategies; Instrument development

TIIVISTELMÄ

Äidinmaidon tarjoaminen on yksi äidin tärkeimmistä tehtävistä keskosien tehohoitajakson aikana. Äidinmaito vähentää keskosien kuolleisuutta ja sairastavuutta, ja lypsäminen sitoo äidin tärkeäksi osaksi vauvan hoitotiimiä. Tutkimuksen ensimmäisen vaiheen tarkoituksena oli kuvata keskosien äitien rintamaidon lypsämisen kokemuksia ja selviytymismenetelmiä. Toisessa vaiheessa tarkoituksena oli arvioida kehitetyn Coping with Milk Expressing for Preterm Infants (CMEPI) mittarin psykometrisiä ominaisuuksia, ja selvittää sosiodemografisten tekijöiden, lypsämisen käytäntöjen, rintamaidon riittävyyden, lypsämisen stressin, selviytymismenetelmien ja lypsämisessä pärjäämisen välisiä yhteyksiä.

Ensimmäisessä, laadullisessa vaiheessa selvitettiin äitien kokemuksia maidon lypsämisestä ja imetyksestä integroivan kirjallisuuskatsauksen avulla ($n = 23$ julkaisua) käyttäen temaattista analyysia sekä kuvailevalla laadullisella tutkimuksella ($n = 130$ äidin kertomusta) käyttäen induktiivista sisällönanalyysia. Selviytymisen käsite tunnistettiin keskeiseksi käsitteeksi analyysien kuluessa. Tämän johdosta analyysia jatkettiin tunnistamalla äitien maidon lypsämisessä käyttämiä selviytymismenetelmiä sekundaarianalyysissa. Molemmat aineistot analysoitiin käyttäen deduktiivista sisällönanalyysia. Transaktionaalista teoriaa stressistä ja selviytymisestä käytettiin teoreettisena viitekehysenä.

Tuloksien mukaan maidon lypsäminen oli äideille tärkeä tapa osallistua vauvan hoitoon, toteuttaa äitiyttä ja luoda ja ylläpitää suhdetta vauvaan. Toisaalta lypsäminen nähtiin myös pakollisena tehtävänä, jotta imetys myöhemmin mahdollistuisi. Äidit kohtasivat monia haittatekijöitä lypsämisessä, kuten uupumusta, turhautumista, käytännön ongelmia, ongelmia johtuen äidin ja vauvan erosta sekä maidon riittävyyden ongelmia. Laadullisten tulosten mukaan lypsämisen stressaavuus ja koettu huono pärjääminen haittasivat lypsämistiheyden ylläpitoa. Tutkimuksessa löydettiin useita tunteiden hallintaan ja ongelmanratkaisuun kohdentuvia selviytymismenetelmiä.

Tutkimuksen toisessa, määrällisessä vaiheessa selviytymismenetelmät operationalisoitiin CMEPI mittariksi. Mittarin psykometrisiä ominaisuuksia tutkittiin käyttäen sekä sairaalahoidossa olevien että kotiutuneiden keskosien äitien kyselyaineistoja ($n = 174$). Lisäksi mitattiin sairaalahoidossa olevien keskosien äitien ($n = 129$) sosiodemografisten ominaisuuksien, lypsämiskäytäntöjen, lypsämiseen liittyvän stressin, selviytymismenetelmien ja lypsämisessä pärjäämisen välisiä yhteyksiä käyttäen kahden muuttujan menetelmiä sekä monimuuttujamallinnuksia.

CMEPI mittari osoittautui hyväksyttävän validiksi ja reliaabeliksi uudeksi mittariksi. Mittari sisälsi viisi osa-mittaria: Loitontaminen, Aktiivisuus ja Opettelu, Hallitseminen, Mahdollistaminen ja Rajoittaminen sekä Positiivinen Ajattelu. Sosiodemografiset tekijät, lypsämiseen liittyvä stressi tai koettu pärjääminen eivät olleet yhteydessä lypsämistiheyteen. Äidit kokivat vain kohtalaista lypsämiseen liittyvää stressiä laktaation varhaisvaiheessa. Lypsämiseen liittyvä stressi, aikaisempi kokemus vastasyntyneiden teho-osastolta ja vauvan ikä olivat yhteydessä selviytymismenetelmien käyttöön. Selviytymismenetelmät olivat merkitsevä mediaatiotekijä lypsämiseen liittyvän stressin ja koetun pärjäämisen välillä.

Tulokset osoittavat, vastakkaisesti laadullisten tutkimusten löydöksiin nähden, että koettu pärjääminen lypsämisen kanssa ja lypsämisfrekvenssi eivät ole yhteydessä toisiinsa. Tukemalla äitien selviytymismenetelmiä ohjauksen keinoin ei ehkä voida vaikuttaa äitien lypsämistiheyteen, mutta se saattaa olla keino tukea äitien koettua pärjäämistä lypsämisessä.

Avainsanat: Keskonen; Rintamaidon lypsäminen; Vastasyntyneiden tehohoito; Selviytymiskeinot; Mittarin kehittäminen

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List of abbreviations

| | |
|---------------------------------|--|
| α | Cronbach alpha coefficient |
| ADHD | Attentive deficit and hyperactivity disorder |
| β | Regression coefficient |
| BPD | Bronchopulmonary dysplasia |
| CI | Confidence interval |
| CMEPI | Coping with Milk Expressing for Preterm Infants |
| CINAHL | The Cumulative Index to Nursing and Allied Health |
| CMV | Cytomegalovirus |
| d | Cohen's d , effect size |
| df | Degrees of freedom |
| EFA | Exploratory factor analysis |
| ELBW | Extremely low birth weight |
| F | The distribution of F |
| f^2 | Anticipated effect size |
| FIL | Feedback inhibitor of lactation |
| GA | Gestational age |
| I-CVI | Item-level content validity index |
| LCPUFA | Long-chained polyunsaturated fatty acid |
| M | Arithmetic mean |
| M | Mediator in mediation analysis |
| MAStARI | Meta Analysis of Statistics Assessment and Review Instrument |
| Md | Median |
| Medline | Medical Literature Analysis and Retrieval System Online |
| N | Sample size |
| NEC | Necrotizing enterocolitis |
| NICU | Neonatal intensive care unit |
| OMM | Own mother's milk |
| OR | Odds ratio |
| p | Statistical significance |
| PAF | Platelet-activating factor |
| PsycINFO | Psychological database |
| PTSD | Post-traumatic stress disorder |
| Q ₁ , Q ₃ | 25 th , 75 th percentile |
| QARI | Qualitative Assessment and Review Instrument |
| r | Pearson product-moment correlation coefficient |
| R^2 | Coefficient of determination |
| RDS | Respiratory distress syndrome |

| | |
|-----------|---|
| r_s | Spearman rho |
| ROP | Retinopathy of prematurity |
| SAME | Secondary Appraisal of Milk Expressing |
| S-CVI | Scale-level content validity index |
| <i>SD</i> | Standard deviation |
| SIgA | Secretory immunoglobulin A |
| SPSS | Statistical Package for the Social Sciences |
| Tol | Tolerance |
| TTSC | Transactional theory of stress and coping |
| VIF | Variance inflation factor |
| VLBW | Very low birth weight |
| X | Independent variable in mediation analysis |
| Y | Dependent variable in mediation analysis |

List of appendixes

Appendix 1. Literature searches for the summary

Appendix 2. Items of the CMEPI scale and supporting evidence

Original Publications

The summary is based on the articles presented below. The articles are cited in text with roman numbers (I–IV). The summary contains also unpublished study findings.

- I Ikonen R, Paavilainen E & Kaunonen M. 2015. Preterm Infants' Mothers' Experiences with Milk Expression and Breastfeeding: An Integrative Review. *Advances in Neonatal Care* 15 (6), 394–406.
- II Ikonen R, Paavilainen E & Kaunonen M. 2016. Trying to Live with Pumping: Expressing Milk for Preterm or SGA Infants. *MCN: The American Journal of Maternal/Child Nursing* 41 (2), 110–115.
- III Ikonen R, Paavilainen E, Sukanen M & Kaunonen M. Measuring Coping with Breast Milk Expression among Preterm Infants' Mothers. Instrument Development and Psychometric Assessment. Submitted.
- IV Ikonen R, Paavilainen E, Helminen M & Kaunonen M. 2017. Preterm Infants' Mothers' Initiation and Frequency of Breast Milk Expression and Exclusive Use of Mother's Breast Milk in Neonatal Intensive Care Units. *Journal of Clinical Nursing* doi: 10.1111/jocn.14093

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1 Introduction

Preterm birth (before 37 completed weeks of gestation) is an interruption of the natural process of becoming a mother and a family. The pregnancy and maturation to motherhood cease due to unexpected birth (Rossman et al. 2015). The mothers are thrown into a frightening situation (Aagaard & Hall 2008). The situation is often characteristic of several losses. First, the delivery may be sudden and unexpected, and the infant is taken away immediately after the birth (Rossman et al. 2015). The separation continues, as admission to the open ward neonatal intensive care unit (NICU) creates a physical barrier to closeness, and restrictions and control by NICU staff may create feelings of emotional separation (Aagaard & Hall 2008, Cleveland 2008, Flacking et al. 2012). The appearance of the infant and the surrounding wires and technology may further foster the feelings of abnormality and emotional separation. Due to separation, the mothers are at risk to lose the feeling of connection and motherhood. The NICU environment may be overwhelming with strange and frightening sights, alarm sounds, and technology (Aagaard & Hall 2008.) Because of the infant's fragility and need of special care, common maternal actions such as carrying, diapering, and feeding are often restricted. Nurses may control the interaction between the mothers and the infant, and the mothers may have to negotiate with the nurses in order to touch or hold their infants (Aagaard & Hall 2008, Cleveland 2008). Finally, the mothers are at risk to lose the expected and normal breastfeeding experience. They discover that breastfeeding becomes a different experience, and several unfamiliar skills needed to be learned (Nyqvist & Kylberg 2008).

On average, 3000 families confront this situation annually in Finland, and globally 14.9 million infants are born prematurely every year (Blencowe et al. 2013, National Institute for Health and Welfare 2017). Preterm births have several consequences on the infant, on mother, and on lactation. First, preterm birth is the leading cause of infant mortality, and preterm infants have increased risk for morbidity (Blencowe et al. 2013). Second, preterm birth causes distress for the mothers (Aagaard & Hall 2008), who may suffer from posttraumatic stress disorder and perceive an infant as vulnerable for years after their NICU experience (Shaw et al. 2013, Horwitz et al. 2015a, 2015b). Third, the mothers have to initiate their lactation with expressing, and breastfeeding is often delayed until the infant is matured. Breastfeeding rates are substantially lower in preterm infants than in term infants in Finland (National Institute for Health and Welfare 2012) and worldwide (Bonet et al. 2011, Rollins et al. 2016), despite the fact

that women have positive attitudes toward breastfeeding during pregnancy (Laanterä et al. 2010) and after the birth of preterm infants (Niela-Vilen et al. 2016). The National Institute for Health and Welfare has outlined proposals for action to promote breastfeeding among term and preterm infants in Finland (Hakulinen et al. 2017).

Breast milk is identified as important to reduce mortality and morbidity of preterm infants (American Academy of Pediatrics 2012). Despite the restrictions and changes in breastfeeding initiation and maintenance, providing breast milk and breastfeeding may be ways to create connection to the infant and to perform motherhood in NICU (Cleveland 2008, Flacking et al. 2016). In other words, breast milk acts as a mediator between preterm birth and physical consequences for the infant and psychological consequences for the mother. The mother plays a unique role in her infant's care, and the availability of "medicinal" breast milk is fully dependent on her practices and her ability to initiate and maintain lactation. This is often both a supportive and obstructive factor for the mother, as it renders her a necessary part of the NICU team and partially responsible for her infant's survival.

The NICU staff has an important role to alter the consequences of preterm birth. Declaration of the Rights of the Child requires them to avoid mother-infant separation (Article 9) and provide adequate nutrition to children, as well as information and guidance of breastfeeding (Article 24) (Unicef 2014). Parents need emotional support, empowerment, a friendly environment and a supportive unit policy, counseling, and opportunities to practice new skills through guided participation (Cleveland 2008). Neonatal care should be family-centered (Nyqvist et al. 2012), meaning that family should be considered as a client of NICU, rather than in the context of an infant (see Friedman et al. 2003). These requirements reflect the need for patient autonomy. Autonomy is one of the essential principles and concepts in nursing (Lachman 2006). Demand to respect patient autonomy is written in ethical codes in nursing (American Nurses Association 2001, Finnish Nurses Association 2016). Despite these guidelines, several cases of misconduct that violate the mothers' right to autonomy and the role of primary caregiver have been reported (Aagaard & Hall 2008, Cleveland 2008). The mother-infant relationship and communication may be regulated by the nurses; the mothers may confront unjustified limitations (Cleveland 2008) and are often under constant supervision (Aagaard & Hall 2008). The mothers may have to negotiate with the nurses just to be able to care for their infants (Aagaard & Hall 2008). In this context, voicing their concerns and demanding their rights are problematic, since labeling them as "difficult mothers" could lead to negative relationships with nurses and make even more vulnerable the position of the mothers and the infants (Aagaard & Hall 2008, Cleveland 2008).

In addition to caring for the infant in NICU, initiating and maintaining lactation in the NICU context requires skilled counseling and support. Facilitating support is

described as problem-solving, individual, and reinforcing (Bernaix et al. 2006, Nyqvist & Kylberg 2008, Swanson et al. 2012). Practical advice and demonstrations from the nurses are also valuable (Nyqvist & Kylberg 2008, Swanson et al. 2012). Furthermore, the mere presence and availability of the healthcare staff, without them taking any action, is important for the mothers in creating an atmosphere of calmness and security (Björk et al. 2012). On the other hand, staff who are unskilled, disrespectful, oppressive, insensitive, and practice non-individual counseling are recognized as barriers to lactation and mothers' well-being (Bernaix et al. 2006, Nyqvist & Kylberg 2008, Sisk et al. 2010). In Finland, breast milk expression counseling (Ikonen et al. 2016) and breastfeeding counseling (Niela-Vilen et al. 2015) have been identified to include several defects. Despite the importance of breastfeeding counseling, health care staff may have substantial gaps in their knowledge and skills (Rollins et al. 2016). Family-centered, individual care with respect for patient autonomy is also essential in breastfeeding counseling in the NICU context.

As a young nurse in a NICU, I saw breastfeeding as an essential part of motherhood, and witnessed how the mothers of preterm infants struggled to make breastfeeding fluent and unproblematic. I had a tenuous idea that breastfeeding is something big and meaningful for those mothers. And yet, I was confused when I saw the mothers complicate their breastfeeding journey from the very beginning. I advised them to express milk frequently and continue to do so until the infant is mature enough to be able to suckle at the breast. Despite my advice, the mothers expressed infrequently, paced their expressing sessions to excess, and ceased them even as they wished for successful breastfeeding. Why did the mothers not respond to advice? Does this phenomenon consist of more than simple actions? How stressful is expression for the mothers? Are the mothers too stressed and too tired to be able to express? These questions were the starting points for this study.

Understanding mothers' experiences with and practices of milk expression are cornerstones for adequate and evidence-based counseling to promote preterm infants' and mothers' well-being during the NICU admission and after discharge. The aim of this study was to describe preterm infants' mothers' experiences with and practices of coping with breast milk expression.

2 Review of the literature

2.1 The search strategy

The review of the literature presented in this chapter aims to provide a framework for this study. The literature review describes the impact of preterm birth on infants, on lactation, and on mothers. Systematic searches for this summary were conducted to describe (1) the evidence and rationale of using breast milk for preterm infants and recommended practices to promote breastfeeding, and stress and coping from three viewpoints: (2) the transactional theory of stress and coping (TTSC), (3) mothers' stress when having a preterm, NICU-hospitalized infant, and (4) mothers' coping in NICU and postdischarge. Previous studies of mothers' experiences and coping strategies related to milk expression are not a part of the framework of this study, and thus not presented in this section. A literature review of expression-related experiences and coping strategies was undertaken to answer one of the research questions in this study, and therefore is presented as a part of this study's data and results (Articles I and III, summary). The framework of the study was built simultaneously with the study process, thus exploring mothers' experiences with expressing (Articles I and II) were inductive in nature, and the TTSC was selected after conducting that part of the study and identifying coping as a central concept.

Breast milk, lactation, and breastfeeding in the context of a preterm infant were examined by searching systematic reviews of the topic. This strategy was selected because a great many studies and reviews have been conducted about this topic. Some primary studies were searched manually and included if the reviews did not cover the viewpoints adequately. Literature by Richard Lazarus and Susan Folkman were searched to describe the TTSC. Existing studies on maternal stress when having a preterm, NICU-hospitalized or NICU-graduated infant were searched systematically. The viewpoint of stress was chosen because a stressful event is a starting point of the TTSC, a theoretical framework of this study. The coping strategies used by the mothers of preterm infants were also explored systematically. The investigation into the mothers' coping strategies was conducted in January 2016, and other searches were conducted in July 2016. The searches were updated in May 2017 to detect newly published studies. Medical Literature Analysis and Retrieval System Online (MEDLINE), The Cumulative Index to Nursing and Allied Health (CINAHL),

Cochrane Library, and PsycINFO databases were used. The searches are described in Appendix 1. Furthermore, some basic literature and sources from the World Health Organization and the National Institute for Health and Welfare were used.

2.2 Preterm infant, milk expressing, and breastfeeding

2.2.1 Preterm infants and risks of premature birth

A preterm infant is born before 37 gestation weeks; 36⁺⁶ gestational age (GA) at the latest (Preterm Birth: Current Care Guidelines 2011, Blencowe et al. 2013). Late preterm infants are born between 34⁺⁰ and 36⁺⁶ gestation weeks, and extremely preterm infants are born before 28⁺⁰ GA. The borderline between miscarriage and childbirth is 22⁺⁰ gestation weeks. (Preterm Birth: Current Care Guidelines 2011.) Infant's birth weight is also used as a criterion of prematurity. An infant is born prematurely and has low birth weight if that birth weight is less than 2500 grams, very low birth weight (VLBW) if the birth weight is less than 1500 grams, and extremely low birth weight (ELBW) if the weight is less than 1000 grams (Preterm Birth: Current Care Guidelines 2011). In Finland, 5.7% (n = 3078) of infants were born before 37 gestation weeks in 2016 (National Institute for Health and Welfare 2017).

Premature birth is a risk for mortality. Globally, preterm birth is the leading reason of neonatal mortality (Blencowe et al. 2013). Perinatal mortality is highest among infants of very low GA at birth, and decreases when GA increases (Milligan 2010). In Finland during 2015, perinatal mortality was 607, 134, and 25 deaths per 1000 births in gestation weeks 23, 28, and 34, respectively (National Institute for Health and Welfare 2016a). Mortality has decreased over time among preterm infants born > 24 weeks (Milligan 2010). It is argued that mortality among infants born at 22–23 gestation weeks remains unchangingly very high (Milligan 2010), but Stoll et al. (2015) found the largest gains in survival rates among infants born at 23 and 24 gestation weeks from 1993 to 2012. The decrease of mortality is due to development of technologies and medication, especially the use of antenatal corticosteroids, increased obstetrical interventions and active management of pregnancies near the limit of liability, aggressive ventilation treatment and the use of surfactants, infection prevention, and use of human milk (Stoll et al. 2015).

Despite the increased survival rates, morbidity rates have remained high, especially among very preterm infants. It is argued that the limit of viability has been reached, but morbidity remains as a challenge (Allen et al. 2011). Sepsis (Stoll et al. 2015), necrotizing enterocolitis (NEC) (Stoll et al. 2015), and intracranial bleeding

(McCormick et al. 2011, Stoll et al. 2015) are prevalent problems during a NICU stay. Preterm birth has several long-term consequences as well. Retinopathy of prematurity (ROP) can lead to visual impairment; lung problems, especially respiratory distress syndrome (RDS), can lead to bronchopulmonary dysplasia (BPD) and asthma (Milligan 2010, Stoll et al. 2015, McCormick et al. 2011). Furthermore, neurological disabilities, such as cerebral palsy (Milligan 2010, Engle 2011, McCormick et al. 2011), cognitive and intellectual dysfunction (Milligan 2010, Engle 2011, McCormick et al. 2011), neuromotor dysfunction (Milligan 2010, McCormick et al. 2011), and difficulties with languages (Milligan 2010) are more prevalent among preterm infants than among their term counterparts during childhood and adolescence. Social difficulties and attentive deficit and hyperactivity disorder (ADHD) are also more prevalent (Milligan 2010, Engle 2011, McCormick et al. 2011). Furthermore, preterm infants more often have negative standard deviation scores for height, weight, and head circumference (Milligan 2010). To sum up, premature birth poses a risk for survival of the infant, and several morbidities can occur because of prematurity, especially among infants born extremely prematurely.

2.2.2 Breastfeeding recommendations and their foundations

Human breastmilk is therefore not only a perfectly adapted nutritional supply for the infant, but probably the most specific personalized medicine that he or she is likely to receive, given at a time when gene expression is being fine-tuned for life. (Victora et al. 2016, p. 486.)

The American Academy of Pediatrics recommends that all preterm infants should receive human milk, and their own mothers' milk should be the primary diet. Pasteurized donor milk should be the second choice (American Academy of Pediatrics 2012). In Finland, no specific nutritional guidelines for preterm infants exist, but exclusive breastfeeding is a primary diet for infants under six months (National Institute for Health and Welfare 2016b) and breastfeeding and breast milk expressing should be supported during the infant's hospitalization (National Nutritional Council 2010). The storage and pasteurization of donor milk significantly destroys the components of human milk; for example, 50% of secretory immunoglobulin A (SIgA) and 65% of lactoferrin are lost as a result of pasteurization (Heiman et al. 2006). Within the first month of an infant's life, most of the benefits of human milk are dose-dependent, illuminating the importance of high volumes of human milk (Meier et al. 2010, Ahrabi & Schanler 2013). Two protective mechanisms have been found during this period. First, human milk has probiotic and prebiotic activity, promoting the healthy bacterial colonization in the sterile gut (Meier et al. 2010), especially in the

NICU environment (Hartz et al. 2015). Second, the volumes of human milk are associated with the closure of paracellular pathways between enterocytes in the infant's gut. As a result of the closure, the translocation of high-molecular-weight bacteria and their toxins to the bowel wall is inhibited. During this period, the effect of donor milk has not been studied, but even small amounts of artificial milk interrupt the colonization and have an independent, pro-inflammatory effect. (Meier et al. 2010.)

It can be assumed that preterm infants will have the same short- and long-term benefits of breastfeeding as term infants. These benefits include lower rates of respiratory tract infections, otitis media, gastrointestinal tract infections, sudden infant death syndrome, allergic diseases, celiac disease, inflammatory bowel disease, obesity, diabetes, childhood leukemia and lymphoma and better neurodevelopment outcomes (Horta et al. 2007, American Academy of Pediatrics 2012, Victora et al. 2016). However, well-controlled studies that demonstrate the associations between breastfeeding and these outcomes in preterm infants' population have not been presented (Meier et al. 2010).

The energy sources in human milk are carbohydrates, proteins, and fat. The major carbohydrate in human milk is lactose, which, after metabolized into galactose and glucose, supplies energy to the rapidly growing brain (Riordan 2010a, Smith 2013). Other carbohydrates include over 130 different kinds of oligosaccharides, which have immunological functions (Hanson 2004, Meier et al. 2010, Smith 2013). The main proteins in human milk are whey and casein. Human milk includes more whey than casein (90% whey, 10% casein in early lactation, 60% whey and 40% casein in mature milk). Therefore, milk forms a soft, easily digested mass in infants' stomachs. (Riordan 2010a, Smith 2013.) Among preterm infants, the use of human milk is associated with improved clinical feeding tolerance (Boyd et al. 2007, American Academy of Pediatrics 2012). The total fat content is highly variable, and depends on the stage of lactation, breastfeeding frequency, and duration of the breastfeeding session. Triglycerides predominate in human milk. In addition, milk includes cholesterol and long-chained polyunsaturated fatty acids (LCPUFAs), which have important functions in metabolism and development of nervous system. (Smith 2013.) Human milk includes all required vitamins and minerals, except vitamin D, for full-term normal birth weight infants (American Academy of Pediatrics 2012). However, human milk has an insufficient amount of protein, and the adequacy of the amount of calcium and phosphorus is unclear, taking into account that those minerals have higher bioavailability in human milk than in supplemental products (Cohen & McCallie 2012).

Preterm infants' mothers' breast milk differs from the milk of full-term infants' mothers. Preterm infants' mothers' milk contains more protein and energy. Preterm infants' mothers' milk contains 30% higher fat concentration, providing more than 50% of energy intake in preterm infants. It has a higher content of sodium, chlorine,

potassium, calcium, iron and magnesium. The breast milk of mothers of preterm infants is significantly higher in SIgA, lactoferrin and other anti-infective properties. (Hurst & Meier 2010, Riordan 2010a, Gidrewicz & Fenton 2014.)

Human milk feeding is associated with lower rates of sepsis in preterm infants (American Academy of Pediatrics 2012, Patel et al. 2013). It has been suggested that this is due to the bioactive components in breast milk, particularly SIgA, lactoferrin, and oligosaccharides. In addition to these direct protective components, breast milk consists of growth factors and cytokines, which facilitate the maturity and growth of the gut, and therefore reduces the risk for translocation of potential pathogens. (Patel et al. 2013.) Human milk feeding is also associated with lower rates of NEC (Boyd et al. 2007, Ip et al. 2007, Sullivan et al. 2010, American Academy of Pediatrics 2012, Gephart et al. 2012, Raval et al. 2013, Kim 2014). Generally, milk has several anti-inflammatory components, and it has the capacity to control the early bacterial colonization of the gut (Hanson 2004, Kim 2014). Further, the protection offered by milk to NEC is suggested to be a result of several milk components. Lactoferrin has been suggested to have a major role in preventing NEC, as it has both anti-microbial activity and immunomodulatory properties (Adamkin 2012, Kim 2014). Second, human milk contains a platelet-activating factor (PAF)–acetylhydrolase, which degrades PAF and as a result, reduces the inflammation in the gut. Third, SIgA antibodies and the oligosaccharide receptor analogues prevent bacteria from attaching to the gut epithelium. (Hanson 2004, Gephart et al. 2012, Kim 2014.) Growth factors, especially the epidermal growth factor, limit ileal damage and thus act as a protective factor (Gephart et al. 2012, Kim 2014). Last, the induced production of interleukin-10 at the site of injury in the gut is associated with the milk's ability to reduce the severity of NEC (Hanson 2004). Breastfeeding is associated also with lower rates of ROP. The antioxidant components—inositol, LCPUFAs, vitamin E, beta-carotene, lutein, zeaxanthin, lactoferrin and enzymes—are speculated to protect against oxidative damage in retina. Furthermore, the protection against sepsis may protect indirectly against most severe stages of ROP. (American Academy of Pediatrics 2012, Manzoni et al. 2013.)

In contrast to the benefits, breast milk forms a risk for Cytomegalovirus (CMV) infection if the mother of a preterm infant is CMV-seropositive. The current evidence suggests that breast milk-acquired infections with Cytomegalovirus-related sepsis-like syndrome are relatively rare, and the benefits of breast milk outweigh the risks of CMV-infection. (Lanzieri et al. 2013.)

Lower sepsis and NEC morbidity rates may be associated with lower long-term growth failure and neurodevelopment disabilities (American Academy of Pediatrics 2012, Hsiao et al. 2014). Mental, motor, and behavior ratings are higher in breast milk-fed preterm infants (American Academy of Pediatrics 2012); however, among VLBW

infants there exists no strong evidence of neurodevelopmental and cognitive benefits (Ip et al. 2007, Koo et al. 2014). These advantages are dose-dependent, meaning that high doses of human milk impacts morbidities in the neonatal period (first 14 to 28 days). Breast milk-fed preterm infants have fewer rates of hospital readmission during the first year of life (American Academy of Pediatrics 2012) and shorter NICU stay. (Meier et al. 2010.) Breast milk-fed preterm infants have lower rates of metabolic syndrome, lower blood pressure, lower low-density lipoprotein concentrations and improved leptin and insulin metabolism in adolescence (American Academy of Pediatrics 2012).

In Finland, about 40 percent of preterm infants are exclusively breastfed at the age of less than one month. Exclusive breastfeeding means that the infant receives only breast milk, water and/or nutrient supplements. At the age of 4 months, 0% of preterm infants were exclusively breastfed. (National Institute for Health and Welfare 2012.) Berry, fruit and vegetable purees are commonly recommended to preterm infant at the age of three to four months in Finland (Metsäranta & Saarinen 2016, Terveyskylä 2017). This is not in line with the guidelines of World Health Organization (2016). Furthermore, about 90%, 45% and 15% of preterm infants are either exclusively or partly breastfed at the age of <1 month, 4 months and 11 months, respectively. (National Institute for Health and Welfare 2012.)

In summary, human milk is the gold standard for nutrition for preterm infants (American Academy of Pediatrics 2012). The advantages of mothers' own breast milk cannot be fully covered with donor milk. It is particularly important that the preterm infant receive its mother's own, unpasteurized colostrum and mature milk during the first days after birth and the first 14-28 days of its life, and that the colonization and development of the gut is not interrupted by artificial milk. (Meier et al. 2010.) The benefits of breast milk for preterm infants are well-documented, although the exact components and mechanisms of these advantages are not fully understood. The breastfeeding rates among preterm infants in Finland are suboptimal.

2.2.3 Lactation in mothers of preterm infants

Lactation occurs as a result of several hormonal mechanisms. During pregnancy, hormones initiate the structural proliferation of the breasts (Lactogenesis I). The ductal tree growth and proliferation and further formation of lobules occur in the first half of pregnancy as a result of estrogen and progesterone influence. During the second half of pregnancy, the alveolar cells differentiate into secretory cells. These cells in the mammary glands begin to secrete colostrum. Prolactin stimulates this change. The

secretory cells are still relatively small, and open tight junctions between the cells allow large molecules to pass into the colostrum. (Riordan 2010b, Lamb 2013.)

Lactogenesis II, i.e., copious milk secretion, occurs when the level of progesterone rapidly decreases, as a result of the expulsion of the placenta. At the same time, the basal level of prolactin remains relatively high, and breast stimulation further causes peaks in prolactin levels. These changes lead to a rapid synthesis of breast milk by day four postpartum. The alveolar cells swell up, and the tight junctions between those cells close. As a result, the amount of milk increases significantly, and the large molecules are no longer able to pass from the maternal plasma through alveolar cells to the milk. The levels of sodium, chlorine and protein decrease and the levels of lactose and lipids increase. (Riordan 2010b, Lamb 2013.)

While prolactin is the main hormone in milk secretion at the early phase of lactation, milk ejection (so-called let-down reflex) is initiated by oxytocin. Milk is stored in alveoli, which are surrounded by myoepithelial cells. Oxytocin causes a contraction of the myoepithelial cells, which increases intraductal pressure, and results in milk ejection from the breast. Without this hormonal-initiated reflex, only a few drops of milk can be expressed from the breast. (Riordan 2010b, Lamb 2013.)

The hormonal mechanisms do not differ among mothers of term and preterm infants (Riordan 2010b). Nevertheless, preterm infants' mothers have more difficulties in reaching an adequate milk amount than mothers of term infants (Hill et al. 2005a, Hill et al. 2009), since milk secretion can be hampered. Lactogenesis II can be delayed because of mothers' medications during pregnancy and labor, and because of lack of frequent stimulation (Hartman et al. 2003). Preterm infants' pump-dependent mothers have lower basal prolactin levels, presumably as a result of shorter pregnancy. The levels elevate to normal when simultaneous breast stimulation is implemented via a hospital-grade pump; as a result, higher prolactin levels combined with higher expressing frequency positively influence milk production. Interestingly, oxytocin levels have been found to be higher in preterm infants' mothers. Higher oxytocin levels may be an adaptive response to the situation, helping the mothers to bond with their infants without tactile stimulation, and protecting them from overreacting to the stressful situation of having a critically-ill, hospitalized infant. (Hill et al. 2009.) Stress and lactation have a complex biological relationship. Although both prolactin and oxytocin levels rises during stress, stress can also directly and indirectly (e.g., endocrinal opiates) interfere with the function of these hormones. Stress can interfere with the milk ejection reflex; as a result of inadequate drainage of the breasts, milk supply decreases. (Lau 2001, Hill et al. 2003.)

By day nine and beyond, removal of milk is essential to maintenance of established secretion, as milk secretion shifts from endocrine control (hormone-driven) to autocrine control (milk removal-driven). This means that the produced milk should be

removed from the breasts; otherwise the feedback inhibitor of lactation (FIL) will decrease milk synthesis. FIL is a compound in milk itself. (Riordan 2010b.) The removal of milk, as well as milk ejection reflex, can be interrupted by pumping. This is because most pumps use only vacuums to remove milk from the breast, while an infant uses vacuum and compression, and respond to lower milk flow by increasing the suckling frequency. (Mannel & Walker 2013.) Furthermore, oxytocin release can be interrupted due to the lack of physical contact with the infant or because of maternal stress (Lau 2001, Mannel & Walker 2013). Incomplete drainage of the breasts due to interrupted let-down reflex will lead to decreased or ceased milk secretion (Lau 2001).

Some external factors have been described, which may affect milk production in preterm infants' mothers. Timing of decision to breastfeed (Hill et al. 2005b, Hill & Aldag 2005), maternal education (Hill et al. 1999a, Hill et al. 2005b), maternal race (Hill et al. 1999a), annual income \geq 50,000 USD (Hill et al. 1999a, Hill & Aldag 2005), and previous breastfeeding experience (Hill et al. 1999b) have been found to affect milk output and adequacy of breast milk. Furthermore, a preterm infant's GA at birth (Hill et al. 2005b, Hill & Aldag 2005) and birth weight (Hill & Aldag 2005) correlate to milk output for the mother. Furthermore, time of initiation of breast stimulation (Hill et al. 1999a, Hill et al. 2001, Hill et al. 2005b, Hill & Aldag 2005, Parker et al. 2013), frequency of stimulation (Hill et al. 1999a, Hill et al. 2001, Hill et al. 2005b, Parker et al. 2013), breast massage combined with simultaneous pumping (Jones et al. 2001, Renfrew et al. 2009), and frequency of kangaroo care (Hill et al. 1999a, Hill et al. 2005b, Hill & Aldag 2005, Acuna-Muga et al. 2014, Parker et al. 2013) correlate positively to milk output. Breast pumps that mimic the unique sucking patterns (Meier et al. 2012) provide an opportunity to control speed and suction (Larkin et al. 2013) and result in greater milk volume during the pumping session. Regardless of the hormonal relationship between stress and lactation, maternal mood stages do not affect milk output (Hill et al. 2005b). The use of domperidone (prolactin releasing D₂ receptor antagonist; commonly used as an antiemetic drug) have a short-term moderate effect of increasing milk output (Donovan & Buchanan 2012).

In summary, the basic hormonal mechanisms behind the milk secretion are similar among mothers of full-term and preterm infants. However, several factors are identified that potentially interfere with this process. Preterm, pump-dependent mothers have lower basal prolactin levels, but scholars have argued that their oxytocin levels can rise as an adaptive response to intense stress (Hill et al. 2009). Stress can also interfere with the milk ejection reflex; the inadequate breast drainage leads to decreased milk secretion (Mannel & Walker 2013). Expression practices are important for adequate milk secretion, as lactogenesis II can be delayed because of lack of frequent stimulation (Hartman et al. 2003), and higher expressing frequency combined with higher prolactin levels are associated with increased milk production (Hill et al. 2009).

2.2.4 Clinical pathway of preterm infants' breastfeeding

Breastfeeding is initiated by expressing, since the preterm infant is often too immature to suckle at the breast (Lanese & Cross 2013, Nyqvist et al. 2013). Kangaroo care (skin-to-skin holding) should be initiated as soon as possible (Nyqvist et al. 2013), and there is strong evidence that skin-to-skin holding and kangaroo care promote breastfeeding (Nyqvist et al. 2013, Lucas & Smith 2015, Niela-Vilen et al. 2016). Kangaroo care can be considered as the earliest form of breastfeeding among preterm infants. As the infant matures, rooting, latching, and suckling develop (Nyqvist et al. 1999). The stable infant is able to maintain physical stability at the breast at the age of 27-28 gestation weeks (Lucas & Smith 2015). Preterm infants are able to root, latch, and suckle at the age of 29 gestation weeks, and can exclusively breastfeed at the age of 32-35 gestation weeks (Nyqvist 2008, Lucas & Smith 2015).

Several interventions have been identified to increase preterm infants' breastfeeding. Kangaroo care (McInnes & Chambers 2008, Renfrew et al. 2009, Ahmed & Sands 2010), postnatal support (McInnes & Chambers 2008), peer counseling (Renfrew et al. 2009, Ahmed & Sands 2010), milk intake measurement post-discharge (Ahmed & Sands 2010), and post-discharge lactation counseling (Ahmed & Sands 2010) have been identified as increasing breastfeeding rates among preterm infants. The evidence of supplementing by a cup or by a tube is insufficient (McInnes & Chambers 2008, Renfrew et al. 2009, Collins et al. 2016, Flint et al. 2016). Furthermore, it has been found that the use of donor human milk is associated with better rates of any breastfeeding at discharge, but not with exclusive breastfeeding (Williams et al. 2016).

Recent literature has provided evidence-based recommendations for preterm infants' mothers' breastfeeding counseling. The recommendations are based on the Baby-Friendly Hospital Initiative (World Health Organization & UNICEF 2009), and expanded for neonatal units (Nyqvist et al. 2012). The guiding principles of counseling are individuality, family-centeredness, and continuity of care (Nyqvist et al. 2012). Furthermore, the NICUs should have a written breastfeeding policy, and they should provide breastfeeding-related education to staff. The hospitalized pregnant women should receive information about breastfeeding and lactation management. Furthermore, early, continuous, and prolonged kangaroo care should be encouraged, and the mothers should receive counseling regarding how to initiate and maintain lactation. Early breastfeeding should be established with infant stability as the only criteria, and other food or drink than breast milk should be offered only if it is medically indicated. Infants and mothers should not be separated. Semi-demand or demand breastfeeding should be encouraged, bottles should be avoided at least until breastfeeding is established, and pacifiers and nipple shields should be used only as

necessary. Finally, parents should be prepared for continued breastfeeding, and access to breastfeeding support services should be ensured after discharge. (Nyqvist et al. 2013.)

2.3 Stress and coping

2.3.1 Defining stress, appraisal, and coping

The theoretical framework of this study is the TISC, which is cognitive-phenomenological theory of psychological stress, and the relational, process-oriented, ongoing cycle of cognitive appraisal and coping is used to mediate the transactional person-environment relationship (Folkman & Lazarus 1980, Lazarus & Folkman 1984, Folkman 1984, Lazarus & Folkman 1987). Stress occurs when external or internal demands are deemed to be a threat, a challenge or a harm-loss in a specific situation (Folkman & Lazarus 1980). Notably, stress should not be understood solely as a negative force, since it may motivate a person to excel (Lazarus 2006). Stress does not exist in the event (i.e., is not a stimulus), nor it is a response; it occurs as a result of an interaction between a person and the environment (Folkman 1984, 1985). Folkman (1984, p. 840) defined stress as “a particular relationship between the person and the environment”. This relationship is bidirectional and reciprocal: a person affects and is affected by the environment (Folkman 1984). The mediators for this transactional relationship are appraisal and coping (Folkman & Lazarus 1980).

Stress leads the person to cognitively evaluate the event in relation to one's values, goal commitments, beliefs, and situational intentions (Folkman 1984, Lazarus 2012). Primary and secondary appraisals are evaluations of what is at stake (primary appraisal) and what coping resources are available (secondary appraisal) (Folkman & Lazarus 1980). To be more precise, primary appraisal refers to judgments regarding whether a transaction is irrelevant (no significance for well-being), benign-positive (not taxing and only positive outcomes), or stressful (taxing and potentially negative outcomes). However, these judgments are not mutually exclusive, since one transaction can include outcomes that are appraised as both positive and negative. (Folkman 1984.) In the context of health, this is often the case, since medical interventions (e.g., surgery) are expected to improve one's health, yet are stressful events with risks of adverse outcomes. In the case of a stressful transaction, a person evaluates further if the transaction is harm/loss (damage or loss occurs), threat (potential harm or loss), or challenge (an opportunity for growth, mastery or gain), and proceeds to secondary appraisal (Folkman & Lazarus 1980, Folkman 1984, Lazarus & Folkman 1984).

Secondary appraisal refers to evaluation of available coping resources and options (Folkman 1984). Again, multiple options are identified. A person may appraise the need of constructive actions, more information, acceptance, or holding back from acting (Folkman & Lazarus 1980, Lazarus & Folkman 1984). Secondary appraisal refers to control, which are generalized beliefs and situational appraisals of the controllability of the encounter and outcome (Folkman 1984). Need for constructive actions or more information indicate the sense of controllability, while acceptance and holding back from acting indicate that a person perceives the situation as less controllable (Folkman & Greer 2000). A sense of control refers also to generalized beliefs about a person's own competence to handle the situation (also called self-confidence, mastery, or sense of coherence), and the person's motivation and goals (Lazarus & Folkman 1987). Primary and secondary appraisals determine the degree of experienced psychological stress (Folkman & Lazarus 1980).

Lazarus & Folkman (1984, p. 141) define coping "as constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person." The definition highlights coping as a process independently of its outcome (Folkman 1984, Lazarus & Folkman 1984). The actions the person actually performs are significant, regardless of how beneficial those actions are (Lazarus & Folkman 1984). Previous works have stated that coping strategies should not be judged as good or beneficial and bad or deleterious (Lazarus & Folkman 1984, Folkman 1984). However, subsequent studies associate avoidant coping strategies with negative outcomes, such as physical symptoms (Billings et al. 2000), and avoidant coping strategies are also described as dysfunctional by some researchers (Shaw et al. 2013, Horwitz et al. 2015b). Lazarus and Folkman (1987) suggested that the "goodness" of coping strategies depends on the user, the time of use, environmental and intra-psychic factors, and the outcomes.

Coping has two functions: to regulate the emotions or distress (emotion-focused coping) and to manage the problem (problem-focused coping) (Folkman & Lazarus 1980, Folkman 1984). These two dimensions are often used simultaneously to cope with stress, particularly in the most stressful situations (Folkman & Lazarus 1980, Folkman & Lazarus 1985). Furthermore, the complexity of a stressful encounter leads to employment of both problem-focused and emotion-focused strategies (Folkman & Lazarus 1980, Lazarus 1993). Moreover, a third type of coping has also been identified, called meaning-based coping. This refers to relinquishment of untenable goals and formulation of new, achievable goals (Park & Folkman 1997, Folkman & Greer 2000). Furthermore, short-term time-outs without actual avoidance have been identified as a coping strategy, such as peaceful moments or temporary respites during a stressful situation (Folkman & Moskowitz 2000a). Individual differences in emotion reflect differences in coping strategies, that is, coping strategies differ from person to person

(Folkman & Lazarus 1985). For example, persons with depressive symptoms choose more coping strategies of seeking support and wishful thinking than persons without such symptoms (Coyne et al. 1981). The coping process is dynamic and situational; the person changes the coping strategies during the process, in accordance with the situation and the environment. (Folkman et al. 1986, Lazarus 1993.)

The relationship between a person and the environment ties up stress, appraisal, and coping. The person is in a reciprocal relationship with the environment: the person affects and is affected by the environment. (Folkman & Lazarus 1980.) Stress occurs from this relationship (Folkman & Lazarus 1980), and a person and environment are not separable: an event in the environment is meaningless without a person to be affected, and vice versa (Lazarus & Folkman 1987). Furthermore, appraisal and coping are affected by the environment, since the environment enables or inhibits a person in selecting appraisal alternatives and in mobilizing coping strategies. In fact, Folkman & Lazarus (1980) found high variability of coping strategies among the same people from one stressful situation to another. This led them to suggest that person-environment and situational factors influence the selection of coping strategies, not static personal factors. In general, appraisal and coping are seen as mediators in the person-environment relationship. (Folkman & Lazarus 1980.) This is an ongoing cycle: Changes in a person-environment relationship lead to reappraisal of the situation, which leads to mobilizing appropriate coping strategies. Such strategies then alter the person's thoughts and feelings about the situation or alter the situation, which will lead to reappraisal (Folkman & Lazarus 1980, Lazarus & Folkman 1984). Situations perceived as highly controllable (i.e., person appraised the need for constructive actions or information) lead the person to mobilize problem-focused coping strategies; in the case of less-controllable situations (appraised as need of acceptance or holding back from acting), emotion-focused strategies predominate (Lazarus & Folkman 1984, Folkman & Greer 2000).

Numerous outcomes have been identified as a result of the transactional process. The immediate event outcome is the person's judgment of how successfully the encounter was resolved (Folkman et al. 1986, Folkman & Greer 2000). The judgment is subjective, as it is based on the person's individual goals, values, and expectations (Folkman et al. 1986). As described earlier, the unsatisfactory outcome is not the final outcome, but it leads to new appraisal and mobilization of different, often meaning-based, coping strategies (Folkman & Greer 2000). Furthermore, coping is a mediator of positive and negative emotions (Folkman & Lazarus 1988), as emotion outcome can be either positive emotion or distress (Folkman & Greer 2000). Positive reappraisal, goal-directed problem-focused coping, and creation of positive meaning with the event are associated with positive affect (Folkman & Moskowitz 2000b). Long-term effects include psychological well-being, somatic illness or health, and social functioning

(Lazarus & Folkman 1987). However, the outcomes are measured mainly subjectively; more objective measurement of outcomes of coping, such as behavioral and health-related outcomes, is needed (Lazarus 2000).

Recently, the theory of stress, appraisal and coping has been expanded. The studies of dyadic coping have suggested that it is not simply the sum of two individual's coping strategies (Folkman 2009). Furthermore, proactive coping (i.e., coping with a presumed stress) has been identified (Folkman 2009).

To sum up, stress is a result of imbalance between a person's resources and environmental demands. Stress initiates the ongoing cycle of appraisal and selection of coping strategies. Coping strategies aim to regulate the person's feelings (emotion-focused strategies) and change the demand (problem-focused strategies), and typically these two forms of coping occur simultaneously. Avoidant coping strategies are associated with negative outcomes. As a result of adequate appraisal and use of coping strategies, the person achieves equilibrium again.

2.3.2 Mothers' stress in a neonatal intensive care unit and after discharge

Stress in preterm infants' mothers has been widely studied. A systematic search identified 30 studies that describe maternal stress in NICU and post-discharge, up to 12 months of an infant's corrected age. Furthermore, one Finnish study (Järvinen et al. 2013) was found by hand search. All of the studies used the quantitative approach. Maternal stress was measured with two well-established instruments. Parent Stress Scale: Neonatal Intensive Care Unit is used to measure NICU-related stress (Melnik et al. 2006, Lau et al. 2007, Holditch-Davis et al. 2009, Zerkowitz et al. 2011, Marticardi et al. 2012, Montirosso et al. 2012, Morey & Gregory 2012, Habersaat et al. 2013, Järvinen et al. 2013, Shaw et al. 2013, Montorosso et al. 2014, Pritchard & Montgomery-Hönger 2014, Shaw et al. 2014, Hoffenkamp et al. 2015, Horwitz et al. 2015a, 2015b, Samra et al. 2015, Baía et al. 2016, Park et al. 2016, Pichler-Stachl et al. 2016). It has 26-34 items, and three dimensions: Sights and Sound, Infant's Behavior and Appearance, and Parental Role Alteration. In some studies, the fourth dimension with 12 additional items, called Staff Behavior and Communication, have been added (Melnik et al. 2006, Pritchard & Montgomery-Hönger 2014, Samra et al. 2015). The scale has acceptable psychometric properties. The second scale is Parenting Stress Index, which is used to measure parental stress post-discharge (Candelaria et al. 2006, Kaarsen et al. 2006, Gray et al. 2012, Ravn et al. 2012, Tallandini et al. 2012, Spinelli et al. 2013, Edwards et al. 2016). The scale has a long version (101-123 items), which includes three dimensions (Child Characteristics, Parental Characteristics, Life Stress) with several sub-dimensions. The short version (36 items) also has three dimensions

(Parenting Distress, Parent-Child Dysfunctional Interaction, and Difficult Child). This scale is a basis for several translated versions, such as the Swedish Parenthood Stress Questionnaire (Flacking et al. 2013, Mörelius et al. 2015), and Nijmeegse Ouderlijke Stress Index (Dutch, Meijssen et al. 2010). The psychometric properties have been well established. Another scale to measure maternal stress post-discharge was also identified, as Holditch–Davis et al. (2009, 2014) and Cho et al. (2016) used The Parental Stress Scale: Prematurely Born Child. This scale is also internally consistent.

Surprisingly, high levels of stress among preterm infants' mothers have not been found. During the NICU stay, the overall stress is low to moderate, with means ranging from 1.8 (Järvinen et al. 2013) to 4.0 (Baía et al. 2016), range 1–5. The highest levels of stress are in Parental Role Alteration, with means ranging from 2.4 (Järvinen et al. 2013, Pritchard & Montgomery–Hönger 2014) to 4.1 (Baía et al. 2016). Parental role stress is lower at the time of discharge than during the first weeks after the NICU admission (Zelkowitz et al. 2011, Marticardi et al. 2012), regardless of interventions. The lowest levels of stress have been measured in Staff Behavior and Communication, means ranging from 0.9 (Melnik et al. 2006) to 2.9 (Samra et al. 2015). After the infants' discharge, stress levels are also moderate. For up to two months of corrected age, moderate stress levels of ($M = 2.3$) have been measured (Flacking et al. 2013, Mörelius et al. 2015) (range 1–5). At four months, maternal stress levels are also moderate, $M = 205.2$ (range 136–320) (Spinelli et al. 2013), and $M = -34.65$ (range -60...+5) (Candelaria et al. 2006). The interpretations of the results were hampered by the fact that minimum and maximum values of the scales have not been reported in several reports (Kaaresen et al. 2006, Meijssen et al. 2010, Ravn et al. 2012, Tallandini et al. 2012, Cho et al. 2016). Some studies indicate that stress levels decrease significantly over time (Marticardi et al. 2012, Tallandini et al. 2012, Järvinen et al. 2013), but similar stress levels at different time points have also been reported (Kaaresen et al. 2006, Mörelius et al. 2015).

The studies have identified several factors that are associated with maternal stress. Infants' low pain management (Montirosso et al. 2014), singleton pregnancy (Baía et al. 2016), length of hospitalization, and lower socio-economical resources (Montirosso et al. 2012) have been associated with higher NICU-related stress. Longer hospitalization periods for maternal antepartum have also been associated with stress regarding sights and sounds of the NICU (Pichler–Stachl et al. 2016). Samra et al. (2015) and Cho et al. (2016) identified association between skin-to-skin contact/kangaroo care and NICU-related maternal stress, but Flacking et al. (2013) or Mörelius et al. (2015) did not find such association between skin-to-skin contact and maternal stress post-discharge. Mothers have reported higher stress levels than fathers in NICU (Marticardi et al. 2012, Järvinen et al. 2013, Baía et al. 2016). After discharge, several factors have been associated with higher maternal stress: cumulative psychological risk (Candelaria et al.

2006), psychological distress (Meijssen et al. 2010), poor dyadic adjustment (Gray et al. 2012, Edwards et al. 2016), impaired couple relationship (Edwards et al. 2016), maternal older (Flacking et al. 2013) or younger age (Meijssen et al. 2010), incubation care (Flacking et al. 2013), and absence of a partner (Meijssen et al. 2010). Interestingly, infant's birth weight, GA (Kaaresen et al. 2006) or cumulative medical risk (Candelaria et al. 2006) have not been associated with maternal stress after NICU hospitalization. In fact, maternal stress levels have not differed significantly between preterm and full term among healthy infants' mothers (Gray et al. 2012). However, Spinelli et al. (2013) reported an association with infant's medical risk and maternal stress post discharge.

Associations remain conflicting between stress, post-traumatic stress disorder (PTSD), depression, and anxiety. Zerkowitz et al. (2011) and Habersaat et al. (2013) did not find an association between stress and PTSD, but other study did find such an association (Holditch–Davis et al. 2009). Interestingly, Shaw et al. (2014) found that mothers with higher NICU-related stress had lower PTSD scores (Shaw et al. 2014). Maternal stress have been associated with depressive symptoms (Holditch–Davis et al. 2009, Järvinen et al. 2013, Spinelli et al. 2013), but findings from Zerkowitz et al. (2011) contradicted that association. An association between state anxiety and stress has been found (Holditch–Davis et al. 2009). Maternal stress has been associated with perceived vulnerability of an infant (Horwitz et al. 2015a, 2015b).

Lau et al. (2007) described the association between stress and maintenance of milk expression. They found that higher stress levels in parental role alteration were negatively correlated to milk expression frequency (Lau et al. 2007). Furthermore, higher stress level in parental role alteration has been associated with lesser use of developmentally supportive behaviors during bottle-feeding (Park et al. 2016).

To sum up, the mothers of preterm infants suffer from low to moderate stress during the NICU hospitalization. The greatest levels of stress have been measured during the first weeks of admission, and in parental role execution in the NICU environment. Collaboration and communication with staff are the least stressful elements for the mothers. After discharge from NICU, the reported stress levels are moderate, and the effects of time on maternal stress remain conflicting. Several maternal characteristics have been identified as associated with stress, but the results are highly conflicting. Cumulative psychological risks, including lower socio-economical resources and psychological distress, as well as poor dyadic adjustment, have been consistently associated with higher levels of maternal stress. Associations between PTSD, depression, and stress remain also unclear and conflicting. Association between maternal stress and lactation has been studied minimally. The discrepancies of the results are not surprising, however, because two important mediators exist between stress and outcome: appraisal and coping, as discussed in the previous chapter (Folkman 1984)

2.3.3 Mother's coping with the birth of a preterm infant

Mothers' coping strategies during the NICU stay and postdischarge have been explored in three qualitative, three quantitative, and one mixed-method studies. Two of the studies (Cervantes et al. 2011, Baum et al. 2012) described VLBW infants' mothers' strategies.

Several emotion-focused coping strategies have been identified in qualitative studies. Premature birth have been viewed in a positive light, as the mothers frame preterm birth as a lifesaver for a baby (Baum et al. 2012), believe that things happen for a reason (Rossman et al. 2015), and frame infant's oxygen therapy in a positive light (Cervantes et al. 2011). Spirituality and religiousness have also been identified as an emotion-focused strategy. The mothers perform religious and spiritual thoughts and actions (Rossman et al. 2015, Baum et al. 2012), use magical means by avoiding actions (e.g., avoid talking about the infants' progress) that could have caused a "bad eye" (e.g., reverse progress) for their infants, (Baum et al. 2012), and blame themselves or someone else for causing the premature birth by a "bad eye" (Baum et al. 2012).

Seeking information and support have been identified as a problem-focused coping strategy. The mothers join discussion groups to gain peer support (Goutaudier et al. 2011), and talk with a trusted person (Rossman et al. 2015). They also look for information, ask questions, and try to stay informed about their infants' condition and progress (Goutaudier et al. 2011, Rossman et al. 2015). On the other hand, the mothers also spend time outside the hospital to have a break (Goutaudier et al. 2011), and write in a journal (Rossman et al. 2015). Another coping strategy is to regulate the distance between mothers and their infants. Some mothers spend a lot of time with their infants in order to repair things or fight fears of death (Goutaudier et al. 2011), and build a maternal relationship by collaborating with a health care staff or performing motherly functions (Baum et al. 2012). Notably, expressing milk has been recognized as one motherly function (Baum et al. 2012). Conversely, some mothers withdraw from contact with the infant as a protective coping strategy (Rossman et al. 2015). The coping strategies differ from mother to mother (Goutaudier et al. 2011).

Maternal coping strategies have been measured with two scales: The Brief COPE, which has 28 items, two adaptive coping scales (emotion- and problem-focused coping) and one maladaptive scale (dysfunctional) (Shaw et al. 2013, Horwitz et al. 2015b). The scale is internally consistent (Shaw et al. 2013, Horwitz et al. 2015b). Another scale is The Coping Health Inventory, with 44 items and 3 sub-scales: maintaining family integration, cooperation, and an optimistic definition of the situation (Rowe & Jones 2010). Notably, these scales have not been developed to specifically measure coping strategies of preterm infants' mothers. According to quantitative studies, the mothers cope most by integrating, followed by coping by

consultation and coping by support/stability both in the NICU and post-discharge (Rowe & Jones 2010). The exact frequency of coping strategies have been impossible to evaluate, because the study reports (Horwitz et al. 2015b, Rowe & Jones 2010) did not present minimum and maximum values for the scales. Positive correlation between maternal education and the use of coping strategies have been found (Shaw et al. 2013). Furthermore, the use of dysfunctional coping strategies have been associated with a risk of PTSD (Shaw et al. 2013) and perceiving an infant as vulnerable (Horwitz et al. 2015b).

To conclude, several emotion- and problem-focused coping strategies have been identified. In qualitative studies, religious strategies, as well as gaining peer support and information, are prevalent. Coping strategies have been measured with two scales, but both of these are general scales—not developed especially for preterm infants’ parents. Some outcomes of coping strategies have been identified, but these focus on dysfunctional coping.

2.4 Summary of the literature review

To conclude, prematurity is a risk for mortality and morbidity of an infant. Providing breast milk significantly decreases mortality and morbidity during the intensive care, and it has also positive long-term effects. The advantages of mothers’ own breast milk cannot be covered fully with donor breast milk. Although the hormonal mechanisms that initiate lactation are similar in preterm and full term infants’ mothers, several factors do interfere with lactation. One of the factors is expression, which is essential to initiate and maintain lactation in a situation when a preterm infant is unable to breastfeed. The mothers have to initiate expression and maintain sufficient expression frequency in a stressful situation. The most stressful time period is the first weeks from admission, and the most stressful is altering parental roles in the NICU context. The mothers cope with this stress by emotion-focused strategies and problem-focused strategies. Dysfunctional coping strategies are associated with negative outcomes, such as a risk of post-traumatic stress disorder and perceiving an infant as vulnerable.

The mothers’ experiences and practices related to breast milk expressing are relevant, since adequate lactation—and consequently the infant’s chance to receive essential breast milk—are fully dependent on mothers’ motivation, tolerance and ability to maintain sufficient expression frequency in a stressful situation. Despite this, mothers’ experiences of or practices with milk expressing have not been fully studied. Furthermore, expression-related stress, coping strategies, or managing with expressing have not been measured. Previous study findings are combined in a framework and are presented in figure 1.

| | | | |
|------------------------------|---|---|--|
| Event | Preterm birth | | |
| Impact on | Infant | Lactation | Mother |
| Reaction /consequence | Risk of mortality Risk of morbidity Sepsis NEC Intracranial bleeding ROP RDS BPD Neurological disabilities Social difficulties, ADHD | Impeding factors Maternal medications Lower basal prolactin levels Stress Lack of frequent stimulation Inadequate removal of milk Lack of skin-to-skin contact | Stress Moderate level Highest during the first weeks The most stressful parental role alteration |
| Mediators | Interventions Antenatal corticosteroids Obstetrical interventions Ventilation treatment Surfactants Infection prevention Breast milk | | Coping Emotion-focused Problem-focused Dysfunctional Maintaining family integration Cooperation Optimistic definition Integrating Consultation Support/Stability |
| Outcomes | Reduced by breast milk NEC Sepsis ROP Long-term growth failure Neurodevelopmental disabilities Hospitalization Metabolic syndrome Hypertension | | Equilibrium Dysfunctional coping Risk of PTSD Perceiving an infant as vulnerable |
| Context | Sociodemographic characteristics. NICU environment. Counseling and support. | | |

Figure 1. Framework of the study

3 Aims of the study

The general aim of this study was to describe and explain preterm infants' mothers' experiences and practices (i.e. initiation and frequency of expressing, the amount of expressed milk) of and coping with breast milk expression. The aims of the first phase were to describe mothers' experiences with expressing breast milk for preterm infants and to describe mothers' coping strategies in milk expression. In the second phase of this study, the aims were to evaluate the psychometric properties of the developed Coping with Milk Expressing for Preterm Infant (CMEPI) scale; to explore the association of mothers' and infants' characteristics to milk expression practice; use of breast milk in NICU; to explore the association of mothers' and infants' characteristics to expression-related stress, use of coping strategies, and managing with expressing; and finally, to explore the association of expression-related stress, coping with expressing frequency and managing with expressing. The study topics within the study framework are presented in Figure 2.

The research questions were as follows:

First phase

1. What kind of experiences do the preterm infants' mothers have in breast milk expression and breastfeeding? (Articles I, II)
2. What kind of coping strategies do the mothers of preterm infants use with milk expressing? (Article III, summary)

Second phase

3. What are the psychometric properties of Coping with Milk Expressing for Preterm Infant scale? (Article III)
4. What is the association between the mothers' and infants' characteristics to expressing practices: initiation and frequency of expressing, and exclusive use of mothers' own milk in NICU settings? (Article IV)
5. What is the association between mothers' and infants' characteristics, expression-related stress, coping strategies, and managing with expressing? (Summary)
6. What is the association between expression-related stress, coping strategies, expressing frequency, and managing with expressing? (Summary)

| | | | |
|------------------------------|---|---|--|
| Event | Preterm birth | | |
| Impact on | Infant | Lactation | Mother |
| Reaction /consequence | Risk of mortality Risk of morbidity Sepsis NEC Intracranial bleeding ROP RDS BPD Neurological disabilities Social difficulties, ADHD | Impeding factors Maternal medications Lower basal prolactin levels Stress Lack of frequent stimulation Inadequate removal of milk Lack of skin to skin contact Experiences Expressing-related stress | Stress Moderate level Highest during the first weeks The most stressful parental role alteration |
| Mediators | Interventions Antenatal corticosteroids Obstetrical interventions Ventilation treatment Surfactants Infection prevention Breast milk | Expressing-related coping strategies | Coping Emotion-focused Problem-focused Dysfunctional Maintaining family integration Cooperation Optimistic definition Integrating Consultation Support/Stability |
| Outcomes | Reduced by breast milk NEC Sepsis ROP Long-term growth failure Neurodevelopmental disabilities Hospitalization Metabolic syndrome Hypertension | Managing with expressing Expressing frequency | Equilibrium Dysfunctional coping Risk of PTSD Perceiving an infant as vulnerable |
| Context | Sociodemographic characteristics. NICU environment. Counseling and support. | | |

Figure 2. The study topics within the study framework.

Note: Lighter font in the figure indicates topics which have been studied in previous studies and thus forms framework of the study. Black font indicates the study topics which were described and/or measured in this study.

4 Methodology and methods

4.1 Design

The study follows the traditional pathway from qualitative phase through instrumentation to quantitative phase (Polit & Beck 2012). In the first phase, mothers' experiences with milk expression were explored with qualitative descriptive design (Sandelowski 2010). During this phase, the concept of coping was identified, and the study proceeded via secondary analysis (Long-Sutthall et al. 2010) to identify maternal coping strategies in milk expression. The quantitative phase of the study consists of developing a scale to measure mothers' expression-related coping strategies, measuring the psychometric properties of the developed scale, and measuring mothers' expression practices and coping strategies (Polit & Beck 2012, Kellar & Kelvin 2013). The design of both phases of the study is presented in Table 1 and 2, respectively. In the following sections, qualitative (Phase I) and quantitative (Phase II) materials and methods are described.

Table 1. Design of the qualitative phase of the study

| Aims | Materials | Analysis methods | Reported |
|---|---|-----------------------------|----------------------|
| To describe mothers experiences with breast milk expressing and breastfeeding | Previous studies (n = 23) | Inductive thematic analysis | Article I |
| To describe mothers' experiences with milk expressing | Mothers' answers to an electronic questionnaire with open-ended questions (n = 130) | Inductive content analysis | Article II |
| To describe mothers' coping strategies in milk expressing | Previous studies (n = 23) and mothers' answers to an electronic questionnaire with open-ended questions (n = 130) | Deductive content analysis | Article III, summary |

Table 2. Design of the quantitative phase of the study

| Setting | Aim | Materials | Measures | Analysis methods | Reported |
|----------------------------------|---|---|--|---|-----------------|
| Cross-sectional and longitudinal | To evaluate the psychometric properties of the developed Coping with Milk Expressing for Preterm Infants (CMEPI) scale | Expert panel (n = 5), NICU–hospitalized infants’ mothers’ answers to a paper-based survey (n = 129) and NICU–graduated infants’ mothers’ answers to an electronic survey (n = 45) | Demographics Secondary Appraisal of Milk Expressing (SAME) CMEPI Managing with expressing Expression frequency | Content Validity Indexes Descriptive statistics Item analysis Binary analysis (Spearman rho, Mann Whitney U) Multivariate analysis (Exploratory factor analysis, Linear regression) Reliability tests (Cronbach alpha, Spearman rho) | Article III |
| Cross-sectional | To explore mothers’ and infants’ characteristics’ association with milk expression practices and exclusive use of own mothers’ milk | NICU–hospitalized infants’ mothers’ answers to a paper-based survey (n = 129) | Demographics Expression-related stress Expression initiation and frequency Index of Breastfeeding Status (IBS) | Descriptive statistics Binary analysis (Mann Whitney U) Multivariate analysis (Logistic regression) | Article IV |
| Cross-sectional | To explore mothers’ and infants’ characteristics’ association with expression–related stress, coping strategies, and managing | NICU–hospitalized infants’ mothers’ answers to a paper-based survey (n = 129) | Demographics Expression-related stress CMEPI Managing with expressing Expression frequency IBS | Descriptive statistics Binary analysis (Two–tailed independent samples t test) Multivariate analysis (Linear regression) | Summary |
| Cross-sectional | To explore the associations between expression–related stress, coping strategies, managing, and expressing frequency | NICU–hospitalized infants’ mothers’ answers to a paper-based survey (n = 129) | Demographics Expression-related stress CMEPI Managing with expressing Expressing frequency | Bivariate analysis (Pearson product moment correlation) Multivariate analysis (Linear regression, Mediation analysis) | Summary |

4.2 Phase I: Describing the mothers' experiences and coping strategies of milk expressing

4.2.1 Review of previous studies

The study was initiated by a review with the purpose of reviewing previous studies to detect potential gaps of knowledge, previous theoretical frameworks, and applied methodological approaches (Evans 2007). Integrative review (Article I) was conducted to describe preterm infants' mothers' experiences with breast milk expression and breastfeeding (research question 1). The data were collected via Medline, CINAHL, PsycInfo, and Cochrane databases. The conceptual and operational definitions of concepts of population, phenomena of interest, and context were determined (Joanna Briggs Institute 2011). Furthermore, inclusion and exclusion criteria were defined as follows: preterm infant was defined as an infant born before or at 36+6 gestation weeks or weighing less than 2500 grams at birth. Mothers of full-term infants, as well as other family members or healthcare professionals, were excluded. Expression was defined as breast-pumping with hands or with a pump to provide mothers' own milk for preterm infants. Breastfeeding was direct breastfeeding with or without a nutritive purpose. Furthermore, the context was NICUs in developed countries; both NICU-hospitalized and NICU-graduated infants' mothers were included. The searches were conducted using the following terms: breastfeeding/milk expression/lactation/milk ejection, and low birth weight/very low birth weight/premature/extremely premature infant/intensive care, neonatal/intensive care units, neonatal/premature labor/birth/childbirth, and family/multiparas/primiparas/mothers/maternal behavior/maternal role/mother-child relations/mother-infant relations/parental-infant bonding. English-language and publication years 2002-2014 were used as limitations. The searches resulted in 1701 citations. Of those, 1531 were excluded by title, 28 due to duplications, 78 by abstracts, and 41 by full texts, resulting in 23 studies. The data were collected from February to August 2013, and updated in November 2014.

4.2.2 Primary analysis of previous studies

The studies were evaluated for quality using Qualitative Assessment and Review Instrument (QARI) and Meta Analysis of Statistics Assessment and Review Instrument (MAStARI) (Joanna Briggs Institute 2011). None of the studies were excluded due to poor quality. The majority of the included studies were conducted in North America (n = 11, 47.8%), used descriptive qualitative design (n = 11, 47.8%), were conducted

during the infant's hospitalization (n = 13, 56.5%), and had good quality (n = 20, 87.0%).

Integrative review was selected as an appropriate method, since the data were heterogeneous regarding methodological designs, time frame, breastfeeding methods (expression/breastfeeding), and infants' GA at birth. Integrative review has an advantage over integrating diverse experiences using qualitative methods (Whittemore & Knafl 2005). The studies were read several times. To achieve a comprehensive and interpretative representation of heterogeneous and generous data, thematic analysis was selected (Braun & Clarke 2006). The relevant data were extracted to items, which were then coded. The codes were further united to groups, and the groups formed subthemes and themes (Braun & Clarke 2006). Conclusion-drawing and verification by returning to the primary data and presenting supporting and conflicting evidence together with the results finished the analysis process (Whittemore & Knafl 2005). During the analysis process, a reflective diary was written.

4.2.3 Narratives collection and participants

With the aim to further answer research question 1, the data describing mothers' experiences with milk expression (Article II) were collected. The data consisted of narratives of 130 mothers. The data were collected in a development project called Unimpeded Breastfeeding, coordinated by the Finnish Breastfeeding Peer Support Association. The project took place in 2011–2013 in collaboration with 12 peer support associations. The data were collected in collaboration with Finland's Association of Premature Babies' Parents. The nationwide project aimed to identify barriers of breastfeeding and overcome them with peer support (Imetyksen tuki ry 2014). The project was funded by Finland's Slot Machine Association.

The data were collected from February to March 2013. The Internet-based questionnaire with open-ended, thematic questions was administered via both associations' Facebook pages. The short invitation described the aim of the project, the procedures, and the inclusion criteria. A clear statement that the answers will be used for research purposes was provided. The link led the potential participant to an information sheet which provided information about the aim of the project and the research, voluntariness and confidentiality. Proceeding to questions was considered consent to participate.

The questionnaires were administered using ZEF-software, an Internet-based program for collection of both qualitative and quantitative data (Zef 2017). The questionnaire consisted of closed-ended questions about demographic variables (mothers' age, education, previous breastfeeding experience, length of previous

breastfeeding, infant's GA at birth, birth weight, length of hospitalization in NICU, and a child's age at the time of answering). Open-ended questions were as follows: How did you initiate pumping? How did you feel when pumping for the first time? How did the pumping continue? What kind of feelings did you experience during pumping? What kind of support motivated you to continue pumping? What was hard for you? The questionnaire consisted also of questions about expression counseling, breastfeeding, and kangaroo care, but these results have been reported elsewhere (Ikonen et al. 2016, Vänni et al. 2016, Myllymaa et al. 2017). The inclusion criteria were as follows: a mother of preterm singleton, twin, or multiple infant(s) (born at <37 gestation weeks or birth weight < 2500 grams), the infant(s) were hospitalized in NICU, and the mother has milk-expressing experience. The child's age at the time of participating was not used as exclusion criteria, since the aim was to gather heterogeneous and varied data.

In total, answers were initiated by 201 participants. Of those, 150 participants completed the questionnaire. Furthermore, 20 participants were excluded because infants were admitted to a maternity ward ($n = 6$), the lack of pumping experience ($n = 8$), and substantial amount of missing data ($n = 16$). Maternal mean age was 33.8 years ($SD = 5.6$, range 21–50), and they were highly educated (73.1 %, $n = 95$ of respondents held college or university level degree). Over half of the mothers (58.5 %, $n = 76$) had previous breastfeeding experience; the mean length of previous breastfeeding was 12.4 months ($SD = 10.5$, range 0–61 months). The infants' mean GA at birth were 31 gestation weeks ($SD = 3.7$, range = 23–38), and mean birth weight 1642 grams ($SD = 721.9$, range 550–3550). The children's mean age at the time of participation were 3.9 years ($SD = 4.3$, range 0–20), albeit almost half of the children (42.3%, $n = 33$) were less than two years old.

4.2.4 Primary analysis of narratives

To answer research question 1, the data were analyzed with inductive content analysis. The aim was to reach a data-rich, structured description of maternal experiences of breast milk expression (Graneheim & Lundman 2004, Elo & Kyngäs 2008, Sandelowski 2010). Written data were checked for accuracy and read several times to reach an overall idea of the content. The meaning unit was defined as a mother's response to a single question. The length of the unit ranged from two word to six sentences, and conveyed the same central meaning (Graneheim & Lundman 2004). Codes ($n = 768$) were extracted from the meaning units, and classified to internally homogenous and externally heterogeneous sub-categories. The sub-categories were then united by their semantic content to categories and main categories (Graneheim &

Lundman 2004, Elo & Kyngäs 2008). As a result of the analysis, an underlying meaning, the theme, was identified (Graneheim & Lundman 2004). A reflective diary was written during the analysis process. The main purposes of the diary were to recognize similarities and controversies between maternal narratives and the researcher's pre-understanding and to make reasoning behind the analysis process more visible.

The data were quantified using the present/absent method, and frequencies were calculated in relation to the total number of respondents. The frequencies of the categories and demographic characteristics were analyzed using descriptive quantitative methods. The inductive content analyses were performed using MS Word, and the frequencies were calculated with IBM SPSS Statistics for Windows (Armonk, NY, IBM Corp), version 21.0.

4.2.5 Secondary analysis of previous studies and narratives

The secondary analysis was conducted to answer research question 2. According to the integrative review (Article I), preterm infants' mothers' milk expression efforts have not been studied from the viewpoint of coping. The concept of coping was found during the analysis of the review. Previous studies have used the concept of adaptation to describe maternal efforts in expression (Flacking et al. 2006, Hurst et al. 2013). The review suggested that coping, as a process-oriented, situational, and non-judgmental concept (Folkman 1984) could be suitable for describing this phenomenon. Furthermore, expression was identified as a stressful and demanding task that taxes maternal resources. Mothers' ability to regulate the time and efforts they spend on expressing, as well as their efforts to master their milk supply, were identified as part of a concept of controllability, one of the central concepts in the TTSC (Folkman 1984). Both emotion- and problem-focused coping strategies were initially identified in the review. These findings suggested the suitability of coping as a guiding concept in scale development.

Mothers' narratives (n = 130) and studies from integrative review (n = 20) were used to identify maternal coping strategies. The dataset of integrative review (n = 23) were reviewed, and studies related to milk expression were extracted. The excluded three studies discussed only experiences related to breastfeeding, not expressing. The data collection methods have been described earlier.

Secondary analysis is a method of determining answers to research questions that differ from those answered in primary analyses (Long–Sutthall et al. 2010). To evaluate the eligibility of the datasets for secondary analysis, the research questions and methodology applied to the primary studies were compared with those underlying the

targeted secondary analysis (Thorne 1994, Long–Sutthall et al. 2010). The research questions in the primary studies were intended to comprehensively explore mothers' experiences with milk expressing; the concept of coping emerged during the primary analyses, thus supporting the suitability of these studies for secondary analysis (Thorne 1994, Long–Sutthall et al. 2010). Both the primary and secondary analyses used a qualitative descriptive design, which also supported the eligibility of the studies for a second round of examination (Thorne 1994, Long–Sutthall et al. 2010).

Integration is a method for analyzing two datasets independently so that their interdependence is identified (Creswell & Plano Clark 2010). It was deemed appropriate because the qualitative data, which provided rich, detailed narratives, complemented the study reports, which contained abstract and broad descriptions of the phenomenon being studied. The two datasets were analyzed individually, after which the results were combined when the subcategories of coping strategies were formulated.

The deductive content analysis was conducted to identify maternal coping strategies. An unconstrained categorization matrix (Elo & Kyngäs 2008) was developed on the basis of the coping strategies defined by Lazarus and Folkman (1984). The unconstrained categorization matrix is presented in table 6 (page 64). Meaning units were extracted from both datasets, condensed, and coded into the categorization matrix (Elo et al. 2014). In the next phase, the coded meaning units were inductively analyzed to form subcategories. The aim was to create subcategories within the bounds of the unconstrained matrix using the principles of inductive content analysis (Elo & Kyngäs 2008). The subcategories from both datasets were then compared and, if possible, combined.

4.3 Phase II: Measuring mothers' expression–related practices, stress, coping strategies, and managing

4.3.1 Scale development and evaluation of translational validity

As previously described, mothers' stress and coping strategies have been studied in NICU and post-discharge settings. However, it was suggested that, because of several concurrent stress sources, a general scale would not be valid to measure expression-related coping strategies. The initial identification of such strategies suggested also that, albeit the suitability of the division of the strategies to emotion- and problem-focused strategies, the strategies differed from general strategies on a practical level. Importantly, the strategies to cease the source of stress were not covered in the general

scale, apparently because most of the stressful situations—like illness, economic difficulties, and death of a relative—are not possible to cease. These findings suggested the need to develop a new scale. The decision to choose a situation-oriented approach led to situation-specific, non-generalizable scale (Folkman & Lazarus 1980). For more general use, scales measuring coping strategies in NICU context are available (e. g. the Brief COPE, Carver 1997).

The items of the CMEPI scale were formulated from the results of the deductive analysis. The Classical Measurement Theory was used as a base of the operationalization (Streiner & Norman 2003, Polit & Beck 2012). The theory led to development of a scale in which every item has an equal weight and intensity; the items are similar to each other and are presumed to be comparable indicators of the underlying construct (i.e., latent variable), and in which the response scale is bipolar and similar in each items (Streiner & Norman 2003, Polit & Beck 2012). The goal of the first phase of item generation was to freely record a large pool of items (DeVellis 2003). The first round generated 357 items, which were then reviewed to identify and discard redundant and overlapping items. After two rounds of review, the number of items was reduced to 124 and finally to 61. The review and identification of redundant items were conducted by the research group, with help from seminar group of doctoral students. The process was conducted via discussion until consensus was reached.

The typology of validity and reliability by DeVon et al. (2007) were applied to examine the psychometric properties of the CMEPI scale (Table 3) and thus gain answer to the research question 3. The 61-item version of the CMEPI scale was used to evaluate its translational validity. Content validity of the developed CMEPI scale was assessed via subjective evaluations by an expert panel (Polit et al. 2007, Polit & Beck 2012). A target expert panel consisting of six members was recruited. One of the experts declined for personal reasons. The final panel consisted of two researchers with experience in scale development and research on breastfeeding, one neonatologist, one International Board Certified Lactation Consultant, and one registered neonatal nurse. The selection of the panel members was based on experience in all relevant aspects; namely, familiarity with the phenomenon of interest, expertise related to the conceptual framework, expertise in scale development, and clinical expertise (Grant & Davis 1997). The number of experts was determined on the basis of recommendations (Grant & Davis 1997, Polit & Beck 2012) and availability in a small language area. The experts were informed about the purpose of the scale, the theoretical framework, and the proposed theoretical structure of the scale (Grant & Davis 1997). The experts were requested to evaluate item relevance on a 4-point Likert scale (1 = irrelevant, 4 = highly relevant). The experts also provided additional comments regarding the items (Grant & Davis 1997). Only minor revisions in wording

were made in accordance with the comments of the experts, and no items were added or omitted. A second evaluation was therefore deemed unnecessary (Polit et al. 2007).

Face validity, which refers to a scale's grammar, syntax, appropriateness, and logical flow (DeVon et al. 2007), was evaluated by 10 preterm infants' mothers with expressing experiences. Two mothers also served as breastfeeding peer counselors, and one mother was not a native Finnish speaker. The mothers were recruited via social media. The questionnaires were sent to the mothers electronically, and the mothers replied by e-mail to open questions regarding the ease of answering and the understandability of the items.

Table 3. The typology of validity and reliability used in this study (DeVon et al. 2007)

| The types and definitions of validity and reliability | | Measures in the study |
|--|--|---|
| Construct validity | | Item analysis, factor analysis |
| A scale measures the intended construct; correspondence between the items and operationally defined concepts | Translational validity | Face A scale looks to measure it's construct; easy to understand, logical |
| | Criterion validity | Content Items covers adequately and are appropriate indicators of the scale's construct |
| | | Concurrent A sub-scale or scale correlates to theoretically associated construct |
| | | Predictive A scale is a valid predictor of an expected outcome |
| | | Convergent A scale correlates to another measure of the same construct |
| | Discriminant A sub-scale or scale does not correlate positively to theoretically different construct | |
| Reliability | | |
| The scale's ability to measure consistently the intended construct | Stability (test-retest) A scale's ability to perform stable measurements in a specific time period | Measured with correlation between two weeks |
| | Equivalence (internal consistency) Items' ability to fit together conceptually | Measured with Cronbach alpha coefficient |

4.3.2 Data collection and participants

To answer research questions 3-6, the data were collected in two hospitals in Southern Finland. One of the hospitals was a university hospital with 12 beds in tertiary care NICU and 17 beds in level II NICU. In the tertiary care NICU, only cardiac surgery and extracorporeal membrane oxygenation were outsourced to another hospital.

Another hospital was a central hospital of 10 beds on level II NICU. The infants born later than 30 GA were hospitalized in this NICU; the smaller and high-risk infants were also admitted after the treatment period in the university hospital.

The sample sizes were determined based on power analysis and general guidelines. For two-tailed independent samples t test, $n = 128$ is sufficient to eliminate type II error (Cohen's $d = 0.5$, power 0.8, $\alpha = 0.05$) (Kellar & Kelvin 2013, Soper 2017a). For linear regression, sample size of $n = 128$ allows to add at maximum of 12 predictors to the model ($f^2 = 0.15$, power = 0.8, $\alpha = 0.05$) (Soper 2017b), and in logistic regression 5–10 events per covariate is a sufficient sample size (Hosmer et al. 2013). For exploratory factor analysis (EFA), the rule of thumb is 10 participants per an item; however, sample size larger than 100 is also considered adequate (Kellar & Kelvin 2013).

Questionnaires were used to collect the data. The researcher visited the NICUs twice a week, and selected the eligible mothers with a nurse. The questionnaires were administered to the mothers by a nurse, after receiving personal instructions from the researcher. The questionnaire included a written information sheet, a consent form, and an envelope. The mothers had the opportunity to talk with the researcher in order to obtain additional information; two mothers used this opportunity. The mothers returned the consent form and the questionnaire in a closed envelope to the nurses' station, from where the researcher collected them. The data collection period took place from June 2015 to September 2016, in total 18 months.

The inclusion criteria were that a mother had preterm, singleton or twin infant(s) (< 37 gestation weeks or birth weight < 2500 grams) hospitalized in the unit. The infant's age was > 6 days, so that lactogenesis II had initiated and the mother had the experience of daily expressing. The mother had to express breast milk for her infant(s). The mothers with especially burdening situation were excluded, evaluated by the nurses. This burden may have been related or unrelated to the situation of an infant. This exclusion criterion excluded the mothers with extremely sick infants, but they were eligible to participate later.

In total, 133 questionnaires were returned; the loss was 38.4%. In total, 4 questionnaires were excluded because of missing information (> 40% of the questionnaire was not completed) ($n = 2$), and because the infant was less than six days old ($n = 2$). The final sample size was 129 mothers.

Subsequently, another dataset from discharged preterm infants' mothers was collected. This dataset was only used to evaluate the psychometric properties of the CMEPI scale (research question 3). The participants were recruited via social media (Facebook). This was selected because social media reaches 82% of young people (age 25-32 years) in Finland; of those, 89 % used social media almost daily. Facebook is the most popular social media platform; 95% of social media users used Facebook.

(Statistics Finland 2014.) The invitations were distributed to three popular groups or pages: Imetyksen tuki ry (closed breastfeeding peer support group), Kevyt-yhdistyksen ystävät-page (page for peer support association of preterm babies' parents) and Laktivistiäiti-page (page for breastfeeding related information). Together, the groups and pages had 26 102 members/followers at the time of starting data collection. The data were collected from June 2016 to September 2016.

The inclusion criteria were that the mothers had preterm (born < 37 GA of birth weight < 2500 grams) infant or twins, the infants have been discharged from a maternity ward or from NICU, the mothers expressed breast milk or had ceased expressing within 8 weeks, the mothers were over 18 years old and able to understand and fill the questionnaire in Finnish. The time limit of 8 weeks from ceasing expressing was set so that the mothers could recall the used coping strategies.

The data were collected using electronic questionnaires (e-lomake, University of Tampere). The invitation included a link to an information sheet. After reading the sheet, the potential participant proceeded to the consent form, and filled it. The link to the questionnaire was sent to the provided e-mail address. Another link to the second questionnaire was sent 12 days after the first questionnaire. The time was based on recommendations of suitable time for test-retest reliability tests (Rattray & Jones 2007). For both questionnaires, a reminder was sent after three days, if needed.

In total, 71 mothers filled out the consent form and 59 (83.1%) completed the first questionnaire. Nine mothers (15.3%) were excluded at this point because more than eight weeks had elapsed from their expressing. These mothers were informed and thanked by e-mail. The second questionnaire was sent to 50 mothers, and 33 (66.0%) of those returned it filled, and thus completed the study. Five mothers had participated during hospitalization and after discharge, and their responses were excluded from the latter dataset. The final sample size was 45 mothers in the first data collection point and 33 mothers in the second data collection point.

Table 4 presents the demographic characteristics of the participants. The mothers of discharged infants were significantly more educated, and naturally, the infants were significantly older in the group of discharged infants. No other differences were found.

Table 4. Demographic characteristics of the participants

| Characteristic | Descriptive statistics | | Sig difference |
|--|------------------------|--------------------|--------------------|
| | Hospitalized infants | Discharged infants | <i>p</i> |
| Age, years, <i>M</i> (<i>SD</i>) | 31.3 (5.2) | 31.4 | .940 ^a |
| Marital status, n (%) | | | .293 ^b |
| In relationship | 119 (92.2) | 44 (97.8) | |
| Single | 10 (7.8) | 1 (2.2) | |
| Completed degree, n (%) | | | .009 ^c |
| Vocational or less | 57 (44.2) | 10 (22.2) | |
| College or university | 72 (55.8) | 35 (77.8) | |
| Hospital-home distance, kilometers, <i>Md</i> (<i>Q1-Q3</i>) | 20.0 (8.0-52.3) | 12.5 (7.0-50.5) | .465 ^d |
| Previous NICU experience, n (%) | | | .784 ^b |
| No | 114 (88.4) | 41 (91.1) | |
| Yes | 15 (11.6) | 4 (8.9) | |
| Previous expression experience, n (%) | | | .203 ^c |
| No | 75 (58.1) | 31 (68.9) | |
| Yes | 54 (41.9) | 14 (31.1) | |
| Financial woes n (%) | | | .096 ^c |
| Yes (1-3.0) | 56 (43.4) | 26 (57.8) | |
| No (3.1-5) | 73 (56.6) | 19 (56.6) | |
| Physical well-being, n (%) | | | .811 ^c |
| Good (3.1-5) | 80 (62.0) | 27 (60.0) | |
| Poor (1-3.0) | 49 (38.0) | 18 (40.0) | |
| Psychological well-being, n (%) | | | .952 ^c |
| Good (3.1-5) | 79 (61.7) | 28 (62.2) | |
| Poor (1-3.0) | 49 (38.3) | 17 (37.8) | |
| Gender, n (%) | | | .750 ^c |
| Female | 58 (45.0) | 19 (42.2) | |
| Male | 71 (55.0) | 26 (57.8) | |
| GA at birth, <i>Md</i> (<i>Q1-Q3</i>) | 33.3 (30.7-35.0) | 33.0 (31.5-34.4) | .632 ^d |
| Delivery type, n (%) | | | .667 ^c |
| Vaginal | 65 (50.4) | 21 (46.7) | |
| Caesarean | 64 (49.6) | 24 (53.3) | |
| Pregnancy, n (%) | | | .069 ^c |
| Singleton | 102 (79.1) | 41 (91.1) | |
| Twin | 27 (20.9) | 4 (8.9) | |
| Age, weeks, <i>Md</i> (<i>Q1-Q3</i>) | 1.4 (1.1-2.0) | 12.0 (8.0-20.0) | <.001 ^d |

n = 174 (hospitalized infants n = 129 and discharged infants n = 45); Analysis methods: ^a Two-tailed independent samples t test; ^b Fisher's exact test; ^c Chi-square; ^d Mann Whitney U test

4.3.3 Measures

Maternal appraisals were measured with Secondary Appraisal of Milk Expressing (SAME) scale. The SAME scale was only used for criterion validity purposes (research question 3). This scale was based on Lazarus & Folkman's (1984) operationalization of appraisal. The items measured four needs: need for constructive actions, need of information, need of acceptance and need of holding back from action, in the context of expressing. The items were modified to measure mothers' appraisal of expressing, not appraisal of their life situation in general. Two researchers operationalized the items independently, and the items were modified until consensus was reached. The items measured with a 4-point Likert scale whether the mothers can do something about succeeding in expressing (need for constructive actions), need to know more about expressing (need of information), had to accept expressing (need of acceptance), or had to hold herself back from doing what she wanted to do because of expressing (need of holding back). The first two items indicated the sense of controllability, while the latter two indicated the uncontrollability of expression.

Mothers' coping strategies were measured with the CMEPI scale. The development and content of the scale has been described previously.

Mothers' experiences of stressfulness of and managing with expressing were measured with two questions. The scale was a visual analog scale, ranging from 0 = extremely stressful / not managing to 10 = not stressful / managing very well. Furthermore, maternal socio-demographic factors (age, marital status, education, economical status, home-hospital distance, previous children, their admissions to NICU, previous breastfeeding and expressing experience, and physical and psychological condition), infants' characteristics (gender, GA at birth, birth weight, type of delivery, age at the time of participation), and expression practices (initiation time, frequency, mothers' prediction of the time of continuing) were measured. The portion of mothers' own breast milk in infants' total milk intake was measured with Index of Breastfeeding Status (Labbok & Krasovec 1990).

4.3.4 Statistical analyses

For psychometric evaluation of the CMEPI scale (research question 3), the datasets of hospitalized and discharged preterm infants' mothers were combined ($n = 174$). The demographic characteristics of the mothers differed only in education and infants' age, and therefore it was considered that the combining can be done. The reason for combining the datasets was that the data were skewed in the hospitalized infants' mothers' dataset, and therefore combining these datasets provided more normally

distributed and better discriminated data, as well as a more sufficient sample size for factor analysis.

The analyses were initiated with item analysis (Ferketich 1991). The discrimination power of the items was examined by the distribution of the answers to the scale. The criterion for poor discrimination power was that >85% of the participants had chosen the same option (Ferketich 1991). The inter-item and item-to-total correlations were examined with Pearson product-moment correlation coefficient and Spearman rho (Kellar & Kelvin 2013). Based on the item analysis, the items with $r < .30$ and $r_s < .30$ were excluded, since they were considered to not have sufficient contribution to the scale. Construct validity was examined with EFA (DeVon et al. 2007, Fabrigar & Wegener 2012). Principal component extraction with Equamax rotation was used (Fabrigar & Wegener 2012, Kellar & Kelvin 2013). Kaiser-Meyer-Olkin (.778) and Bartlett's Test of Sphericity ($p < .001$) indicated that the sampling adequacy was sufficient for EFA (Kellar & Kelvin 2013).

Criterion validity was examined with Spearman rho between the formed sub-scales, as well as between the whole CMEPI scale and expression frequency and managing with expression. The associations between appraisal methods and coping strategies were examined with a Mann Whitney U test. The formed factors were expected to relate to appraisal methods so that emotion-focused coping strategies correlated positively with appraisal methods, illuminating a lack of controllability, whereas problem-focused coping strategies were expected to correlate positively with appraisal methods, suggesting controllability (Lazarus & Folkman 1984). Multiple linear regression was used to further examine if the coping strategies are predictors of management of expression and expression frequency. Internal consistency was studied with Cronbach alpha coefficient of the formed sub-scales as well as of the whole CMEPI scale (Kellar & Kelvin 2013). Test-retest reliability was studied with the data of discharged infants' mothers. With this, Spearman rho was used.

Mothers' expression-related stress, coping strategies, managing with expression, and expressing frequency were described using means and standard deviations for normally distributed variables, and medians, 25th percentiles, and 75th percentiles for skewed variables. The ordinal scale variable, use of own mother's milk (OMM), were described using medians and 25th and 75th percentiles. The skewness of the variable was examined comparing means and medians, means and standard deviations, and using Fisher's measure of skewness and Fisher's measure of kurtosis (for normally distributed variable $z = -1.96...1.96$), and Kolmogorov-Smirnov (for normally distributed variable $p > .05$). Furthermore, histograms were observed to evaluate the distribution of the variables. (Kellar & Kelvin 2013). Expression-related stress (skewness $z = -1.34$, kurtosis $z = -2.57$, $p = .022$), coping strategies (skewness $z = -1.64$, kurtosis $z = -0.32$, $p = .200$), managing with expressing (skewness $z = -2.39$,

kurtosis $z = 0.77, p = .200$), and expression frequency (skewness $z = -0.13$, kurtosis $z = 0.68, p < .001$), were all considered as normally distributed. The distribution of expression-related stress, managing with expressing, and expression frequency were not unambiguous; therefore both parametric and nonparametric tests were done. Differences in the results were not found, therefore the variables were treated as normally distributed and only parametric tests were used. The missing values in coping strategies ($n = 18, 0.03\%$) were imputed with the item mean (Polit & Beck 2012). The other dependent variables had no missing values.

To identify the predictors of inadequate expressing initiation, frequency, and non-exclusive use of OMM (research question 4), multiple logistic regression was used. The expressing practices were defined as inadequate if expression was initiated after six hours postpartum or expression frequency was six times or less per a day (Nyqvist et al. 2013). The first category of IBS (100% of OMM, no other milk) was used as exclusive use of OMM. The dichotomization of the predictors is described in Table 8 (pages 68–69). The cut-off point for financial woes and physical and psychological well-being were determined to be 3.0 in five-point scale, based on researcher's evaluation. In these analyses, mothers' age, hospital-home distance, infant's GA at birth, chronological age, and expression-related stress were used as continuous variables. Forward stepwise regression was used to identify significant predictors (Hosmer et al. 2013). Furthermore, associations between expression initiation, expressing frequency, and use of OMM were studied using Mann Whitney U test.

The associations between mothers' and infants' characteristics and dependent variables (expression-related stress, coping strategies, and managing with expression) (research question 5) were studied using a two-tailed independent samples t test. Associations between expression-related stress, coping strategies, managing with expressing, and expressing frequency (research question 6) were studied using a Pearson product-moment correlation coefficient.

The modeling of expression-related stress, coping strategies, and managing with expression (research questions 5 and 6), multiple linear regression was used (Kellar & Kelvin 2013, Weisberg 2014). First, coping strategies were used as a dependent variable. Independent variables were expression-related stress and mothers' and infants' characteristics, which were identified as significantly associated with coping strategies (i.e., previous NICU experience yes/no, physical well-being good/poor, and infant's chronological age dichotomized at median value). The cut-off point of significance was determined to be $p \leq .10$, since type II error cannot be eliminated in this data where some classes of independent variables were smaller than suggested in power analysis (i.e., for independent samples t test, $n = 64$). Second, managing with expression was used as dependent variable, and expression-related stress, coping strategies, along with significant mothers' and infants' characteristics (i.e., physical well-

being, psychological well-being, infant's chronological age) were used as independent variables. In these analyses, distribution of residuals was evaluated with histograms (Kellar & Kelvin 2013). Homoscedasticity was evaluated with plot of residuals against independent variables, and normal probability plot. With expression-related stress and managing with expression, the assumption of normally distributed residuals was not fulfilled, and therefore the distribution was corrected by squaring the variables. (Metsämuuronen 2002.) Using this correcting, the distribution of residuals was considered as acceptably normal. Collinearity was evaluated with tolerance (Tol) and Variance Inflation Factor (VIF). In the regression models $Tol \geq 0.801$ and $VIF \leq 1.248$, which were considered to demonstrate acceptable collinearity (O'Brien 2007, Weisberg 2014). The enter method was used.

To further answer research question 6, mediation analysis was conducted. Mediation analysis is a method to examine structural relationships in the data (MacKinnon 2008, Iacobucci 2011). The aim of the analysis method is to determine if a variable (M) mediates the relationship between independent (X) and dependent (Y) variables, described as $X \rightarrow M \rightarrow Y$ (MacKinnon et al. 2007, Iacobucci 2011). According to the TTSC (Lazarus and Folkman 1984, Folkman & Lazarus 1988), coping strategies are mediators between stress and outcomes. In addition to theoretical support from the TTSC, prerequisites of mediation analysis were considered to be sufficiently fulfilled; significant relation between the independent variable and dependent variable, as well as between the independent variable and the hypothesized mediator, were observed. Moreover, both the independent variable and the mediator were significantly related to the dependent variable when assessed together (MacKinnon et al. 2007). Furthermore, the absolute value of relation coefficient between independent and dependent variables must be larger independently than in the model in which mediation variable is added (MacKinnon et al. 2007). These prerequisites were evaluated with correlation coefficients and multiple linear regression modeling. The sample size should be at least 400–500 subjects to achieve satisfying power and to detect the mediated effect (Fritz & MacKinnon 2007). In this data the sample size was much smaller, but this weakness was considered to relate to type II error. Therefore, if significant effects were found, the results were at least suggestive.

All analyses except mediation analysis were done using IBM SPSS Statistics for Windows (Armonk, NY, IBM Corp.) versions 23.0 and 24.0 by the researcher. Mediation analysis was done by the biostatistician using Stata/SE 14.0 for Windows. "Binary mediation" program was used with "bootstrap" command for calculating confidence intervals (CI).

In all analysis, a level of significance was determined to be $p < .05$, and 95% CI were used (Kellar & Kelvin 2013).

5 Results

5.1 Mothers' experiences with breast milk expressing and breastfeeding

This section answers research question 1. Integrative review (Article I) revealed that the mothers coped with the birth of preterm infants by expressing and breastfeeding. Beneficial breast milk was both a supportive and obstructive factor, since offering breast milk was motivated by the fact of the essentialness of breast milk, and at the same time offering breast milk was a way to decrease the feelings of guilt for the mothers (Krouse 2002, Bernaix et al. 2006, Flacking et al. 2006, Sweet 2006, Flacking et al. 2007, Sweet 2008a, 2008b, Lee et al. 2009, Boucher et al. 2011, Rossman et al. 2011, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). Achieving breastfeeding was a paradoxical experience. Expression was the necessary evil to provide breast milk and to achieve breastfeeding, but at the same time expressing was empowering and a source of joy and hope (Krouse 2002, Bernaix et al. 2006, Flacking et al. 2006, Nyqvist & Kylberg 2008, Sweet 2008b, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Rossman et al. 2011, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). Breastfeeding was seen in a positive light as natural and extremely desired, and the physical closeness was especially experienced as very positive (Krouse 2002, Pridham et al. 2004, Bernaix et al. 2006, Flacking et al. 2006, Flacking et al. 2007, Nyqvist & Kylberg 2008, Sweet 2008a, 2008b, Lee et al. 2009, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). Expression and breastfeeding were the ways to rebuild mother-infant connection and motherhood. They were seen as an integral part of motherhood, and motherhood was developed and confirmed by expression and breastfeeding (Bernaix et al. 2006, Sweet 2006, Flacking et al. 2007, Sweet 2008a, 2008b, Lee et al. 2009, Boucher et al. 2011, Swanson et al. 2012). On the other hand, because of an urge to validate motherhood, expression and breastfeeding were perceived as obligatory (Krouse 2002, Sweet 2006, Flacking et al. 2007, Sweet 2008a, 2008b). Expressing and breastfeeding were important to establish and continue a connection to the infant (Krouse 2002, Flacking et al. 2006, Flacking et al. 2007, Sweet 2008a, 2008b, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Boucher et al. 2011, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013) but expression was also

the only thing the mothers could do for their infants (Flacking et al. 2007, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Swift & Scholten 2010, Rossman et al. 2011, Swanson et al. 2012, Myers & Rubarth 2013, Rossman et al. 2013). (Article I.)

The mothers had to cope with several barriers and concerns related to expression and breastfeeding. The mothers coped with new demands as they had to reevaluate their breastfeeding goals, as well as learn new coping strategies and several unfamiliar practical skills (Pridham et al. 2004, Bernaix et al. 2006, Flacking et al. 2006, Sweet 2006, Nyqvist & Kylberg 2008, Sweet 2008a, Lee et al. 2009, Swift & Scholten 2010, Boucher et al. 2011, Swanson et al. 2012, Rossman et al. 2013). The NICU environment was a specific barrier, since the objectification of breast milk, separation of mothers and infants, and lack of privacy led to difficulties in expression and breastfeeding (Krouse 2002, Bernaix et al. 2006, Flacking et al. 2006, Sweet 2006, Nyqvist & Kylberg 2008, Sisk et al. 2010, Björk et al. 2012, Swanson et al. 2012, Flacking & Dykes 2013, Myers & Rubarth 2013). Some mothers liked to gain peer support by expressing with others, and some found it beneficial to express at their infant's bedside (Flacking et al. 2006, Hurst et al. 2013). Expression specifically included concerns, as it was demanding and exhausting, interfered with daily life, and caused practical problems regarding equipment and transportation (Krouse 2002, Pridham et al. 2004, Bernaix et al. 2006, Flacking et al. 2006, Sweet 2008b, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Swift & Scholten 2010, Rossman et al. 2011, Swanson et al. 2012, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). Furthermore, insufficiency of milk was a common problem (Krouse 2002, Hurst et al. 2004, Callen et al. 2005, Bernaix et al. 2006, Jones et al. 2009). Despite the anticipated naturalness of breastfeeding, it was not free of concerns. Problems with latching, positioning a tiny infant, poor milk transfer, and establishing breastfeeding were concerns for the mothers and sources of negative feelings (Krouse 2002, Pridham et al. 2004, Bernaix et al. 2006, Flacking et al. 2006, Flacking et al. 2007, Jones et al. 2009, Lee et al. 2009, Swift & Scholten 2010). Several breastfeeding counseling interventions were experienced conflictingly, as test-weighing and scheduled feeding were experienced as helpful and troublesome (Krouse 2002, Hurst et al. 2004, Flacking et al. 2006, Nyqvist & Kylberg 2008, Lee et al. 2009, Boucher et al. 2011, Björk et al. 2012, Hurst et al. 2013). Uncertainty regarding supplementation was prevalent (Hurst et al. 2004, Callen et al. 2005, Sweet 2006, Flacking et al. 2007, Nyqvist & Kylberg 2008, Björk et al. 2012) and as successful breastfeeding was a precondition to discharge, breastfeeding and discharge became competitive goals (Flacking et al. 2006, 2007, Swift & Scholten 2010, Boucher et al. 2011). Ceasing expression and breastfeeding was a coping strategy for the mothers in the situation when exhaustion, frustration, and unmanageable breastfeeding problems were overwhelming (Krouse 2002, Pridham et al. 2004, Jones et al. 2009, Lee et al. 2009, Swift & Scholten 2010, Swanson et al. 2012).

After the decision to cease, the mothers had both positive and negative feelings and consequences (Krouse 2002, Flacking et al. 2007, Sweet 2008b, Boucher et al. 2011, Björk et al. 2012, Swanson et al. 2012). (Article I.)

The mothers (n = 130) told in their narratives how they tried to live with pumping (Article II). They had to manage the situation, daily life and feelings as they looked forward to easier breastfeeding. The mothers described how expression was helpful for them, as they were able to provide beneficial breast milk for their infants and contribute to their care by expressing. While the situation was a helpful factor, it also hindered expression, since mothers' compromised physical condition and fatigue, worry for their infants' survival and condition, and mother-infant separation hampered expression. Several things helped the mothers to manage daily life. These factors included sufficiency of time, adequacy of equipment, and sufficiency of milk amount. However, the demand of scheduling expressing, arduousness, inadequateness of equipment or lack of equipment and pumping spaces hindered managing daily life. Expression initiated both positive and negative feelings, which the mothers had to manage. Familiarity, neutrality, and successfulness of expressing were the sources of positive emotions, while unawareness, weirdness, inadequateness, and loneliness reinforced negative feelings. Ultimately, the mothers looked forward to easier expressing by being confident in their success at it and at breastfeeding. In this, they were persevering and goal-oriented. In contrast to seeing breastfeeding as worth pursuing, expressing itself was unnatural, difficult and even shaming, despite its obligatory nature. (Article II.)

The studies (Article I & II) revealed several similar findings (Table 5). The birth of a preterm infant and following intensive care was a time period filled with anxiety and worry. In this situation, expressing breast milk and helping an infant through milk was helpful action, and the mothers coped with the situation by expressing. Because of the importance of milk, the mothers saw expressing in a positive light and as an important task. Furthermore, it was a way to contribute to the care in a NICU where common mothering tasks were restricted. Despite the helpfulness, expressing itself was exhausting and stressful. The NICU environment was seen as an impeding factor, and the mother-infant separation was a particularly stressful experience that impeded expressing. The mothers had also practical concerns, and lack of adequate equipment and time obstructed keeping the scheduled expression frequency up. Altogether, expressing was seen as a hard but obligatory task to achieve breastfeeding.

Table 5. Mothers' experiences with breast milk expressing: Results of mothers' narratives (Article II) and supporting findings of integrative review (Article I)

| Main categories | Categories | Subcategories | Supporting findings |
|---|---|---|---|
| Managing with the situation | Expressing as a helping factor (n=90, 69.2%) | Valuable milk For a motherhood For an infant | The benefits of milk as a major motivation Expressing supported and validated motherhood and connection with the infant; integral part of motherhood Expressing as a way to compensate for the preterm birth Expressing as the only doable thing |
| | Contextual obstacles (n=55, 42.3%) | Mother's illness Worry about an infant Separation | Separation from the infant:: difficulties in expressing, the feelings of a lost connection |
| Looking forward to easier breastfeeding | Looking to the future (n=63, 48.5%) | Trust for succeeding Sense of direction Hope for breastfeeding Trust for impermanence | Expressing as a priority Expressing as a necessary act to achieve breastfeeding |
| | Hardness of expressing (n=42, 32.3%) | Unnaturalness Difficultness Obligation | The objectification of breast milk Expressing as a necessary evil to provide milk |
| Managing with daily life | Helpful practical factors (n=40, 30.8%) | Sufficiency of time Helpful equipment and environment Sufficiency of milk | |
| | Impeding practical factors (n=109, 83.8%) | Concerns with time Arduousness Concerns with equipment and environment Insufficiency of milk | The difficulties of scheduling Expressing interfered with everyday life The lack of privacy in NICUs and availability of a pump An insufficient milk supply |
| Managing with feelings | Supportive feelings (n=62, 47.7%) | Familiarity Neutrality Succeeding | Expressing as a source of joy, fulfillment, and structure Rewarding and empowering Positive outcomes of ceasing |
| | Impeding feelings (n=108, 83.1%) | Unawareness Unfamiliarity Stressfulness Loneliness Frustration Exhaustion | Need to learn unfamiliar skills and coping strategies An insufficiency of milk: negative feelings and ceasing Expressing as demanding, frustrating, and exhausting; required perseverance |

5.2 Maternal coping strategies in breast milk expressing

As a result of the secondary analysis, several emotion- and problem-focused coping strategies were found (research question 2). The result of the analysis is presented in Table 6.

The first emotion-focused coping strategy was that the mothers reminded themselves that expressing and breast milk are valuable to their infants, are promotive of breastfeeding, and are a part of motherhood. The mothers conceived of expressing as a way to continue and strengthen their interrupted biological, physical, and emotional relationship with their babies (Krouse 2002, Flacking et al. 2006, Sweet 2008b, Lee et al. 2009, Sisk et al. 2010, Swanson et al. 2012, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). The mothers' narratives indicated that the existence and survival of infants served as a driver of milk expressing; this was also present in the studies (Bernaix et al. 2006, Flacking et al. 2007, Sweet 2008b, Lee et al. 2009, Myers & Rubarth 2013). The maternal narratives and research indicated that the perceived benefits of breast milk and its necessity to an infant's well-being served as strong motivators and imperatives to tolerate the demands of expressing (Krouse 2002, Bernaix et al. 2006, Lee et al. 2009, Rossman et al. 2011, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). The mothers were equally inspired by breastfeeding as the ultimate goal of expressing; this coping strategy was also discussed in several studies (Pridham et al. 2004, Bernaix et al. 2006, Nyqvist & Kylberg 2008, Sweet 2008b, Sisk et al. 2010, Hurst et al. 2013, Rossman et al. 2013). Furthermore, the mothers viewed breast milk as the only givable and concrete value that they can provide to their infants (Jones et al. 2009, Lee et al. 2009, Swift & Scholten 2009, Sisk et al. 2010, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). Their role as a breast milk provider was considered a means of caring and contributing to care (Sweet 2008b, Swanson et al. 2012, Rossman et al. 2013) and a source of positive emotions (Krouse 2002, Sweet 2008b, Lee et al. 2009, Rossman et al. 2011, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). The maternal narratives and studies revealed that expressing was seen as an integral part of motherhood and a mother's duty (Bernaix et al. 2006, Sweet 2008b, Lee et al. 2009, Sisk et al. 2010, Rossman et al. 2011, Swanson et al. 2012, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). (Article III.)

Other emotion-focused coping strategies employed by the mothers included believing in succeeding and normalizing the situation. The mothers described how they reassured themselves that their lactogenesis and milk supply will be sufficient and how they viewed increased and substantial milk supply as encouraging and supportive of expressing. Another specific strategy was to think of expressing as a temporary requirement, with the mothers envisioning this stage to span a limited period (e.g., a

specific infant age range). The mothers in both datasets put their minds at ease by reminding themselves that even a small amount of milk is important (Lee et al. 2009, Swanson et al. 2012). Expressing was also perceived as funny, easy, exciting, or normal to facilitate tolerance. Additionally, the mothers concentrated on the positive aspects, importance, or fluency of expressing (Krouse 2002, Bernaix et al. 2006, Flacking et al. 2006, Sweet 2008a, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). For example, they considered expressing an important duty and a means of setting aside time for themselves. Expressing was likewise comprehended as a source of structure in the mothers' narratives and previous studies (Nyqvist & Kylberg 2008, Sweet 2008b, Lee et al. 2009, Sisk et al. 2010, Swanson et al. 2012, Rossman et al. 2013). Concentrating on adequate milk supply helped the mothers endure expressing and build up confidence in their success (Bernaix et al. 2006, Lee et al. 2009, Swanson et al. 2012). (Article III.)

The narratives and previous works indicated that some mothers deemed expressing an overwhelming task, being preoccupied with the negative aspects of expressing as they exerted efforts to tolerate this activity. These mothers conceived of expressing as fraught with difficulty, unnatural, and exhausting (Krouse 2002, Bernaix et al. 2006, Sweet 2008a, 2008b, Jones et al. 2009, Lee et al. 2009, Sisk et al. 2010, Boucher et al. 2011, Rossman et al. 2011, Swanson et al. 2012, Hurst et al. 2013, Myers & Rubarth 2013, Rossman et al. 2013). Some mothers comprehended expressing as useless (Sweet 2008a, Sisk et al. 2010, Björk et al. 2012, Hurst et al. 2013) and as an obstacle to daily life (Krouse 2002, Pridham et al. 2004, Sisk et al. 2010, Myers & Rubarth 2013, Rossman et al. 2013). The unmanageability of the situation drove the mothers to give up and escape from their predicament. They stated that expressing is excessively time-consuming (Hurst et al. 2013). In narratives, the mothers described expressing as impossible, given that they were often too exhausted to continue with this duty. Ceasing expressing was seen as the only solution to cope. As they discontinued expressing, the mothers concentrated on the advantages derived from ceasing, such as having the opportunity to take care of themselves and spend time with their infants. The mothers reassured themselves that an infant's need for breast milk was fulfilled by efforts to maintain their emotional well-being during and after the difficult decision to cease expressing. (Article III.)

A number of problem-focused coping strategies were also adopted by the mothers. The narratives and several studies illustrated how the mothers sought social support from counseling (Flacking et al. 2006, Nyqvist & Kylberg 2008, Sweet 2008a, Boucher et al. 2011, Rossman et al. 2011, Björk et al. 2012, Swanson et al. 2012) and from someone with whom they can share their experiences (Krouse 2002, Bernaix et al. 2006, Sweet 2008a, Lee et al. 2009, Sisk et al. 2010, Rossman et al. 2011). Some of the

mothers used pumping with other mothers as a coping strategy (Nygqvist & Kylberg 2008). Both previous studies and the narratives identified asking for help with household duties and scheduling everyday life as contributory to mastering expressing (Krouse 2002, Flacking et al. 2006, Flacking et al. 2007, Sweet 2008b, Lee et al. 2009, Sisk et al. 2010). For some of the mothers, being unyielding in their commitment to expressing (Flacking et al. 2006, Swanson et al. 2012, Hurst et al. 2013) and deciding that they will do anything to manage associated challenges facilitated their endurance of expressing demands. These mothers recognized the need to ensure effective expressing, and were intent on preventing failure. (Article III.)

The mothers also actively sought information on expressing. They attempted to master the activity by learning how to express efficiently (Swanson et al. 2012), learning how to operate within the limits of their well-being (Flacking et al. 2006, Sweet 2008b, Boucher et al. 2011), and acquiring information on expressing and breast milk. Other important strategies that emerged in previous research and the narratives were the creation of a comfortable environment (Nygqvist & Kylberg 2008, Sisk et al. 2010, Björk et al. 2012, Hurst et al. 2013) and the procurement of expressing equipment (Bernaix et al. 2006, Sisk et al. 2010, Hurst et al. 2013). Some of the mothers used expressing at their infants' bedsides as a coping strategy, but others evaluated this approach as non-beneficial or uncomfortable (Hurst et al. 2013). Recreational activities, such as reading books or watching television, were adopted as methods of tolerating expressing, as well as rapid pumping (Sisk et al. 2010, Hurst et al. 2013). The mothers also actively arranged schedules for expressing (Krouse 2002, Sisk et al. 2010, Hurst et al. 2013). (Article III.)

Controlling and comparing milk amount is a prevalent coping strategy among the mothers, as indicated in the narratives and previous studies (Sweet 2006, 2008a, Sisk et al. 2010, Björk et al. 2012, Swanson et al. 2012, Hurst et al. 2013, Rossman et al. 2013). The mothers intentionally prevented a reduction in milk amount (Boucher et al. 2011). In cases where milk supply was inadequate, they exerted efforts to identify the causes (Nygqvist & Kylberg 2008, Lee et al. 2009, Boucher et al. 2011) and increase supply to a desirable level (Jones et al. 2009, Lee et al. 2009, Björk et al. 2012). Finally, the mothers confronted unmanageable situations that arose from expressing by considering ceasing. When the need for expressing exceeded their capability to fulfill such a requirement, the mothers tended toward discontinuing expressing. They decreased the frequency with which they pumped milk against the advice of nurses and skipped pumping schedules (Krouse 2002, Pridham et al. 2004, Hurst et al. 2013). Some mothers decided to discontinue expressing, being driven toward this option by unmanageable demands (Krouse 2002, Pridham et al. 2004). These behaviors were well-documented in the mothers' narratives. (Article III.)

Table 6. Results of the secondary analysis: Categorization matrix and formed subcategories

| Main category | Categories | Subcategories |
|--|--|--|
| Coping <i>"...constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person." (Lazarus & Folkman 1984, p. 141)</i> | Emotion-focused coping | For infant, breastfeeding, and motherhood Reassuring confidence and neutralizing the situation Emphasizing advantages Emphasizing disadvantages Giving up and escaping |
| | Problem-focused coping | Seeking social support Being tenacious |
| | <i>The efforts to obtain information and mobilize actions to change the reality.</i> | Learning new skills and obtaining information Arranging favorable circumstances Controlling milk amount Skipping and ceasing |
| | | |

5.3 Psychometric properties of the CMEPI scale

5.3.1 Validity

Psychometric properties of the developed CMEPI scale were evaluated to answer research question 3. According to expert panel evaluation ($n = 5$), the scale had acceptable item-level and scale-level content validity ($I-CVI = 1.00$ in 54 items, $S-CVI/Ave = 0.97$) (Polit et al. 2007). The preterm infants' mothers ($n = 10$) considered the scale understandable, logical and easy to answer. These results suggest that the CMEPI scale has acceptable translational validity. (Article III.)

Validity and reliability of the CMEPI scale were evaluated using combined data from hospitalized and discharged infants' mothers ($n = 174$). Construct validity evaluations were initiated by item analysis (Ferketich 1991). Five items had poor discriminant power (more than 85% of answers were distributed in one answer option). Furthermore, 13 items had no contribution to the scale (inter-item correlation coefficients $< .30$). In total, 14 items were excluded from the scale prior to EFA. The EFA was initiated with a 47-item scale. Based on communalities ($< .25$) and factor loadings ($< .30$), three items were further excluded, resulting in a 44-item scale. The EFA resulted in 5 factors: Alienating (13 items), Activity and Learning (9 items),

Mastering (8 items), Facilitation and Delimitation (7 items), and Positive Thinking (7 items) (Table 7). In total, 41.3% of variance was explained by the factors. These results present evidence of acceptable construct validity. (Article III.)

Significant correlations between the sub-scales indicated discriminant and concurrent validity in a multi-dimensional scale. Evidence of concurrent validity was found, since using the appraisal method of altering the situation was associated with lesser use of alienating strategies ($Md = 2.2$, $Q_1-Q_3 = 1.8-2.5$ vs. $Md = 2.5$, $Q_1-Q_3 = 2.2-2.7$ $p = .029$, respectively) and more use of facilitation and delimitation ($Md = 1.9$, $Q_1-Q_3 = 1.4-2.1$ vs. $Md = 1.4$ $Q_1-Q_3 = 0.9-1.9$ $p = .025$, respectively). Appraisal method of holding back from acting was associated with higher use of alienating strategies ($Md = 2.5$, $Q_1-Q_3 = 2.4-2.8$ vs. $Md = 2.2$, $Q_1-Q_3 = 1.6-2.4$, $p < .001$, respectively), and lesser use of facilitation and delimitation ($Md = 1.6$, $Q_1-Q_3 = 1.3-1.9$ vs. $Md = 1.9$, $Q_1-Q_3 = 1.6-2.1$ $p = .004$, respectively) and positive thinking ($Md = 1.9$, $Q_1-Q_3 = 1.4-2.1$ vs. $Md = 2.0$ $Q_1-Q_3 = 1.6-2.3$ $p = .034$, respectively). Acceptance ($\beta = .33$, $p < .001$) and Positive Thinking ($\beta = .41$, $p < .001$) were significant predictors of subjective managing with expression. Mastering ($\beta = -.23$, $p = .014$) and Facilitation and Delimitation ($\beta = -.26$, $p = .007$) were predictors of expression frequency. These results indicated criterion validity of the CMEPI scale. (Article III.)

Table 7. Sub-scales of the CMEPI scale and their descriptions

| Sub-scale | Description |
|-------------------------------|---|
| Alienating | Seeing expressing burdening and overwhelming, alienating both emotionally and practically. |
| Activity and Learning | Thinking expressing as a learnable action, seeking information, counseling and support and thinking expressing as a way to be an active part of an infant's care team |
| Mastering | Actions toward managing expressing, organizing time and equipment for expressing, managing milk supply and being tenacious |
| Facilitation and Delimitation | Arranging expressing tolerable and as comfortable as possible; using expressed milk amounts and routines as comforting factors, recognizing their own limits |
| Positive Thinking | Seeing expressing as important, being confident in succeeding, expressing in company with an infant and other mothers |

5.3.2 Reliability

Cronbach alpha coefficient for the whole CMEPI scale was .87, indicating acceptable equivalence reliability. Three subscales had acceptable internal consistency (Alienating $\alpha = .85$, Activity and Learning $\alpha = .75$, Mastering $\alpha = .71$), but in two subscales, internal consistency was unacceptably low (Facilitation and Delimitation $\alpha = .64$,

Positive Thinking $\alpha = .59$). Test-retest reliability (stability) was good ($r_s = .82$), but Mastering subscale had low test-retest reliability ($r_s = .61$). The results suggested that the whole CMEPI scale had acceptable reliability, but two subscales indicated no internal consistency and one subscale indicated poor test-retest reliability. (Article III.)

For this summary, Cronbach alpha coefficients in hospitalized infants' mothers' dataset ($n = 129$) were also calculated. For the subscales, Cronbach alpha coefficients were as follows: Alienating $\alpha = .81$, Activity and Learning $\alpha = .78$, Mastering $\alpha = .69$, Facilitation and Delimitation $\alpha = .64$, and Positive Thinking $\alpha = .57$. For the whole CMEPI scale, the Cronbach alpha coefficient was .86.

5.3.3 Summary of the psychometric properties of the CMEPI scale

The CMEPI scale showed evidence of validity. Content validity was very good, and the construct of the scale was meaningful and acceptable. Length of the scale was reduced to 44 items (28% reduction), which improved the usability. Evidence of criterion validity was also found, although some expected associations remained absent. The reliability of the whole CMEPI scale was acceptable, but not all subscales showed evidence of reliability. To sum up, the psychometric properties of the CMEPI scale was acceptable for a newly developed scale.

5.4 Expressing practices, expressing-related stress, coping strategies, and managing with expressing

5.4.1 Initiation and frequency of expression and use of mothers' breast milk in NICU

Expression practices and use of mothers' own milk (research question 4) were studied in the hospitalized infants' mothers' sample ($n = 129$). The median time for expression initiation was 9 hours (Q_1 – $Q_3 = 5.0$ – 24.0) and range from 0 to 80 hours. The mean expression frequency was 5.8 times per a day ($SD = 1.5$), range 1.5–10. As described in Article IV, previous NICU experience ($OR = 4.52$, 95% $CI = 1.01$ – 20.36), infant's male gender ($OR = 3.29$, 95% $CI = 1.39$ – 7.82), caesarean section ($OR = 3.06$, 95% $CI = 1.28$ – 7.31), poor psychological condition ($OR = 3.03$, 95% $CI = 1.21$ – 7.60), and high GA at birth ($OR = 1.29$, 95% $CI = 1.11$ – 1.50) were risk factors for late initiation of expression (≥ 6 hours from birth). None of the studied characteristics were predictors of inadequate expression frequency (≤ 6 times per a day). Furthermore,

financial woes ($OR = 2.96$, $95\% CI = 1.36-6.43$), lack of previous expression experience ($OR = 2.54$, $95\% CI = 1.16-5.59$), and late GA at birth ($OR = 1.22$, $95\% CI = 1.07-1.39$) were predictors of non-exclusive use of mothers' own breast milk in NICU. Late expression initiation was associated with non-exclusive use of mothers' breast milk. Measured with an IBS scale, the mothers who had initiated expression within 6 hours from birth had a median value of 1 (i.e., exclusive use of breast milk, $Q_1-Q_3 = 1.0-2.0$), while for mothers with late initiation, the median value was 2 (i.e., more than 80% of mothers' breast milk, $Q_1-Q_3 = 1.0-3.0$). The difference was statistically significant ($p = .020$). (Article IV.)

5.4.2 Expression-related stress, coping strategies, and managing with expressing

Mothers' and infants' characteristics' associations with expression-related stress, coping strategies, and managing with expression (research question 5) were studied in hospitalized infants' mothers' sample ($n = 129$). The mothers felt themselves to be moderately stressed because of expression ($M = 6.2$, $SD = 2.7$). The mothers with previous expression experience felt themselves less stressed than mothers without such experience ($M = 6.9$, $SD = 2.4$ vs. $M = 5.7$, $SD = 2.7$, $p = .010$, respectively). Good physical ($M = 6.7$, $SD = 2.6$ vs. $M = 5.5$, $SD = 2.7$, $p = .013$) and psychological ($M = 6.9$, $SD = 2.6$ vs. $M = 5.1$, $SD = 2.5$, $p < .001$) well-being were associated with expression-related stress. (Table 8.)

The mothers widely used expression-related coping strategies to tolerate expressing ($M = 2.1$, $SD = 0.3$). The most widely used coping strategy was mastering ($M = 2.6$, $SD = 0.4$), followed by alienating in its reversed form ($M = 2.5$, $SD = 0.4$), positive thinking ($M = 1.9$, $SD = 0.5$), facilitation and delimitation ($M = 1.8$, $SD = 0.5$), and activity and learning ($M = 1.5$, $SD = 0.5$). Mothers with previous NICU experience and poor physical well-being used significantly less coping strategies ($M = 1.9$, $SD = 0.3$ vs. $M = 2.1$, $SD = 0.3$, $p = .004$ and $M = 2.0$, $SD = 0.3$ vs. $M = 2.1$, $SD = 0.3$, $p = 0.021$, respectively). Furthermore, mothers of younger infants used more widely coping strategies than mothers of older infants ($M = 2.2$, $SD = 0.3$ vs. $M = 2.1$, $SD = 0.3$, $p = .045$, respectively). (Table 8.)

The mothers felt that they manage with expressing well ($M = 7.3$, $SD = 1.7$). Good physical ($M = 7.6$, $SD = 1.6$, vs. $M = 6.8$, $SD = 1.8$, $p = .014$) and psychological ($M = 7.6$, $SD = 1.6$ vs. $M = 6.7$, $SD = 1.9$, $p = .004$) well-being, as well as infants' age ($M = 7.6$, $SD = 1.7$ vs. $M = 7.0$, $SD = 1.7$, $p = .026$) were associated with managing with expressing (Table 8).

Table 8. Mothers' and infants' characteristics' associations to expression-related stress, coping strategies, and managing

| Characteristic | Stress | | Coping strategies | | Managing | |
|--------------------------------|---------------|----------|-------------------|----------|---------------|----------|
| | <i>M (SD)</i> | <i>p</i> | <i>M (SD)</i> | <i>p</i> | <i>M (SD)</i> | <i>p</i> |
| Mothers' age | | .973 | | .399 | | .111 |
| < 30 years | 6.2 (2.9) | | 2.1 (0.3) | | 7.0 (1.8) | |
| ≥ 30 years | 6.2 (2.6) | | 2.1 (0.3) | | 7.5 (1.7) | |
| Marital status | | .561 | | .760 | | .106 |
| In relationship | 6.3 (2.6) | | 2.1 (0.3) | | 7.3 (1.8) | |
| Single | 5.7 (3.4) | | 2.1 (0.3) | | 6.4 (1.4) | |
| Completed degree | | .537 | | .108 | | .410 |
| Vocational or less | 6.4 (2.9) | | 2.1 (0.3) | | 7.1 (1.8) | |
| College or university | 6.1 (2.5) | | 2.1 (0.3) | | 7.4 (1.7) | |
| Hospital-home distance | | .963 | | .746 | | .190 |
| ≤ 20 kilometers | 6.2 (2.8) | | 2.1 (0.3) | | 7.5 (1.8) | |
| > 20 kilometers | 6.2 (2.5) | | 2.1 (0.3) | | 7.1 (1.7) | |
| Previous NICU experience | | .268 | | .004 | | .547 |
| No | 6.1 (2.8) | | 2.1 (0.3) | | 7.3 (1.8) | |
| Yes | 6.8 (1.8) | | 1.9 (0.3) | | 7.0 (1.7) | |
| Previous expression experience | | .010 | | .117 | | .302 |
| No | 5.7 (2.7) | | 2.1 (0.3) | | 7.1 (1.7) | |
| Yes | 6.9 (2.4) | | 2.1 (0.3) | | 7.5 (1.8) | |
| Financial woes | | .097 | | .500 | | .358 |
| Yes (1–3.0) | 5.8 (2.7) | | 2.1 (0.3) | | 7.1 (1.8) | |
| No (3.1–5) | 6.6 (2.6) | | 2.1 (0.3) | | 7.4 (1.7) | |
| Physical well-being | | .013 | | .021 | | .014 |
| Good (3.1–5) | 6.7 (2.6) | | 2.1 (0.3) | | 7.6 (1.6) | |
| Poor (1–3.0) | 5.5 (2.7) | | 2.0 (0.3) | | 6.8 (1.8) | |
| Psychological well-being | | <.001 | | .171 | | .004 |
| Good (3.1–5) | 6.9 (2.6) | | 2.1 (0.3) | | 7.6 (1.6) | |
| Poor (1–3.0) | 5.1 (2.5) | | 2.0 (0.3) | | 6.7 (1.9) | |
| Gender | | .532 | | .827 | | .418 |
| Female | 6.4 (2.5) | | 2.1 (.03) | | 7.1 (1.9) | |
| Male | 6.1 (2.9) | | 2.1 (.03) | | 7.4 (1.6) | |
| GA at birth | | .449 | | .511 | | .139 |
| ≤ 32 weeks | 5.9 (2.6) | | 2.1 (0.3) | | 6.9 (1.7) | |
| > 32 weeks | 6.3 (2.7) | | 2.1 (0.3) | | 7.4 (1.8) | |

Table 3 continues.

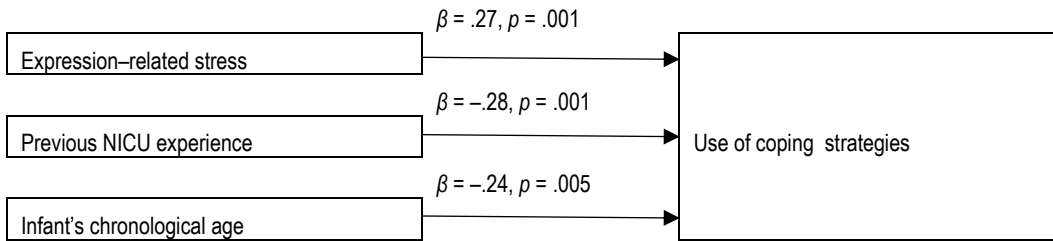
| Characteristic | Stress | | Coping strategies | | Managing | |
|----------------|---------------|----------|-------------------|----------|---------------|----------|
| | <i>M (SD)</i> | <i>p</i> | <i>M (SD)</i> | <i>p</i> | <i>M (SD)</i> | <i>p</i> |
| Delivery type | | .098 | | .555 | | .377 |
| Vaginal | 6.6 (2.6) | | 2.1 (.03) | | 7.4 (1.7) | |
| Caesarean | 5.8 (2.7) | | 2.1 (.03) | | 7.1 (1.8) | |
| Pregnancy | | .329 | | .370 | | .170 |
| Singleton | 6.1 (2.8) | | 2.1 (.03) | | 7.2 (1.8) | |
| Twin | 6.7 (2.2) | | 2.1 (.02) | | 7.7 (1.5) | |
| Infants' age | | .074 | | .045 | | .026 |
| ≤ 1.4 weeks | 6.7 (2.7) | | 2.2 (0.3) | | 7.6 (1.7) | |
| > 1.4 weeks | 5.8 (2.6) | | 2.1 (0.3) | | 7.0 (1.7) | |

n = 129; Analyzed with two-tailed independent samples *t* test

Associations between expression practices, expression-related stress, coping strategies, and managing

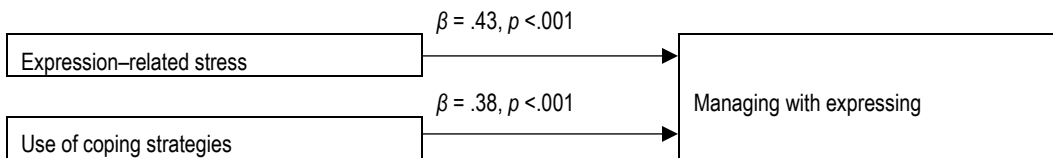
This section answers research question 6. Expression-related stress and use of coping strategies were weakly but significantly correlated ($r = .28, p = .001$). Strong correlations were found between expression-related stress and managing with expressing ($r = .53, p < .001$) and between use of coping strategies and managing with expressing ($r = .54, p < .001$). Based on these results of bivariate analysis, the associations between expression-related stress, coping strategies, and subjective managing with expressing were studied further. Expression frequency was excluded from these analysis, since bivariate analysis suggested that it is not related to stress ($r = .15, p = .086$), coping strategies ($r = .09, p = .334$), or subjective managing ($r = .14, p = .113$). Furthermore, expression initiation time was not correlated with expression-related stress ($r = -.15, p = .096$), use of coping strategies ($r = -.09, p = .345$), or managing with expressing ($r = -.05, p = .577$). Multiple linear regression suggested that expression-related stress, previous NICU experience, and infant's chronological age explained the use of coping strategies. The less stressed the mother felt herself, the more she used coping strategies for expressing. The mothers of younger infants used more coping strategies. Mothers with previous NICU experience used less coping strategies than mothers without such experience. The model explained 20.9% of the variance of the coping strategies. (Figure 3.) Managing with expressing was explained by expression-related stress and use of coping strategies. The less stressed the mother was, the better she felt about her managing. Furthermore, the more the mothers used coping strategies, the better she felt about her managing with expressing. The other

potential variables (physical well-being, psychological well-being, previous NICU experience, and infant’s chronological age) remained non-significant. The regression model explained 42.1% of the variance of the managing with expressing (Figure 4).



Variables not in model: Physical well-being ($\beta = -.14, p = .088$)
 $F(df=4) = 6.8; p < .001; \text{adjusted } R^2 = 0.209$
 $\beta = \text{Standardized beta coefficients}$

Figure 3. Multiple regression model for use of coping strategies



Variables not in the model: Infant’s chronological age ($\beta = -.03, p = .686$), physical well-being ($\beta = -.04, p = .610$), psychological well-being ($\beta = -.04, p = .532$)
 $F(df=5) = 22.4; p < .001, \text{adjusted } R^2 = 0.457$
 $\beta = \text{Standardized beta coefficients}$

Figure 4. Multiple regression model for managing with expressing

The prerequisites for mediation analysis were evaluated by relations between expression-related stress, coping strategies, and managing with expression, as described above. Furthermore, the coefficient relating the stress (independent variable) and managing with expression (dependent variable) was larger in simple linear regression than coefficient relating stress and managing when coping strategies (mediator) was added to the multiple regression model ($\beta = .588$ vs. $\beta = .460$, respectively). Mediation analysis revealed that the direct effect between expression-related stress and managing with expressing (.462, 95% CI = .326–.592) was stronger than the mediation effect of coping strategies (.127, 95% CI = .065–.197). However, the mediation effect was also statistically significant. The proportion of total effect mediated was 0.216. Figure 5 presents the coefficients between expression-related stress, coping strategies, and managing with expressing.

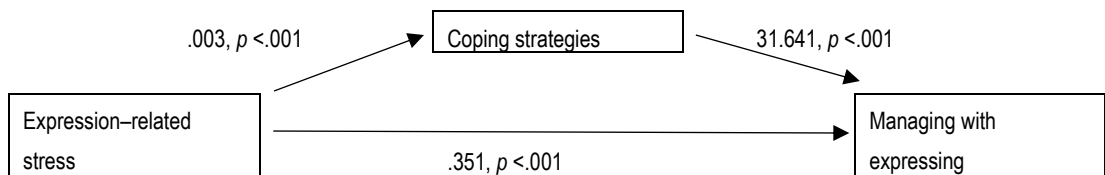


Figure 5. Mediation analysis model for expression-related stress, coping strategies, and managing with expressing

5.5 Summary of the results

The qualitative results of this study indicate that breast milk expressing was an important way to execute motherhood, establish and maintain connection, and contribute to infant care for the mothers. Expressing was seen as an obligatory task to achieve the ultimate goal of breastfeeding. Several obstacles to expression were found, such as stressfulness, exhaustion, frustration, difficulty, scheduling problems, availability of adequate equipment, transportation, NICU environment and mother-infant separation, sufficiency of milk supply, and negative feeling associated with insufficient milk supply. The finding that expressing was only moderately stressful for mothers in the early phase of lactation was surprising and contrary to previous studies. Qualitative studies suggested that the increased expression-related stress and poor management of expressing impeded mothers from maintaining adequate expression frequency. However, the mothers in this study maintain expression frequency despite their expression-related stress, perceived management, or physical or psychological well-being. Mothers with no previous expression experience, and with poor physical or psychological well-being, experienced more expression-related stress; poor physical or psychological well-being was also associated with poorer management of expressing.

The developed CMEPI scale showed acceptable validity and reliability. The scale consisted of five sub-scales: Alienating, Activity and Learning, Mastering, Facilitation and Delimitation, and Positive Thinking. Mothers with no previous expression experience, and mothers of younger infants, used more coping strategies. Expression-related stress, previous NICU experience and infant's chronological age were predictors of use of coping strategies. Expression-related stress and use of coping strategies were the only significant predictors of perceived management of expression. The coping strategies mediated significantly the relationship between expression-related stress and managing. The main results within the framework of this study are presented in figure 6.

| | | | |
|------------------------------|--|---|--|
| Event | Preterm birth | | |
| Impact on | Infant | Lactation | Mother |
| Reaction /consequence | Risk of mortality Risk of morbidity Sepsis NEC Intracranial bleeding ROP RDS BPD Neurological disabilities Social difficulties, ADHD | Impeding factors Maternal medications Lower basal prolactin levels Stress Lack of frequent stimulation Inadequate removal of milk Lack of skin to skin contact Experiences Exhaustion Practical barriers Expression-related stress Moderate | Stress Moderate level Highest during the first weeks The most stressful parental role alteration |
| Mediators | Interventions Antenatal corticosteroids Obstetrical interventions Ventilation treatment Surfactants Infection prevention Breast milk | Expression-related coping strategies Alienating Activity and Learning Mastering Facilitation and Delimitation Positive thinking Used widely | Coping Emotion-focused Problem-focused Dysfunctional Maintaining family integration Cooperation Optimistic definition Integrating Consultation Support/Stability |
| Outcomes | Reduced by breast milk NEC Sepsis ROP Long-term growth failure Neurodevelopmental disabilities Hospitalization Metabolic syndrome Hypertension | Managing with expression Good managing Stress as strong predictor Coping strategies as significant mediator Expressing frequency Independent from mothers' well-being, expression-related stress, coping strategies, and managing with expression | Equilibrium Dysfunctional coping Risk of PTSD Perceiving an infant as vulnerable |
| Context | Sociodemographic characteristics: Previous NICU experience, infant's male gender, caesarean section, poor psychological condition, and high GA at birth were risk factors for late initiation of expression. Financial woes, lack of previous expression experience, and late GA at birth increased risk of suboptimal use of OMM. NICU environment impeded expression. Counseling and support. | | |

Figure 6. Summary of the results within a framework of the study

Note: Lighter font in the figure indicates topics which have been studied in previous studies and thus forms framework of the study. Black font indicates the study findings.

6 Discussion

6.1 Ethical aspects

The overall goal of an ethically sound study is to increase the sum of good, while avoiding long-term, systematic harm (Israel 2015). Ethical standards were followed in this study to meet this goal. The first ethical decision is the selection of the topic (Aho & Kylmä 2012, Polit & Beck 2012). In the first phase, the aim was to describe mothers' experiences of expressing breast milk for preterm infants and to describe mothers' coping strategies in milk expression; qualitative methods were used. The researcher's genuine interest guided the selection of the topic of the study (Polit & Beck 2012). The study was initiated by conducting a review (Article I), which highlighted that there is a gap in the knowledge. Therefore, describing maternal experiences with milk expressing (Article II) and maternal coping strategies (Article III) were justified. Furthermore, exploring maternal experiences and coping strategies was expected to deliver information that both supports the mothers with this demand, and improves opportunities to offer important breast milk for preterm infants. Therefore, the study was expected to be beneficent. In the second phase, the aims were to evaluate the psychometric properties of the developed CMEPI scale; to explore association of mothers' and infants' characteristics to milk expression practice and use of breast milk in NICU; and finally, to explore the association of expression-related stress, coping with expressing frequency and managing with expressing. The scale development does not offer direct benefits for practice, but it is expected to provide advantages in counseling in the future. From an ethical point of view, persevering in development, assessment, and use of the CMEPI scale is important. Incomplete development and single use of measures is a prevalent ethical problem in nursing science (Eriksson et al. 2008, Streiner & Kottner 2014). Investigating associations between stress, coping, and managing with expressing will offer new knowledge and direct implications to the practice, benefiting the mothers and preterm infants. Furthermore, there was a gap in current knowledge about characteristics' associations with expression practice and use of mothers' milk in NICU, and therefore the topic was worth studying.

The major ethical aspects of the empirical study relate to protecting study participants (Israel 2015). Beneficence refers to the principle that participants should be protected from harm, discomfort, and exploitation (Polit & Beck 2012). Because of

the sensitive nature of the topic (Aho & Kylmä 2012), psychological harm was conceivable. In the qualitative phase, the participants were recruited via social media with a neutral announcement. The participants were allowed to check the questionnaire prior to decision-making, and left questions blank if they felt uncomfortable answering them. The data were collected via peer support groups, and therefore peer support was available for the participants afterwards. Some participants said that answering was emotionally burdensome for them. In these cases, the researcher thanked them and reminded them of available peer support. However, the participants' well-being after the participation cannot be ensured in anonymous Internet-mediated research (Aho & Kylmä 2012). On the other hand, a pseudo-therapeutic relationship was prevented by psychological distance between a participant and the researcher (Stark & Hedgecoe 2010). In the quantitative phase, the participants were both mothers of hospitalized infants and mothers of NICU-graduated infants. The questionnaire-based data collection allows the participants to review the questions before making the decision, and to skip questions if desired. Direct contact between the researcher and participants was limited, and nurses recruited the mothers in NICUs. This approach was recommended by the Institutional Review Board and hospital management to protect the patients' privacy. The NICU-hospitalized infants' mothers had daily contact with health care staff in the NICU. The same concerns regarding Internet-mediated study arose in this phase, but similarly, the mothers were already members of a peer support group, and they have frequent follow-ups in child health clinics.

The participants' human dignity (Polit & Beck 2012) was respected in the study. Information about the topic and aims of the study, procedures, benefits and potential risks, confidentiality, handling and archiving of the data, as well as voluntariness, were provided for the participants (Polit & Beck 2012, Israel 2015). The participants received no compensation for their participation. In the qualitative phase, the participants were clearly informed that their responses will be used both in the project and in research purposes. Proceeding to answer the questionnaire after the information sheet was regarded as consent to participate. However, because of Internet-mediated anonymized data collection, it was not possible to verify that the participants were legally eligible to give consent (Stark & Hedgecoe 2010). The aim of the study was written broadly, and therefore the use of the data in secondary analysis was determined to be ethically acceptable (Long-Sutehall et al. 2010). The consent to use data in secondary analysis was impossible to gather due to anonymized data collection. In the quantitative phase, signed informed consents were obtained. The fact that nurses gave the questionnaires to the mothers may have dissipated the border between care and research. However, it was stated clearly in the information sheet that the participants will participate in the research, and the decision to participate or decline did not have

an influence on the care or peer support. With these declarations, the attempt was made to avoid institutional vulnerability (i.e., the potential participator depends on the institution which is hosting the study, leading to a sense of obligation) (Stark & Hedgecoe 2010).

Justice refers to the right to fair treatment and privacy (Polit & Beck 2012). The study participants were mothers of young infants and breastfeeding mothers. Because of the study topic, it was necessary to select participants from this vulnerable group. The data were protected to ensure privacy and confidentiality. The anonymity of the participants in the NICUs was further supported by several practices. The researcher did not directly recruit the mothers, since hospitalization is confidential information. The researcher was told the room number or the place number of the infant in order to disseminate the questionnaires in the NICUs. Patient rooms were not entered, except for a large intensive-care room in order to meet the nurse in charge. The written data have been stored in a locked place, and electronic data in the computer is protected by password. Pseudonymized or anonymized data were used in analysis and in study reports.

Qualitative data were collected by the development project's organization, which obtained consent to use it for research purposes. Therefore, approval from a research ethics committee was not obtained. However, the topic is sensitive, and therefore the approval of the ethics committee would have strengthened the ethics of this study. In the quantitative phase, the study was approved by the Regional Ethics Committee of the Expert Responsibility area of Tampere University Hospital (R15100H and R16100H). The permissions for the studies were obtained from the hospitals and from the chairs of the participating associations.

Good scientific practice is an essential part of ethically sound research (Eriksson et al. 2008, Finnish Advisory Board on Research Integrity 2012). In this study, the guidelines (Finnish Advisory Board on Research Integrity 2012) were followed. The results were reported following the ethical guidelines of conflict of interest, funding, and guidelines regarding authorship of the articles. Other researchers' works were acknowledged properly with citations. (Finnish Advisory Board on Research Integrity 2012.)

6.2 Strengths and limitations of the study

6.2.1 Phase I: Trustworthiness

The integrative review was conducted to clearly identify the problem, conduct a comprehensive literature search, evaluate the data meaningfully, analyze the data to achieve a thorough and unbiased interpretation, and finally to present the results explicitly (Whittemore & Knafl 2005). The research problem was identified clearly using the PICo mnemonic (Joanna Briggs Institute 2011). This helped to identify search terms, inclusion criteria, and with data selection and analysis. In particular, breastfeeding was defined carefully, since a high amount of variability is prevalent when defining breastfeeding in an NICU context. However, the research problem was concerned only with describing existing research. Applying an explicit theoretical perspective in the research aim (Kirkevold 1997) would have advanced the understanding of the phenomena (Whittemore & Knafl 2005). An extensive list of search terms was used to identify the data (Article I). As recommended (Whittemore & Knafl 2005), two additional search strategies (references and first authors of the included studies) were applied to increase the comprehensiveness of the search. However, only electronic databases were used, and including hand searches would have increased the extensiveness of the searches. A major limitation of the review was that only one researcher searched and selected the studies. This could have led to systematic error and biased data (Joanna Briggs Institute 2011) despite the use of explicit checklists. Furthermore, data quality evaluation was done by one researcher. None of the studies were excluded based on the quality evaluation, but some studies with moderate quality were included. Among these studies, validity (Jones et al. 2009) and trustworthiness (Pridham et al. 2004, Callen et al. 2005) of the results can be questioned.

Guidelines of thematic analysis (Braun & Clarke 2006) were applied in data analysis. The findings from primary studies were carefully extracted. However, in this phase, using two researchers would have decreased the potential for error (Joanna Briggs Institute 2011) and excluding relevant extracts (Braun & Clarke 2006). This is a particular problem in this data, since some studies described both mothers' and fathers' experiences. The researcher tried to carefully extract and separate mothers' experiences from fathers' experiences, but in some cases this was impossible. Therefore, the results may have influenced by fathers' experiences. On the other hand, it has been argued that using two coders is not relevant in thematic analysis because of its pure qualitative nature, which renders the goal of the analysis not as objective as possible (Vaismoradi et al. 2013). The selection of suitable code was problematic, since some of the studies

were descriptive in nature and some extended their analysis in a more interpretative and abstract level. This threatens credibility of the study (Lincoln & Guba 1985). The review included studies within 10 years at the time of data collection. Additional searches were conducted during the peer review process, resulting in a time frame from 2002 to 2014. This long timeframe in included studies as well as during the analysis process is a threat to dependability (Lincoln & Guba 1985). However, one pitfall in conducting thematic analysis is in rushing through it without allowing time for interpretative understanding of the data (Braun & Clarke 2006). The researcher's experience in the field may have influenced the analysis process and results, which is a threat to confirmability (Lincoln & Guba 1985). The researcher tried to avoid this by writing a diary during the analysis process (Vaismoradi et al. 2013). The analysis resulted in interpretation of a new insight into the phenomena (Vaismoradi et al. 2013) and new understanding with practical implementations (Whittemore & Knafl 2005), as coping was identified to be a central concept. The review was written with an aim to provide detailed description of the data and analysis to support conclusions (Whittemore & Knafl 2005). The transferability of the study (Lincoln & Guba 1985) was strengthened by this.

The data for the qualitative study to describe mothers' experiences with milk expression were collected via the Internet. The questions regarding the suitability of data collection for the intended focus refer to credibility of the study (Lincoln & Guba 1985, Graneheim & Lundman 2004). The Internet has been recognized as a useful tool to reach small or marginal populations (Wilkerson et al. 2014) or populations who have difficulties leaving their homes (Whitehead 2007), such as mothers of newborn infants. Data collection via the Internet can be assessed as suitable for this population, since mothers aged 18-40 years old are familiar with the technology, and geographical diversity increased heterogeneity of the data (Wilkerson et al. 2014). The Internet can be equal to or even better tool than face-to-face methods to collect data regarding a sensitive topic because of anonymity and lack of social pressure (Whitehead 2007, Wilkerson et al. 2014). Using this approach, geographically heterogenic data, as well as a high variety of experiences (e.g., mothers with moderately preterm infants and mothers with extremely preterm and critically ill infants) were gathered, supporting credibility (Lincoln & Guba 1985, Graneheim & Lundman 2004). Furthermore, descriptions regarding negative emotions and experiences were prevalent in this data, suggesting the lack of social pressure. The sample size was large in qualitative design, and data saturation was achieved, suggesting credibility (Lincoln & Guba 1985, Graneheim & Lundman 2004). In this study, the questionnaires were open to everyone, although the link to the questionnaire was distributed in closed Facebook groups. Meeting the inclusion criteria were determined based on provided information. This approach was at risk of fictional responses, and truthfulness of the answers and

participants cannot be ensured (Whitehead 2007). Despite the risk, the amount of fictional answers in Internet-mediated research is considered to be very low (Buchanan et al. 2005). In this study, the terms and language the mothers used in their responses indicated that they have likely had personal experience in an NICU.

Dependability (Lincoln & Guba 1985, Graneheim & Lundman 2004) of the study was threatened by the fact that no time limitations were used as exclusion criteria. Elapsed time from mothers' NICU experience was highly variable in this data. On the other hand, the data were collected using a questionnaire with open-ended questions, and therefore the questions remained unchanged during the data collection. Using a questionnaire strengthens confirmability, since the researcher had no influence on data collection (Lincoln & Guba 1985). However, dialogue between the participants and the researcher would have enriched the data, increasing its credibility. The researcher had worked a long period of time with preterm infants' families, and therefore she had a strong pre-understanding of the phenomena. The researcher's influence on analysis was diminished by active recognition and by writing a diary during the analysis. On the other hand, the researcher understood the terminology the mothers used in their narratives, and typical care pathways were familiar. This strengthened the active subjective role of the researcher in analysis, and therefore confirmability. Transferability was strengthened by providing clear and distinct description of context, participants and methods (Graneheim & Lundman 2004). The researcher suggests that the results are transferable to mothers who infants are hospitalized in NICUs for another reason than prematurity.

Secondary analysis with the aim to identify mothers' expression-related coping strategies had the same limitations regarding data collection methods as discussed previously. Furthermore, some additional limitations were prevalent. The datasets contained maternal experiences and narratives regarding expressing. Coping strategies were identified by deductive analysis; this feature diminishes the credibility of the work (Elo et al. 2014). Asking the mothers to share their strategies for coping with expressing could have been another useful strategy; however, the complexity and abstract nature of the concept, as well as the different meanings assigned to it in everyday language, could have caused difficulties. Both the first and secondary analysis applied qualitative descriptive design, and therefore the methodological underpinnings of the data were not violated by the secondary analysis (Thorne 1994, Long-Sutehall et al. 2010). This study integrated two different datasets (i.e., a qualitative dataset and a dataset on previous studies). Because methodological literature was not available to guide this approach, the risk of bias exists. Nevertheless, the insights from the maternal narratives were supported by previous literature and vice versa, suggesting the trustworthiness of the results and the saturation of the data. Enlisting two or more researchers to independently perform the analysis would have increased credibility and

conformability (Elo et al. 2014). In this study, one researcher formulated and analyzed the items; the results were presented to the research group and corrected until a consensus was reached.

6.2.2 Phase II: Validity and reliability

In the quantitative phase, the data were collected using convenience sampling. This was a limitation, and using adequate sampling method would have strengthened the study (Polit & Beck 2012). On the other hand, as per the researcher's previous experience, selecting multiple hospitals in the study significantly decreases response rate (Ikonen et al. 2014). This may occur due to a lack of the researcher's active role in data collection. In this study, the researcher visited the NICUs frequently and thus ensured that all eligible mothers were invited to participate. The response rate (61.6%) can be considered good for a sensitive topic and among mothers in stressful and exhausting situations. Because of ethical reasons, information of mothers who declined were not collected, which limits possibilities to evaluate the impact of declining participants' influence on the data. Furthermore, presence of crisis in the family's life was used as exclusion criteria because of ethical reasons. The crises related to infants' extremely critical conditions. This limited the generalization of the results in the most fragile infants' mothers in NICUs and may have caused skewness in measurements regarding mothers' well-being and stress. Furthermore, the mothers were all Caucasian, had fluent Finnish language skills and they were generally well educated, which limited the generalization of the results.

Additional data for validity and reliability assessment of the CMEPI scale were collected via the Internet. The same problem as with qualitative data regarding potential fictional answers was prevalent, although the strategy, where the questionnaire was sent to the participant after consent, may have diminished this risk. The data were checked to detect possible multiple submissions (Whitehead 2007) and none were found. Responses between paper and online questionnaires may vary, and psychometric properties may change subtly (Whitehead 2007). This is a major limitation in this study, and unfortunately the sample sizes do not enable evaluation of the construct validity of the CMEPI scale independently for offline and online measurements. Furthermore, the answers are likely to differ naturally between hospitalized and NICU-graduated infants' mothers, and the effect of measurement strategy (offline/online) cannot be detected.

Measurements with established validity and reliability were not used in this study, since such scales were not available. Expression-related stress and subjective managing with expressing were measured with single questions using a Visual Analogue Scale.

The available measurements measure general stress and appraisal, and therefore they were considered to be invalid. Furthermore, expression frequency was measured at one time point with a single question. Expressing diary would have provided more accurate information about mothers' expressing frequency. Appraisal methods were measured using Lazarus' and Folkman's (1984) checklist, and were modified by adding the word "expressing" in the items. These alterations and compromises reduce the validity of the study (Polit & Beck 2012). The developed CMEPI scale showed acceptable psychometric properties. The development process was conducted using established guidelines of operationalization, content evaluation, item analysis, and measurement of psychometric properties. However, face validity was measured using email-based questions regarding understandability and clarity of the items. Using face-to-face interviews and the think aloud technique would have strengthened validity of the scale (see Kearney 2016). Furthermore, two out of five subscales had unacceptable internal consistency, and one subscale had unacceptable test-retest reliability. These findings further limit the validity and reliability of the CMEPI scale.

The analysis was initiated by carefully checking the entered data. The power analyses (Kellar & Kelvin 2013, Soper 2017a, 2017b) supported the suitability of the selected methods for the data, but in several bivariate analyses the groups of independent variables were too small to achieve statistical power. This increased the risk of type II error. However, the analyses were also conducted using non-parametric tests, and no further statistical significant differences were found. EFA was also conducted with the small sample, and a generally acceptable sample size of 10 participants per item (Kellar & Kelvin 2013) was not fulfilled. Furthermore, the sample size for EFA can be evaluated retrospectively based on communalities and gained factor structure (MacCallum et al. 1999). In this study, the adequate factor structure was gained based on a fixed number of factors. This may indicate that the sample size was insufficient to form adequate factor structure with large factors (number of items) based on eigenvalues. However, the CMEPI scale is a large 44-item scale; the larger the scale, the smaller the percentage of item variance (mean of squared factor loadings) is needed to form a new factor based on eigenvalue greater than 1. (e.g., for 20-item scale 5% of variance = eigenvalue 1.0 vs. 40-item scale 5% of variance = eigenvalue 2.0). As a result of fixed number of factors, the communalities in final factor analysis were < .30 in 11 items. This indicates that the results of EFA should be generalized with caution.

The analyses were conducted using both parametric and non-parametric tests if the distribution of the variable was ambiguous. Dichotomization of dependent variables for multiple logistic regression was done based on current evidence of adequate expression practices and use of mothers' breast milk. The suitability of multiple linear regression was evaluated by distribution of the variables and distribution of residuals

(Kellar & Kelvin 2013, Weisberg 2014), which indicated suitability of the selected analysis method. The amount of variance explained for the models describing the use of coping strategies (20.9%) is low, and the model should be interpreted with caution. The model explained 45.7% of variance in managing with expression; this can be considered as adequate. The prerequisites for mediation analysis (MacKinnon et al. 2007) were fulfilled. The sample size was not adequate for mediation analysis to eliminate type II error (Fritz & MacKinnon 2007). However, statistically significant effects were found, suggesting that the sample size was sufficient for this purpose and the results of mediation analysis were suggestive. A biostatistician was consulted during the analysis, which decreased the possibility of errors in the analysis process and interpretations.

6.3 Discussion of the results

6.3.1 Mothers' experiences and practices of expression

Mothers' experiences with breast milk expression were described in articles I and II. For this discussion, the searches (Article I) were repeated in CINAHL and Medline to detect studies published in 2014-2016 to describe preterm mothers' experiences with milk expressing. No further studies were found. However, two previously published reviews describing expression and breast milk supply in the NICU among term and preterm infants from mothers' perspectives were found (Lucas et al. 2014, Alves et al. 2013). To discuss the results of this study with previous studies, it should be kept in mind that preterm birth and having an premature infant have some unique characteristics, such as interrupted pregnancy, uncompleted growth to motherhood, appearance of the preterm infant, and long hospitalization time (Aagaard & Hall 2008, Goutaudier et al. 2011, Rossman et al. 2015).

Breast milk is highly valued by preterm infants' mothers. The advantages of breast milk (American Academy of Pediatrics 2012) are well known, and these advantages motivated the mothers to initiate and continue expression. In fact, providing breast milk was seen as medicine and lifeline (Article II) and as a lifesaver (Rossman et al. 2013) by the mothers. The strong and consistent message of valuable breast milk further fostered this perception (Articles I, II). In Finland, expecting mothers as well as preterm infants' mothers have positive attitudes toward breastfeeding (Laanterä et al. 2010, Niela-Vilen et al. 2016), and almost all mothers initiate breastfeeding (National Institute for Health and Welfare 2012). However, even mothers with an initial decision to not breastfeed may change their minds after the preterm birth and information

about benefits of breast milk (Lucas et al. 2014). On the other hand, the mothers felt that because of the necessity of breast milk, expression may become an obligatory task (Article I). The mothers felt that providing milk is a way to compensate for the harm of preterm birth for the infant, as well as decrease the feeding of guilt (Article I). However, Finnish mothers did not describe such feelings (Article II).

Expression was viewed as a unique maternal task to contribute to infant care (Articles I, II). The mothers of preterm infants are eager to be useful in the NICU, to provide care, and to create physical and emotional connection with their infants (Aagaard & Hall 2008, Cleveland 2008). In fact, providing breast milk and breastfeeding are ways to facilitate closeness with a preterm infant (Flacking et al. 2016). On the other hand, this could lead to a situation in which milk is the only way to establish and maintain connection to the infant (Article I). Therefore the importance of other ways of closeness, like physical closeness, contributing to infant wellness, understanding the situation, caretaking, and bonding as a family (Flacking et al. 2016) should be kept in mind.

The dependency on the nurses, adjustment to NICU routines, and the need to be qualified as good mothers (Aagaard & Hall 2008, Cleveland 2008) may lead to a situation in which mothers and motherhood are constantly controlled, supervised, and evaluated. In this situation, expression and breast milk are also controlled. The mothers felt that breast milk was objectified by controlling the amounts and charting them (Article I). Furthermore, the adequateness of breast milk was a constant concern for the mothers; mothers compared their milk amount to others' (Articles I, II). This should be minimized by respecting the mothers' autonomy and role as primary caregivers (Nyqvist et al. 2012) as well as avoiding highlighting the needed milk amounts.

Articles I and II revealed consistently that initiating and maintaining lactation was not unproblematic for preterm infants' mothers. Almost three-quarters of the mothers described obstacles in expressing milk (Article II). The NICU environment may serve as an obstacle due to lack of privacy, separation, lack of adequate equipment, and scheduling problems (Articles I, II). These barriers have also been described by Alves et al. (2013) via parents' views on hindering factors. Notably, the NICU environment have also been described as an obstacle to comfortable and natural mothering (Aagaard & Hall 2008, Cleveland 2008) and to mother-infant closeness (Flacking et al. 2012). On the other hand, proximity of an infant have been found to be associated with higher milk volume (Acuna-Muga et al. 2014), although the mothers may feel more comfortable expressing at home (Lucas et al. 2014). The mothers felt uncomfortable to express in front of others and in the hectic NICU (Article I, Alves et al. 2013). This may be cultural, since Finnish mothers did not experience lack of privacy as a problem, but emphasized the importance of peaceful and comfortable

rooms for expressing (Article II). The results highlight the importance of a peaceful, private, and comfortable NICU environment for both mothering and lactation.

The mothers were concerned about perceived insufficiency of milk and actual insufficiency of milk was a prevalent problem, leading to negative feelings (Article I). These findings are parallel to the findings of Alves et al. (2013), who found that difficulties with pumping and worries about sufficiency of milk were often described barriers to breast milk supply. This concern is justified, as in Article IV only half of the mothers actually had sufficient milk supply to meet the infants' requirement. In this study, lack of previous expression experience, financial woes, and infant's high GA were predictors for non-exclusive use of mothers' own breast milk in the NICU. Previous studies have found several factors associated with insufficient milk supply and breastfeeding. These included mothers' age (Hill et al. 2007), previous breastfeeding experience (Hill et al. 1999b, Maastrup et al. 2014), financial status (Hill 1999a, Hill & Aldag 2005, Hill & Aldag 2005), caesarean section (Murase et al. 2014), infant's male gender (Maastrup et al. 2014), GA at birth (Hill & Aldag 2005, Hill et al. 2005b, Maastrup et al. 2014), and twin pregnancy (Hill et al. 2007, Maastrup et al. 2014). Notably, qualitative studies have highlighted mothers' exhaustion and stress as reasons for insufficient milk supply (Article I), but the results of this study (Article IV) or a further quantitative study by Hill et al. (2006) did not support this finding. The results suggest that increasing the milk amount to a sufficient level at the beginning of lactation was difficult, especially for the mothers whose infants are not very preterm, and therefore the milk requirement is higher (Article IV). Furthermore, maintaining lactation is often demanding for the mothers of very preterm infants (Hill et al. 2005b, Maastrup et al. 2014), presumably because of long hospitalization times.

Initiation of expression and expression frequency have been associated with adequacy of milk supply (Hill et al. 1999a, Hill et al. 2001, Hill et al. 2005b, Parker et al. 2013, Maastrup et al. 2014, Murase et al. 2014). Article IV and the summary described factors associated with late initiation and inadequate frequency of expression. The findings revealed that mothers' previous intensive care unit experience, poor psychological well-being, an infant's male gender, caesarean section, and infant's high gestational birth age were predictors of late initiation. As described previously, an infant's male gender (Maastrup et al. 2014) and caesarean section (Murase et al. 2014) have also found to associate with insufficient milk supply. The current study suggested that these factors may hinder the milk supply by delaying initiation of expression. Furthermore, Murphy et al. (2014) have shown that education of health care staff and workforce of lactation consultants decrease the initiation time. These results suggest that by training health care professionals and providing high-quality counseling for the mothers, especially for those who are at risk of late initiation, may decrease expression initiation time.

Interestingly, none of the studied factors were associated with expression frequency. The previous studies have concentrated on expression initiation (Murase et al. 2014, Murphy et al. 2014, Fabiyi et al. 2015) and less is known about mothers' expressing frequency and associated factors. Qualitative studies have indicated that difficulties in scheduling, conflicting advice, and lack of privacy are burdens in maintaining adequate expression frequency (Articles I, II, Alves et al. 2013, Lucas et al. 2014, Ikonen et al. 2016). Furthermore, it is known that expression tends to decrease or even cease two weeks after the birth (Lucas et al. 2014). In this study, however, only one-third of the mothers expressed the recommended amount more than six times per a day, despite the fact that their infants were on average less than two weeks old. The potential explaining factors may be discomfort of expression, and lack of adequate counseling and social support (Lucas et al. 2014, Fabiyi et al. 2015). Systematic assessment and treatment of nipple traumas, adequate information about lactation physiology and required expression frequency, and social support may be effective interventions to increase expression frequency (Alves et al. 2013, Lucas et al. 2014), although Héon et al. (2016) did not find that a systematic counseling intervention had any impact on expression frequency in their pilot study.

As discussed, expression initiation, frequency, and milk supply were inadequate in this study. Results from Articles I and II indicate that the mothers looked forward to easier breastfeeding. In another Finnish study, the mothers exhibited unjustified hopes of easier breastfeeding after discharge (Niela-Vilen et al. 2015). According to the results of this study, the hope of easier breastfeeding after expression phase may be also unjustified. With inadequate expression frequency and inadequate milk supply at the early phase of lactation, mothers are at risk of breastfeeding failure (Hill et al. 2007, Nyqvist et al. 2013). Transition to breastfeeding included additional concerns such as problems with latching and positioning, interfering supplementation and test-weighing, and negative feelings regarding the concerns (Article I). To sum up, active managing of expression-related concerns and insufficient milk supply are essential, because transitioning to breastfeeding does not solve these problems; additional concerns are prevalent.

Previous studies have indicated that expression is extremely stressful and exhausting for the mothers (Article I). Surprisingly, the findings of this study did not support this, as the mothers reported only moderate expression-related stress. Similarly, qualitative studies have indicated that having a preterm, NICU-hospitalized infant is very stressful for the mothers (Aagaard & Hall 2008), but quantitative measures do not fully support this finding (Shaw et al. 2013, Pritchard & Montgomery-Hönger 2014). Hill et al. (2009) have suggested that mothers adapt hormonally to stress, since their oxytocin levels are higher than those of mothers of term, healthy infants. In addition, stress and lactation have a two-fold relationship, since lactation-related hormones affects and are

affected by stress hormones (Hill et al. 2009). In qualitative studies, exhaustion and stress have been identified as barriers to expression and milk supply (Articles I, II, Alves et al. 2013, Lucas et al. 2014). However, in this study, expression-related stress was not associated with expression initiation, frequency or use of mothers' own breast milk (Article IV). Furthermore, the mothers felt that they managed well with expression. These results indicate that mothers may have the potential to increase their expression frequency and thus increase their milk supply.

6.3.2 Coping with milk expression

Coping strategies are essential mechanisms that enable individuals to gain control over or tolerate a situation or demand that taxes or exceeds their resources (Lazarus & Folkman, 1984). The infants' admission to the NICU may be stressful for the mothers (Aagaard & Hall 2008, Cleveland 2008). Parental role alteration (Shaw et al. 2013, Pritchard & Montgomery–Hönger 2014, Horwitz et al. 2015a, Samra et al. 2015,) as well as the first weeks after the NICU admission (Zelkowitz et al. 2011, Marticardi et al. 2012) have been identified as the most stressful time periods for the mothers. Furthermore, as discussed previously, milk expressing was a difficult, exhausting, and demanding task for mothers of preterm infants (Articles I, II). In this study (Article III) several expression-related coping strategies were identified. The results are supported by Lazarus and Folkman's theory (Folkman & Lazarus 1980, Lazarus & Folkman 1984, Folkman & Lazarus 1985) given that the presence of challenging demands drove the adoption of several strategies for tolerating or gaining control over the situation and maintaining equilibrium. First, the results of qualitative secondary analysis are discussed with original theory (Lazarus & Folkman 1984, Folkman & Lazarus 1988) in this section. Then, the psychometric properties of the CMEPI scale are discussed, and the subscales of the CMEPI scale are compared to the existing scale used among mothers of preterm infants (Shaw et al. 2013, Horwitz et al. 2015b).

Folkman and Lazarus (1988) identified four emotion-focused strategies (positive reappraisal distancing, self-controlling, escape-avoidance,) and four problem-focused coping strategies (seeking social support, planful problem-solving, accepting responsibility and confrontive coping). The mothers tried to create a positive outlook, for instance by trying to focus on the benefits of expressing for infants, motherhood, and breastfeeding. Expressing was tolerated by the mothers because they reevaluated it as a means of initiating, sustaining, and strengthening motherhood. Similarly, positively reappraising a situation includes efforts to create positive meaning by focusing on personal growth (Folkman & Lazarus 1988). Notably, distancing (Folkman & Lazarus 1988) was not found in this analysis. This result can be attributed to the fact that the

data in both previous studies and the maternal narratives were collected from mothers who initiated expressing. Mothers who refused to initiate expressing and therefore detached themselves from this situation were excluded from the analysis. In this study, the mothers regulated their perspectives by focusing on the positive aspects of expressing, and disregarding the difficulty and demanding nature of the activity. The mothers also believed in the possibility of success and normalized the negative connotations of expressing; that is, they denied the potential for failure or refrained from viewing expressing as unnatural. Similarly, Folkman and Lazarus (1988) have also found self-control to be a coping strategy that encompasses regulating one's feelings and actions. The fourth emotion-focused coping strategy identified by Folkman and Lazarus (1988) is escape-avoidance, which pertains to behavioral efforts to escape or avoid a situation. In this study, two subcategories that revolve around the negative aspects of expressing, as well as giving up and escaping, are similar to this coping strategy.

With respect to problem-focused coping strategies, seeking social support was found to be prevalent in both the present research and Folkman and Lazarus's (1988) study. The mothers learned new required skills and obtained information on expressing, created a comfortable environment and purchased expressing equipment, and attempted to manage milk amount, which are part of planned problem-solving (Folkman & Lazarus 1988). Controlling milk amount was a strategy that can be considered equivalent to accepting responsibility, which is an approach to setting things right and acknowledging one's role in solving a problem (Folkman & Lazarus 1988). The mothers were insistent in their belief that expressing is obligatory, in correspondence with the concept of confrontive coping (Folkman & Lazarus 1988). Unlike many other demanding situations, such as threats to one's physical well-being, expressing imposes demands that an individual can eliminate from her life. The decision to cease expressing and decrease expressing frequency was therefore recognized as a problem-focused coping strategy in the present study. This approach was not identified by Folkman and Lazarus (1988).

The developed CMEPI scale demonstrated very good content validity (Article III). According to the findings, the experts evaluated that the items of the scale are relevant, and the mothers regarded the items to be understandable. Content validity is difficult to measure accurately (Polit & Beck 2012), and it has been suggested that poor content validity indexes are rarely presented (Kearney 2016). The construct validity was assessed using EFA, which resulted in five meaningful factors: Alienating, Activity and Learning, Mastering, Facilitation and Delimitation and Positive Thinking. Thus, results of qualitative analysis were not supported by EFA. Furthermore, the factors cannot be divided solely to emotion- or problem-focused strategies, but they have elements from both forms of coping. However, some of the factors are mainly emotion-focused (e.g.,

Positive Thinking) or problem-focused (e.g., Activity and Learning). The factors correlated positively and significantly (Article III). This was expected, since a stressful situation leads to use of several simultaneous coping strategies (Lazarus & Folkman 1984).

According to the theory (Lazarus & Folkman 1984), appraisal precedes the selection and use of coping strategies. To measure concurrent validity of the CMEPI scale, appraisal methods were measured with a modified scale. Not all expected associations between appraisal methods and coping strategies were prevalent in this sample. This may suggest weak criterion validity of the CMEPI scale. Alternatively, the appraisal of expression was very homogenic, resulting in very small groups, and therefore resulting in invalid results in statistical tests (type II error). Mainly emotion-focused strategies (Accepting and Positive Thinking) were found to be significant predictors of subjective managing with expression, whereas mainly problem-focused strategies (Mastering and Facilitation and Delimitation) were associated with expression frequency. These results suggest evidence of criterion validity. Notably, samples of hospitalized and discharged infants' mothers were used, and similar associations between coping strategies and expression frequency were not found in the sample of hospitalized infants' mothers. This finding suggest that some external factors (e.g., NICU environment, scheduling problems) may be associated with expression frequency rather than coping strategies in mothers of hospitalized infants.

The BRIEF Cope scale, which have been used to measure general coping strategies of NICU-hospitalized infants' mothers, include three subscales: emotion-focused, problem-focused coping and dysfunctional scale (Shaw et al. 2013, Horwitz et al. 2015b). In this study, found alienating strategies refer to avoidant actions and thinking expressing as unmanageable and intolerable. Unlike in many other stressful situations, mothers are able to avoid expressing; as found in Article I, they use ceasing as the last coping strategy in unmanageable situations. The findings from Articles I and II suggest that ceasing expression brought relief to mothers' lives and thus improves their well-being. Therefore, avoiding expression is may not be solely dysfunctional for the mothers. Furthermore, Lazarus & Folkman (1984) have suggested that coping strategies should not be classified as good or bad.

In this study, the found relationship between expression-related stress and coping strategies was expected. A lower level of experienced stress was associated with higher use of coping strategies for expressing. Conversely, the higher the stress level was, the higher the use of alienating strategies. Furthermore, the use of coping strategies was associated with lack of previous expression experience and with mothers of young preterm infants. Previous studies have not studied associations between mothers' and infants' characteristics and coping strategies. Furthermore, managing with expressing was explained by expression-related stress and use of coping strategies. The mediation

analysis further suggested that the direct relationship between expression-related stress and managing with expressing was stronger than the mediation effect of coping strategies. However, the mediation effect was also significant. The results suggest that experienced stress predicted the experience of managing with expression, which was also supported by qualitative findings (Articles I, II). The use of coping strategies also predicted the experience of managing with expression. This is in line with the theory, as the use of coping strategies is associated with successful resolution of an encounter (Folkman et al. 1986, Folkman & Greer 2000). However, the association between stress and managing is strong, and the use of coping strategies is significant but a weak mediator between those experiences.

Previous studies have indicated that mothers may lose their ability to control the situation and even their autonomy in the NICU (Aagaard & Hall 2008, Cleveland 2008). As a result, they may have to adjust to the NICU's regulations and perform their motherhood duties within the limits set by nurses (Aagaard & Hall 2008, Cleveland 2008). In an uncontrollable situation, a person mobilizes coping strategies that rely on appraised controllability of the event, e.g., by doing small tasks (Folkman & Moskowitz 2000a). These strategies have been identified as beneficial for the person's well-being (Folkman & Moskowitz 2000a). Fluent expression and ability to offer beneficial breast milk can offer small, controllable tasks for the mothers in this stressful situation. By supporting coping strategies that support the sense of controllability, generally in the NICU and specifically related to expression, mothers' well-being may increase and stress levels may decrease. This should be studied further.

Lazarus (2000) highlighted the need of longitudinal research to explore individual coping strategies and their changes over time. The current study was a first step to explore maternal coping strategies in milk expressing, and opens many questions regarding the change of coping functions over time and the predictive power to succeed in expressing. As coping strategies are constantly changing because of environmental changes and alterations in people's appraisals (Lazarus & Folkman 1984), expression-related coping strategies should be studied during specific time periods of the NICU stay. Furthermore, the associations between expression-related coping strategies and objectively measured expression-related and health-related outcomes should be studied (see Lazarus 2000).

As a researcher, I have discovered that the mothers of preterm infants confront several different barriers in expressing. Providing breast milk for their fragile infants can be stressful and exhausting, but on average, the mothers who participated in this study did not consider expression very stressful. I have come to understand that providing breast milk is a way to be a mother to one's preterm infant, as I observed as a young NICU nurse. The question that I pondered was why the mothers do not express as frequently as needed. This remains unanswered. I have found that factors

which I assumed to be the reasons for insufficient expression frequency, such as mothers' well-being and perceived stressfulness of expression, do not explain insufficient expression frequency. Furthermore, I have found several characteristics that are associated with delays in expression initiation, as well as explaining factors for inadequate milk supply. I have also revealed some of the psychological mechanisms the mothers use to tolerate expression. Nonetheless, the underlying reason for infrequent expression remained unsolved.

6.4 Implications for practice

1. The mothers need accurate information and counseling regarding the advantages of breast milk, and importance of immediate initiation and frequent frequency of expression.
2. Mothers of preterm infants confront several practical barriers in expression. Mothers' emotional and physical well-being should be evaluated, and adequate counseling should be provided. Mothers with no previous expression experience and mothers with compromised physical and psychological well-being need special attention, since they experience more expression-related stress.
3. Expression initiation and frequency were suboptimal. The mothers need to be supported by informational, emotional and practical counseling to initiate expression within six hours from birth and maintain expression frequency of more than six times per a day. Special attention should be paid to mothers with: previous NICU experience, male-gender infants, caesarean sections, poor psychological well-being, and late preterm infants.
4. Mothers use several different kinds of coping strategies. The mothers used coping strategies to learn how to express, to master expression, to facilitate and delimitate it, and to think positively. Identification and support of these individual expression-related coping strategies may help mothers to manage with expression. The alienating strategies should not be considered as dysfunctional, since the mothers may cope with an unmanageable situation by avoiding and ceasing expression.
5. Mothers manage with expression fairly well. Mothers with compromised physical and psychological well-being should be supported further, since

compromised well-being was associated with poorer managing. Notably, mothers of older infants felt they managed worse than mothers of younger infants. Therefore expression counseling and support should not be focused on the early phase of hospitalization, but it should continue during the infants' NICU stay.

6. Inadequate expression frequency was not associated with mothers' physical or psychological well-being or expression-related stress or managing with expression. Furthermore, they used a wide array of coping strategies to continue expression. This indicates that the mothers may have potential to increase their expression frequency and thus their milk supply. Potential practical barriers (e.g., lack of privacy or adequate equipment, scheduling concerns) of adequate expressing frequency should be identified and solved individually.
7. Expression may provide a sense of contribution and controllability for the mothers in uncontrollable situations such as an NICU environment. Furthermore, expressing is an important way to provide essential breast milk for preterm infants. These findings suggest that expressing is not solely a burden for the mothers. Counseling and supporting expressing may help mothers to manage with hospitalization of infants and in NICU environment.

6.5 Implications for research

1. There exists an abundance of qualitative research regarding preterm infants' mothers' experiences with expression and breastfeeding. The focus should be shifted to quantitative research, explaining and predicting mothers' experiences and practices.
2. The developed CMEPI scale should be evaluated and developed further with larger and representative samples.
3. The validity of the CMEPI scale among NICU-hospitalized, full-term infants' mothers should be studied.
4. Scales measuring expression-related stress and management of expression should be developed.

5. The associations between expression-related stress, coping strategies, managing with expressing, and expressing frequency should be studied further. In forthcoming studies, representative samples should be collected and more potential variables should be measured and included to models.
6. Longitudinal research on mothers' expression experiences, expression-related stress, utilized coping strategies, and managing with expression should be conducted to examine the outcomes (e.g., successful lactation and achievement of breastfeeding) of these factors.
7. Use of coping strategies should be studied in specific time periods in the NICU and post-discharge, since the use of coping strategies may vary during the expression period.
8. The concept of controllability should be studied within expression. Specifically, the study would focus on controllability or uncontrollability nature of expressing from the viewpoint of the mothers and whether the sense of controllability is associated with expression- and NICU-related stress.

7 Conclusions

1. Breast milk expression is exhausting for preterm infants' mothers, and requires learning several unfamiliar skills. At the same time, expression is a way to perform motherhood, establish and maintain the interrupted connection to the infant, and contribute to the infant's care.
2. Despite the demanding nature of expressing, the mothers reported only moderate expression-related stress, and felt that they can manage with expression fairly well in the early phase of lactation.
3. The developed Coping with Milk Expressing for Preterm Infants (CMEPI) scale showed evidence of validity and reliability among mothers of hospitalized and discharged infants.
4. The mothers used a wide range of expression-related coping strategies to tolerate expressing. The use of alienating strategies was minimal, and the most-used strategy was mastering with expression.
5. Low levels of expression-related stress, along with previous NICU experience and infant's age, were associated with the increased use of coping strategies for expression.
6. Expression-related stress and coping strategies were both independently associated with mothers' managing with expression. Coping strategies constituted a weak but significant mediator between expression-related stress and managing with expression.
7. Subjective managing with expression and expression frequency were unrelated issues. The mothers maintain their expressing frequency regardless of their managing with it, and in turn, expressed in inadequate frequency despite the fact that they felt that they manage with it fairly well.

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Appendixes

Appendix 1. Literature searches for the summary

| Aim | Search terms | Inclusion criteria ² | Titles | Abstracts | Full texts | Accepted |
|---|---|--|--|---------------------------------|--------------------------------|--------------------------------|
| To describe the evidence and rationale of using human milk for preterm infants and the recommended practices to increase the breast milk supply and breastfeeding | infant, premature OR premature birth OR infant, extremely/very low birth weight OR neonatal intensive care OR neonatal intensive care unit AND milk, human OR breast feeding OR breast milk expression AND review | Describes human milk benefits or harms of artificial milk among preterm infants Describes practices or interventions with the outcome of milk supply or breastfeeding Is systematically conducted review | MEDLINE 155 CINAHL 161 PsycINFO 19 Cochrane 108 Excluded duplicants 47 N = 396 Updated search 17 | N = 161 Updated N = 6 | N = 91 Updated N = 1 | N = 23 Updated N = 1 |
| To define coping and stress in the context of transactional theory of stress and coping | Lazarus (AU) OR Folkman (AU) AND coping OR cope OR copes (TX) | Describes Lazarus' transactional theory of stress and coping Author R Lazarus or S Folkman Add definition or related factors to the concepts of stress or coping (No time limitations) | CINAHL 2 MEDLINE 65 Psycinfo 823 Excluded duplicants 68 N = 822 Identified Folkman S or Lazarus RS N = 145 | N = 96 | N = 32 | N = 17 |

| | | | | | | |
|--|--|---|---|----------------------------------|---------------------------------|--------------------------------|
| To describe preterm, NICU hospitalized infants' mothers' stress in NICU and post discharge | infant, premature OR premature birth OR infant, extremely/very low birth OR intensive care, neonatal OR intensive care unit, neonatal AND Stress OR Stress Disorders, Post-Traumatic OR Stress, Psychological OR Stress Disorders, Traumatic, Acute OR Stress Disorders, Traumatic | Describes preterm infants' mothers' stress, its' antecedents, or outcomes in NICU or 12 months post discharge. | MEDLINE 423 CINAHL 312 PsycINFO 186 Excluded duplicants 292 N = 629 Updated 80 | N = 137 Updated N = 31 | N = 94 Updated N = 10 | N = 26 Updated N = 4 |
| To describe maternal coping strategies in NICU and post discharge ¹ | infant, premature OR premature birth OR infant, extremely/very low birth OR intensive care, neonatal OR intensive care unit, neonatal AND coping OR family coping OR coping behavior premature OR preterm OR "low birth weight" OR neonatal (AB) AND coping OR cope* (AB) | Describes preterm infants' mothers' coping strategies (strategies to tolerate, master or reduce demands and stress) in NICU or 12 months post discharge | MEDLINE 404 CINAHL 212 Psycinfo 179 Excluded duplicants 275 N = 520 Updated 27 | N = 117 Updated N = 12 | N = 55 Updated N = 2 | N = 7 Updated N = 0 |

¹The searches were performed as a part of review describing parental coping strategies in NICU and postdischarge. The studies describing mothers' coping were extracted for this summary.

²English language, developed country and time limitation from year 2006 were also used as inclusion criteria.

Appendix 2. Items of the CMEPI scale and supporting evidence

| Item | Evidence |
|---|---|
| <i>Alienating</i> | |
| I feel to be too exhausted to be able to express | Exhausting nature of expressing led the mothers to fatigue. ^{0,1,3,7-9,13-16,18-20} |
| I think that expressing is milk is normal, conventional | Mothers tried to neutralize expressing and thought that it was normal and routine-like. ⁰ |
| I think expressing is distressing | Mothers conceived expressing distressing, stressful, and uncomfortable. ^{0,6} |
| I express milk less often than I have been advised to I skip milk expressing sessions | Mothers expressed less often than they have been advised to, paced expressing, and ceased expressing at night times because of their fatigue and insufficient milk supply. ^{0,8,12} Avoiding expressing was easy for them because a pump did not demand them to express. ⁶ |
| I think that expressing disrupts my daily life | Demanding nature of expressing was difficult and mothers conceived that expressing disrupts their daily life and tasks. ^{0,6,8,12,14,15} |
| I think that being with my baby is more important than expressing | Because of ceasing expressing, mothers had an opportunity to give more time for their infants. ⁰ |
| I think that expressing is difficult | Expressing was exhausting and difficult. ^{0,1,3,6-9,13-16,18-20} |
| I think that it's impossible for me to find time to express | Expressing was conceived as too time-consuming. ^{0,6} |
| Expressing makes me happy | Expressing gave positive and therapeutic feelings to the mothers. ^{0,6,8,9,13,14,16,18,19} |
| I think that expressing is unnatural | Expression was conceived as unnatural, and a relationship with a cold pumping machine was very uncomfortable. ^{0,6} |
| I see positive things about stopping expressing | Because of ceasing expressing, mothers had an opportunity to take care of themselves. ⁰ |
| I think that expressing milk is not going to work out | Some mothers conceived expressing as impossible. ⁰ They thought that because of preterm birth their breastfeeding goals were impossible to achieve. ^{6,12,14,17} |
| <i>Activity and learning</i> | |
| I'm learning to express milk | Expressing was a skill which needed to be learn. ¹⁶ |
| I'm looking for someone that I can talk to about the joys and sorrows of expressing | Emotional support from peer supporters and family members was important, but some mothers missed out on emotional support. ^{0,1,8,9,13,15,16} |
| I'm asking for someone to tell me about expressing | Informative support from health care staff and peer supporters was effective and helpful, but some mothers missed out on support. ^{0,2,3,4,11,13,16,18} |
| I'm asking for 'hands on' guidance on expressing | Mothers valued practical help and demonstrations from health care staff and peer supporters, ^{0,2,7,11,13} but hands-on guidance was also conceived as uncomfortable, ²⁰ and some mothers missed out on practical help. ^{0,11} |
| I'm finding out more about expressing I'm looking for information on the importance of breast milk | Mothers experienced unawareness regarding expressing, ⁰ regardless of continuous discussion of benefits of breast milk in NICU. ^{4,5,9,14,17,18} |
| I'm thinking about my baby when I'm expressing | Mothers thought and visualized their babies to be able to express. ⁰ Offering BM was a way to continue and reestablish the biological, physiological and emotional connection with a baby, ^{0,4,6,8-10,14-16,18} but the pump also presented the detachment from the infant. ⁶ |
| I think I'm participating in the care of my child by expressing milk | Mothers felt that breast milk was the only thing they can provide and a concrete thing to do for the infants. ^{0,7,9,14-16,19,20} Offering milk gave to the mothers concrete feeling of taking care of their infant and contribute to the care. ^{0,14,16,18} |
| I think pumping is adventurous | Mothers thought that expressing was new and adventurous. ⁰ |
| <i>Mastering</i> | |
| I'm learning ways to avoid a decrease in my milk supply | Mothers were concerned about adequateness of their milk supply, ^{3,6,9} and tried to avoid decreased milk amount. ³ |

| | |
|--|---|
| I will buy or borrow a good pump to use | Good pumping machine helped mothers to manage with expressing; on the other hand problems with equipment was a prevalent barrier. ^{0,1,6,10,15} |
| I keep track of the amounts of milk that I've expressed | Mothers monitored and charted their milk amounts. ^{0,2,6,14-18} |
| I express so that I can breastfeed my baby later on | Mothers were supported by the hope of breastfeeding, which were considered to be a reward of expressing. ^{0,1,6,11,12,14,15,18} On the other hand, some of the mothers wanted to maintain their milk supply regardless of the feeding method. ¹ |
| I'm doing everything I can to be able to express | Expressing was important for mothers, ^{0,6,19} and they were ready to do anything to succeed in expressing. ⁰ |
| I organize time for expressing | Arranging time for expressing was difficult, but some of the mothers conceived that they have enough time for expressing. ^{0,6,10} |
| I'm trying to increase my milk supply | Mothers tried to increase their milk supply. ^{0,2,7,9} |
| I think that I'm expressing milk for the sake of my baby | Preterm infant and his survival were reasons to express. ^{0,1,5,6,9,18,19} Expressing was a way to compensate the harm of preterm birth for the infant. ^{6,9,13,14,16,19} |
| <i>Facilitation and delimitation</i> | |
| I'm finding out which pump works best for me | Good pumping machine helped mothers to manage with expressing; on the other hand problems with equipment was a prevalent barrier. ^{0,1,6,10,15} |
| I'm trying to make expressing easy | Pumping outside home was difficult, ⁰ as well as storing and transportation of milk. ^{0,1,10,15} |
| I believe that even a small amount of milk is important | Mothers were happy of even a small amount of milk. ^{0,9,16} |
| I'm concentrating on an adequate milk supply | Adequate milk supply helped mothers to manage expressing, and increased their positive feeling and confidence. ^{0,1,9,16} |
| I'm learning to recognize the limits of my capabilities | Mothers needed to learn functions and limits of their bodies and minds to be able to manage with expressing. ^{3,4,20} |
| I think that expressing milk paces the day | Expressing was mothers' own time ⁰ and a source of joy, structure, and hope. ^{9,11,14-16,18} |
| I try to arrange a comfortable place for myself to express | Comfortable pumping place was important for mothers, but sometimes mothers had to pump in uncomfortable places. ⁰ Mothers wished for peaceful and private place to express. ^{0,2,11,15} |
| <i>Positive thinking</i> | |
| I'm confident that I will succeed in expressing | Mothers felt confident of initiation of their lactation, adequate milk supply and succeeding in expressing. ⁰ |
| I decide to be persistent in expressing; I won't give up | Mothers needed motivation and perseverance in expressing. ^{0,4,6,16} |
| I'm learning to express when I'm with my baby | Mother-infant separation impeded expressing. ^{0,1,4,6,8,10,15} Some of the mothers felt pumping next to their infants comfortable, some found it very uncomfortable. ^{0,6} |
| I think that my baby has received enough of my milk | Mothers conceived that their infants' milk requirement was fulfilled. ⁰ |
| I think that expressing milk is an important task | Mothers considered expressing as worthwhile, important, and valuable task. ^{0,1,2,4,6-9,14-16,18,19} |
| I express when I'm in the company of other mothers | Expression with others was therapeutic. ¹¹ |
| I think that expressing milk is going well | Some of the mothers considered expressing as easy, nice and fluent. ^{0,10} |

Citations:

⁰Maternal narratives (n = 130), ¹Bernaix et al. 2006, ²Björk et al. 2012, ³Boucher et al. 2011, ⁴Flacking et al. 2006, ⁵Flacking et al. 2007, ⁶Hurst et al. 2013, ⁷Jones et al. 2009, ⁸Krouse 2002, ⁹Lee et al. 2009, ¹⁰Myers & Rubarth 2013, ¹¹Nyqvist & Kylberg 2008, ¹²Pridham et al. 2004, ¹³Rossmann et al. 2011, ¹⁴Rossmann et al. 2013, ¹⁵Sisk et al. 2010, ¹⁶Swanson et al. 2012, ¹⁷Sweet 2006, ¹⁸Sweet 2008a, ¹⁹Sweet 2008b, ²⁰Swift & Scholten 2009

Original publications

Preterm Infants' Mothers' Experiences With Milk Expression and Breastfeeding

An Integrative Review

Riikka Ikonen, MNsc, RN; Eija Paavilainen, PhD; Marja Kaunonen, PhD

ABSTRACT

Background: Preterm infants' mothers face several challenges when providing critical breast milk for their infants; therefore, sensitive and evidence-based counseling and support are needed. However, a general view of the experiences preterm infants' mothers can face during their infants' hospitalization and after discharge is lacking.

Purpose: The aim of this integrative review was to explore practical and emotional experiences of preterm infants' mothers with respect to breast milk expression and breastfeeding, from the birth of the preterm infant, during the neonatal intensive care unit (NICU) stay, and postdischarge until the cessation of breastfeeding.

Methods/Search Strategy: A systematic literature search from MEDLINE, CINAHL, PsycInfo, and Cochrane databases were performed. The search resulted in 20 qualitative and 3 quantitative studies. The data were analyzed by thematic analysis.

Findings: Coping was the central theme in mothers' experiences. The benefits of breast milk served both as a supportive factor and an obstructive factor for the mothers, and breastfeeding was used to rebuild connection and motherhood. Simultaneously, the mothers needed to cope with new demands, interfering NICU environment, demanding expressing, and difficulties with breastfeeding.

Implications for Practice: Expressing and breastfeeding are important for the mothers to contribute to their infants' care and to rebuild the interrupted connection. Evidence-based and sensitive informational and practical counseling are vital for the mothers. Intensive emotional support is important during encountered problems and during cessation.

Implications for Research: Future research is needed about mothers' experiences using supplementation methods, test-weighing, exploring experiences of mothers of late-preterm infants, and the validity of the concept of coping with this phenomenon.

Key Words: breastfeeding, infant, lactation, mothers, premature, review

An important part of motherhood for mothers of preterm infants is breastfeeding and providing breast milk to their infants.¹ Breast milk and breastfeeding are the gold standards for preterm infants.² Nevertheless, mothers can face several obstacles and concerns related to expressing (breast pumping to provide mother's own milk to the infant) and breastfeeding (direct-at-breastfeeding with or without a nutritive purpose) during the preterm infant's hospitalization and postdischarge. Particular challenges for mothers who are expressing breast milk or breastfeeding are compromised maternal

milk production,^{3,4} the initiation and establishment of breastfeeding,³ and sensitivity of breastfeeding counseling.⁵ Furthermore, other challenges for mothers of preterm infants are developing and maintaining maternal identity,⁶ separation of mother and infant,¹ maternal stress,⁷ and feelings of anxiety and uncertainty in relation to the infant's discharge.⁸

The expansion of the Baby-Friendly Hospital Initiative^{1,9} addresses the challenges mothers of preterm infants encounter providing breast milk and breastfeeding. The Baby-Friendly Hospital Initiative emphasis on the neonatal intensive care unit (NICU) is to reinforce to mothers of preterm infants the benefits of breast milk and breastfeeding by using evidence-based and high-quality breastfeeding counseling and support during their infants' hospitalization in the NICU and postdischarge.^{1,9} High-quality breastfeeding counseling is facilitated by the staff's attitude toward the mother's individual situation, family-centered care acknowledging and supporting parental roles and rights, continuity of the care, and the expanded Ten Steps to Successful Breastfeeding.^{1,9}

The challenges mothers of preterm infants face, such as compromised milk production, breastfeeding difficulties, and insensitive counseling during hospitalization and after the discharge, have been

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The work was conducted at University of Tampere, Tampere, Finland.

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demonstrated.^{1,3-8} Furthermore, the importance of intensive and skilled counseling, as well as evidence-based interventions, is recognized.^{1,9} However, a general view of the experiences mothers can face during their infants' hospitalization and after discharge is lacking. The general view of experiences of preterm infants' mothers in providing breast milk and breastfeeding is important for deepening the understanding of the reality the preterm infants' mothers live through and for implementing efficiently the guidelines and recommendations into practice. The aim of this review was to explore experiences of preterm infants' mothers with respect to breast milk expression and breastfeeding. The emotional and practical experiences are described from the birth of the preterm infant, during the hospitalization in the NICU, and postdischarge until the cessation of breastfeeding.

METHODS

To evaluate and integrate the diverse experiences mothers of preterm infants describe while milk expressing milk and breastfeeding, the integrative review method¹⁰ was chosen.

Information Sources

The conceptual and operational definitions of variables of interest and inclusion and exclusion criteria (Table 1) were explicitly determined prior to data collection to avoid systematic error and bias in data collection and extraction.¹⁰ On the basis of the guidelines of conducting reviews,¹¹ MEDLINE (Medical Literature Analysis and Retrieval System), CINAHL (Cumulative Index to Nursing and Allied Health Literature), the Cochrane Library, and PsycINFO databases were explored in combination with the following key words: breastfeeding/milk expression/lactation/milk ejection, and low birth weight/very low birth weight/premature/extremely premature infant/intensive care, neonatal/intensive care units, neonatal/premature labor/birth/child-birth, and family/multiparas/primiparas/mothers/maternal behavior/maternal role/mother-child relations/mother-infant relations/parental-infant bonding. Furthermore, the included studies' reference lists and first author's other publications were searched with the stated inclusion and exclusion criteria. The searches were limited to English, peer-reviewed articles published from 2002 to 2014. Both quantitative and qualitative studies were included.

TABLE 1. Operational Concepts and Inclusion Criteria Using PICO Mnemonic^a

| PICO | Inclusion Criteria | Operational Definition | Exclusion Criteria |
|-----------------------|--|--|---|
| Population | Mothers of preterm infants | Preterm infant Born at $\leq 36 + 6$ wk gestational age or birth weight under 2500 g | Term infant (>37 wk gestational age and weighing >2500 g) Experiences of family members, healthcare professionals |
| Phenomena of interest | Mothers' experiences with milk expression or breastfeeding, from the birth of preterm infant, during the NICU stay, until cessation of expression or breastfeeding | Expressing: Breast pumping with hands or with electrical pump to provide mother's own milk to the infant Breastfeeding: Direct-at-breastfeeding with or without a nutritive purpose NICU | Experiences of using donor milk or artificial milk Mothers antenatal perceptions |
| Context | NICUs located in developed or graduated developing countries Study published in peer-reviewed journal 2002-2014 in English | Intensive or intermediate (level II, III, or IV, determined by AAP) neonatal care unit Developed or graduated developing countries Determined by IMF | Breastfeeding late-preterm infants in the maternity ward Studies conducted in developing countries Fugitive literature Editorials, reviews without explanation of used methods |
| Outcome | Not stated | Not stated | Not stated |

Abbreviations: AAP, American Academy of Pediatrics; IMF, International Monetary Fund; NICU, neonatal intensive care unit.
^aPICO Mnemonic from The Joanna Briggs Institute.¹¹

The literature search was performed between February and August 2013, and additional search was performed from November 2014 to include studies published from 2013 to 2014.

Study Selection

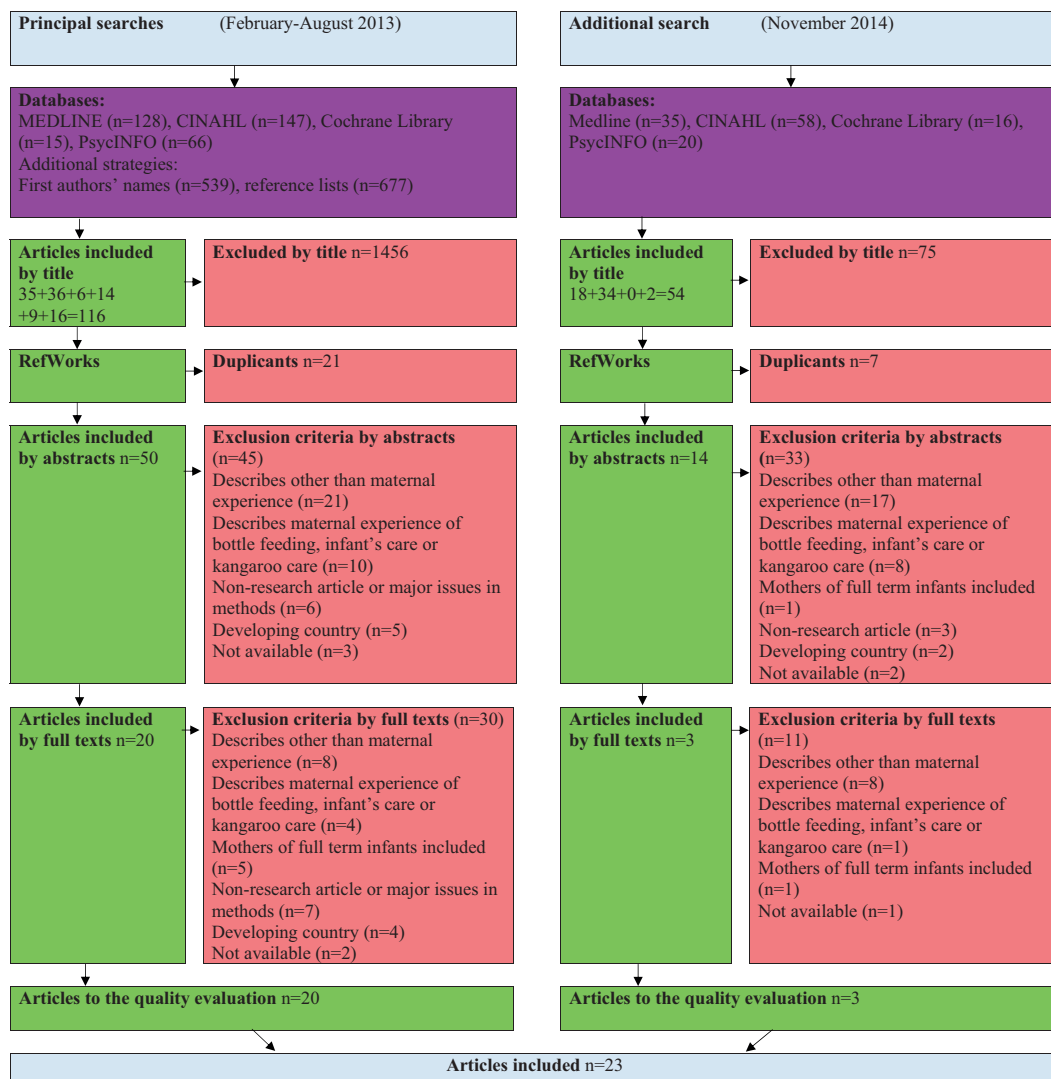
The selection process was performed on titles, abstracts, and full texts (Figure 1). The checklists of operational definitions of variables and inclusion and exclusion criteria were used to avoid systematic bias in data collection. The main exclusion reasons were that the study did not describe the point of view of mothers who were breastfeeding their preterm infants or that the study described maternal experiences with bottle-feeding or infants' care in general (Figure 1). As a result, 23 empirical

studies were included. The quality of the selected studies was evaluated using the QARI instrument for the qualitative studies ($n = 20$) and MASTARI instrument for the quantitative studies ($n = 3$)¹¹ (Table 2).

Data Analysis

The data were analyzed with inductive, overall thematic analysis, as that method offers a flexible method of identifying, analyzing, and reporting themes and of providing interpretative results of the studied phenomenon.¹² The data answering to the aim of the review were extracted verbatim from the selected reports, and reports were then read through to ensure the collection of all relevant data. Data extractions formed data items, from which codes

FIGURE 1



Data searching and selection process.

TABLE 2. An Overview of the Included Studies

| Variable | Studies |
|---|--|
| Location | |
| North America | Bernaix et al, 2006; Boucher et al, 2011; Callen et al, 2005; Hurst et al, 2004, 2013; Krouse, 2002; Myers and Rubarth, 2013; Pridham et al, 2004; Rossman et al, 2011, 2013; Sisk et al, 2010 |
| Australia | Sweet, 2006, 2008, 2009; Swift and Scholten, 2009 |
| Scandinavian countries | Björk et al, 2012; Flacking et al, 2006, 2007; Flacking and Dykes, 2013; Nyqvist and Kylberg, 2008 |
| United Kingdom | Flacking and Dykes, 2013; Jones et al, 2009; Swanson et al, 2012 |
| Taiwan | Lee et al, 2009 |
| Design | |
| Descriptive qualitative | Bernaix et al, 2006; Björk et al, 2012; Boucher et al, 2011; Callen et al, 2005; Krouse, 2002; Lee et al, 2009; Nyqvist and Kylberg, 2008; Rossman et al, 2011, 2013; Sisk et al, 2010; Swanson et al, 2012 |
| Phenomenology | Sweet, 2006, 2008, 2009; Swift and Scholten, 2009 |
| Grounded theory | Flacking et al, 2006, 2007 |
| Ethnography | Flacking and Dykes, 2013; Hurst et al, 2013 |
| Descriptive quantitative | Hurst et al, 2004; Jones et al, 2009; Myers and Rubarth, 2013 |
| Case study | Pridham et al, 2004 |
| Participants | |
| Mothers | Björk et al, 2012; Boucher et al, 2011; Callen et al, 2005; Flacking et al, 2006, 2007; Hurst et al, 2004, 2013; Jones et al, 2009; Lee et al, 2009; Myers and Rubarth, 2013; Nyqvist and Kylberg, 2008; Pridham et al, 2004; Rossman et al, 2011, 2013; Sisk et al, 2010; Swanson et al, 2012 |
| Parents | Bernaix et al, 2006; Flacking and Dykes, 2013; Krouse, 2002; Sweet, 2006, 2008, 2009; Swift and Scholten, 2009 |
| Infants' gestational age in the sample | |
| ≤32 wk | Bernaix et al, 2006; Flacking et al, 2006, 2007; Hurst et al, 2013; Nyqvist and Kylberg, 2008; Pridham et al, 2004; Rossman et al, 2011; Sweet, 2006, 2008, 2009 |
| ≤37 wk | Björk et al, 2012; Boucher et al, 2011; Callen et al, 2005; Flacking and Dykes, 2013; Hurst et al, 2004; Jones et al, 2009; Krouse, 2002; Lee et al, 2009; Myers and Rubarth, 2013; Rossman et al, 2013; Sisk et al, 2010; Swanson et al, 2012; Swift and Scholten, 2009 |
| Time frame | |
| NICU | Bernaix et al, 2006; Björk et al, 2012; Boucher et al, 2011; Flacking et al, 2006; Flacking and Dykes, 2013; Hurst et al, 2013; Jones et al, 2009; Myers and Rubarth, 2013; Nyqvist and Kylberg, 2008; Rossman et al, 2011, 2013; Swanson et al, 2012; Swift and Scholten, 2009 |
| Both NICU and postdischarge | Callen et al, 2005; Krouse, 2002; Lee et al, 2009; Sisk et al, 2010; Sweet, 2006, 2008, 2009 |
| Postdischarge | Flacking et al, 2007; Hurst et al, 2004; Pridham et al, 2004 |
| Quality | |
| Good (QALI 8-10, MASTARI 7-9) | Bernaix et al, 2006; Björk et al, 2012; Boucher et al, 2011; Flacking et al, 2006, 2007; Flacking and Dykes, 2013; Hurst et al, 2004, 2013; Krouse, 2002; Lee et al, 2009; Myers and Rubarth, 2013; Nyqvist and Kylberg, 2008; Rossman et al, 2011, 2013; Sisk et al, 2010; Swanson et al, 2012; Sweet, 2006, 2008, 2009; Swift and Scholten, 2009 |
| Moderate (QALI 4-7, MASTARI 4-6) | Callen et al, 2005; Jones et al, 2009; Pridham et al, 2004 |
| Poor (QALI 1-3, MASTARI 1-3) | |

were identified. Codes ($n = 1092$) were grouped into groups ($n = 92$) by their semantic contents, forming a basis for interpretative subthemes ($n = 8$) and 2 themes,¹² coping with the birth of preterm infant and coping with barriers and concerns. Finally, the subthemes and the themes were reviewed for their internal homogeneity and external heterogeneity, as well as at their correspondence to the data extracts and study reports.¹² Mind maps and notes were used as a help during the analysis. The first author conducted the analysis, and the analysis was reviewed by other authors during and after the analysis process. Furthermore, to achieve the final stage of integrative review, conclusion drawing, and verification, the results of thematic analysis were synthesized and an integrated summation of the phenomenon is presented.¹⁰

FINDINGS

To organize the included studies, a table was created to describe objectives, methods, and main findings of each study (see Supplemental Digital Content 1, available at: <http://links.lww.com/ANC/A11>). The majority of the selected studies were conducted in North America ($n = 11$), were descriptive qualitative studies ($n = 11$), have used only mothers as informants ($n = 16$), described mothers' experiences during the infants' hospitalization in the NICU ($n = 13$), and have good methodological quality ($n = 20$). Furthermore, 10 studies described the experiences of mothers of very preterm infants (≤ 32 weeks gestational age) (Table 2). Nine studies have been conducted in level II or III NICUs, whereas in remaining 14 studies, the level of NICU has not been specified. Only one study described mothers' experiences in rooming-in facility. The experiences of mothers of preterm infants in expressing and breastfeeding were abstracted in 2 themes. The concept of coping was found to be a major theme. First, mothers used expressing and breastfeeding as ways to cope with the birth of a preterm infant, with both positive and negative outcomes. Second, expressing and breastfeeding were highly demanding for the mothers, and they had to cope with emotional and practical barriers and concerns (Table 3).

Coping With the Birth of a Preterm Infant

Studies suggest that the benefits of breast milk and breastfeeding both motivate and obligate mothers to express milk and breastfeed. Bernaix et al,¹³ Boucher et al,¹⁴ Hurst et al,¹⁵ Krouse,¹⁶ Rossman et al,^{17,18} and Sweet¹⁹ stated that awareness of breast milk as the best source of nutrition for preterm infants encouraged mothers to express milk. Furthermore, Lee et al,²⁰ Myers and Rubarth,²¹ and Rossman et al¹⁷ found that offering breast milk was important for mothers because they wanted to avoid exposing

their babies to health-related problems. The mothers trusted the NICU's message regarding the advantages of breast milk.^{13,16,17,20,22-24} Aside from physical benefits, economic and psychosocial advantages were perceived as additional benefits by parents.¹⁶ Swanson et al²⁵ and Sweet¹⁹ revealed that mothers' adherence to their initial decision to breastfeed was not changed by the birth of a preterm infant, but several studies indicated that such birth drove the initiation of breastfeeding, regardless of antenatal decisions.^{13,14,20,25-27} The studies indicated a consistent perception of breast milk and breastfeeding as beneficial to preterm infants, and such benefits function as major motivators for initiating and sustaining lactation.¹³⁻²⁷ Several studies suggest that mothers felt the need to compensate for early birth by providing beneficial breast milk to their infants.^{14,17,18,20} Mothers regarded breast milk and breastfeeding as a means of balancing out the painful intensive care required by preterm infants.^{17,28} Rossman et al^{17,18} and Swanson et al²⁵ described how mothers viewed their bodies as failing them because of premature births and how offering breast milk was the only way to decrease the harm. Milk production reduced the mothers' feelings of guilt.^{17,18,22,25,26} To conclude, the benefits of breast milk and breastfeeding created the urge to compensate for the early birth and the painful intensive care of the infant, as well to decrease mothers' feelings of guilt.^{14,17,18,20,22,25,26,28}

Mothers' responses to expressing were highly paradoxical, even as breastfeeding was perceived as pleasurable.¹⁵ First, expressing was viewed as a necessary evil that must be endured to provide beneficial breast milk to infants.^{5,18,24} Second, expressing was seen as crucial to ensure the ability to breastfeed in future.^{15,24} Elaborating on the mixed attitudes toward breastfeeding, Hurst et al¹⁵ stated that whereas breastfeeding was experienced as intimate, pumping was regarded as "cold." Third, breast engorgement and milk leakage served as incentives for pumping.²⁹ Studies also identified the consequences stemming from the perceived desire and obligation to express. Milk expression was approached with perseverance,^{18,24} thereby causing exhaustion in the mothers.^{15,28} Sweet²³ revealed that mothers wanted to chart milk expression to establish objective evidence of their efforts. The mothers also competed against other mothers.^{24,26} Regardless of the perceived obligation,^{5,15,18,24,29} however, expressing was also consistently viewed as key to coping with an extremely demanding situation.^{13,16,18,22,24,25,27-29} Expressing was an important routine²⁰ and a priority^{18,19,24} for the mothers. Particularly, Björk et al,²² Flacking et al,²⁸ Jones,²⁷ and Rossman et al¹⁸ suggested that achieving adequate milk supply, breastfeeding, and the benefits of breast milk were important reasons for expressing.

TABLE 3. Themes, Subthemes, Main Findings, and Implications for Practice

| Subthemes | Main Findings | Implications for Practice |
|--|--|---|
| <p>Theme: Coping with the birth of preterm infant</p> <p>Beneficial breast milk as a supportive and obstructive factor</p> | <p>The benefits to the preterm infant of breast milk and breastfeeding served as a major motivation to initiate and continue lactation^{13,24}</p> <p>Providing beneficial breast milk was a way to compensate for the preterm birth and decrease the feelings of guilt^{14,17,18,20,22,25,26,28}</p> | <p>Mothers should receive evidence-based information of the benefits of breast milk and breastfeeding, but in a sensitive way</p> <p>Mothers should receive emotional support to cope with difficult emotions in order to avoid relating their coping strategies to breast milk</p> |
| <p>Coping with paradoxical experiences to achieve breastfeeding</p> | <p>Expressing was a necessary evil to provide beneficial breast milk and to achieve breastfeeding.^{5,15,18,24}</p> <p>Expressing was empowering, and a source of joy, structure, hope, and feeling of contribution^{5,13,15,18,20,22,24,25,27,29}</p> <p>Breastfeeding was viewed as natural, instinctive, and extremely desired^{13,15,16,19,24,25,28,30}</p> <p>The physical closeness during breastfeeding was a major source of positive experiences and emotions for the mothers^{5,16,18,20,22,25,26,28}</p> | <p>Mothers should receive strong and consistent emotional support in expressing</p> <p>Expressing should be seen also as a source of managing, not only as a pileup stress</p> <p>Healthcare professionals should maintain hope of breastfeeding during expressing phase</p> <p>Breastfeeding should be initiated as soon as possible to strengthen the mothers' ability to cope with demanding situation</p> |
| <p>Rebuilding connection and motherhood</p> | <p>Expressing and breastfeeding were seen as integral part of motherhood^{13,19,23,24,26}</p> <p>Expressing and breastfeeding developed, supported, and confirmed motherhood^{13,14,20,24,25}</p> <p>Expressing and breastfeeding were important factors to continue and establish a connection with the preterm infants^{14-16,18-20,22,24-29}</p> <p>An urge to validate motherhood and to be a good mother were reasons for the perceived obligation to express and breastfeed^{16,19,23,24,26}</p> <p>Expressing was the only thing the mothers could do for their infants^{17,18,20,21,25-27,29,31}</p> | <p>Because of the strong link between motherhood and expressing and breastfeeding, counseling should be provided in extremely sensitive and encouraging way</p> <p>Expressing and breastfeeding should be recognized as a very important way to rebuild connection and motherhood</p> <p>Expressing should be recognized and supported as a very important way of contribution for the mothers</p> |
| <p>Theme: Coping with barriers and concerns</p> | <p>Coping with new demands</p> <p>The mothers had to reevaluate their breastfeeding goals after the birth of preterm infant^{5,13,18,20,23,30}</p> <p>New coping strategies needed to be learned while persevering with expressing and breastfeeding^{14,26,28,31}</p> <p>Several special and unfamiliar practical skills needed to be learned^{5,14,19,25}</p> | <p>The breastfeeding goals should be discussed with the mother over again after the birth of preterm infant</p> <p>Mothers should receive informational, practical, and emotional counseling and support to cope with new demands in stressful situation</p> |

(continues)

TABLE 3. Themes, Subthemes, Main Findings, and Implications for Practice, Continued

| Subthemes | Main Findings | Implications for Practice |
|---|--|---|
| <p>Managing the NICU environment</p> | <p>The objectification of breast milk should be avoided^{22,23,25} Separation from the infant led to difficulties in expressing and feelings of a lost connection^{5,13,16,21,22,28,29,32} The lack of privacy in NICUs during expressing and breastfeeding interfered^{5,22,25,28,29,32} Some mothers liked to pump or breastfeed with others,²⁸ or at their infant's bedside¹⁵</p> | <p>The desired and actual amounts of breast milk should not be emphasized, and the mothers' opportunities to compare their milk amounts with the others should be restricted Inseparability of the mothers and infants should be ensured through the hospitalization The privacy during expressing and breastfeeding should be provided, but opportunities for peer support and expressing alongside the infant should also be offered</p> |
| <p>Struggling with concerns related to expressing</p> | <p>Expressing was demanding and exhausting and required perseverance^{13,15,18,20,24,25,27,29,31} Expressing interfered with everyday life, and scheduling it was difficult^{15,16,18,21,29,30} The lack of availability of a pump, the transportation of the milk, and combining employment and expressing were barriers^{13,15,21,28} An insufficient milk supply was a common concern in the NICU, at discharge, and postdischarge^{13,16,27,33,34} An insufficient milk supply led to negative feelings^{13,14,17,22,24,25,27,30}</p> | <p>Expressing mothers should receive strong and consistent support, and their efforts should be recognized in a positive manner Healthcare professionals should be observant to recognize the signs of mothers' exhaustion Practical help is needed to promote the coping with everyday life, scheduling, and expressing Evidence-based interventions and support to prevent and care the insufficient milk supply should be implemented Emotional support in case of insufficient milk supply is important</p> |
| <p>Struggling with breastfeeding problems</p> | <p>The problems with latching, positioning, poor milk transfer, and establishing breastfeeding were prevalent^{13,16,20,25,28,30,33} Breastfeeding problems caused several negative feelings for the mothers^{22,26,28,30,31} Test-weighting was seen as troublesome^{5,22,28,34} and helpful^{15,34} Concerns and uncertainty regarding supplementation were prevalent^{5,22,23,26,33,34} Scheduled feeding times interfered breastfeeding,^{5,14,16,20,22} but it was also helpful^{15,16,20,28} Successful breastfeeding as a precondition to discharge made breastfeeding and discharge competing goals^{14,26,28,31}</p> | <p>The breastfeeding problems should be charted individually, and evidence-based counseling should be provided Emotional support in case of breastfeeding problems is important The techniques of estimating the amount of milk, as well as supplementation methods should be chosen individually in collaboration with the mother Unjustified schedules of breastfeeding should be omitted, and cue-based breastfeeding should be established ahead of discharge The strategies to enable discharge regardless of breastfeeding (eg, discharging with a tube) should be considered</p> |
| <p>Cessation as a coping strategy</p> | <p>Exhaustion, frustration, insufficient milk supply, and unmanageable breastfeeding problems led to ceasing breastfeeding^{16,20,25,27,30,31} After the decision to cease breastfeeding, the mothers encountered both positive^{16,24,26} and negative^{14,22,25} feelings and consequences</p> | <p>Ceasing breastfeeding should be recognized as a coping strategy in unmanageable situation Emotional support during and after the decision of ceasing should be provided</p> |

Providing breast milk afforded mothers the sense that they were contributing to the well-being and care of infants.^{18,24,25} Aside from the joy derived from breast milk production,¹⁶ hope was an additional emotion obtained from milk expression.²⁴ Nyqvist and Kylberg⁵ and Rossman et al¹⁸ found that pumping was also regarded as a source of joy and fulfillment. As described by Rossman et al, pumping routines “provided a structure and familiarity in a time of chaos and uncertainty.”^{18(p363)} To conclude, expressing was perceived as very important, rewarding, empowering, and both as a source of a positive feeling of contribution and as a source of joy, structure, and hope in a chaotic, demanding situation.* Flacking et al²⁸ and Sweet¹⁹ found that breastfeeding was viewed as natural and instinctive. Consistent with this finding, several studies added that some mothers and families were strongly committed to breastfeeding.^{13,16,19,24,25,28,30} A contradictory result is the perception of breastfeeding as secondary to maintaining lactation.¹⁹ Nevertheless, the studies consistently indicated that physical closeness and infant behavior during nonnutritive breastfeeding and successful breastfeeding reflect vitality and security to mothers.^{5,16,19,28} Flacking et al²⁸ and Nyqvist and Kylberg,⁵ for example, revealed breastfeeding as a source of closeness between mothers and infants. Moreover, Björk et al²² and Flacking et al²⁶ stated that observing infant behavior reinforced mothers' sense of competence and that being attuned to infant cues diminished their nervousness and endowed in them a feeling of security. The studies also described how the mothers perceived themselves as good mothers and fulfilled as a result of successful breastfeeding attempts.^{18,20,25,26,28} To conclude, the mothers had controversial feelings regarding important† and still unpleasant expressing^{5,15,18,24,29} whereas breastfeeding was seen as eligible, natural, and pleasurable.^{13,15,16,19,24,25,28,30}

Expressing and breastfeeding are important and integral aspects of motherhood¹⁷ and serve as opportunities for building a maternal–infant connection.^{15,29} These findings are supported by Bernaix et al,¹³ Boucher et al,¹⁴ Lee et al,²⁰ Sweet,²⁴ and Swanson et al,²⁵ who added that offering breast milk and breastfeeding are regarded as ways through which motherhood is developed, supported, and validated. Flacking et al^{26,28} and Sweet^{19,23,24} added further that breastfeeding was a marker of good motherhood. In contrast, Nyqvist and Kylberg⁵ argued that motherhood involves more than merely providing breast milk or engaging in breastfeeding. Expressing and breastfeeding are important factors for a mother to establish, maintain, and reestablish a biological, physiological, and emotional connection with her

preterm infant.^{14-16,18-20,22,24-29} At the same time, a pump is viewed as a substitute for an infant and is therefore, like Hurst et al described, “a wedge between the mother and her infant.”^{15(p368)} Flacking et al,²⁶ Jones et al,²⁷ Lee et al,²⁰ Myers and Rubarth,²¹ Sisk et al,²⁹ and Swanson et al²⁵ found that expressing was the only maternal task for the mothers. As discussed by Rossman et al¹⁸ and Swift and Scholten,³¹ mothers deemed the provision of breast milk as a concrete way of caring for and relieving the problems experienced by their infants. Rossman et al¹⁸ reinforced this finding, stating that breast milk provision was the most essential role perceived by mothers¹⁸ and a unique, gendered role for the mothers.^{17,24,28} To conclude, several studies found that an urge to validate motherhood and to be a good mother were also reasons for the perceived obligation to express and breastfeed.^{17,18,20,21,24-29} Flacking et al²⁶ found that in probreastfeeding societies, societal norms strengthen a mother's perceived obligation to breastfeed, whereas Sweet¹⁹ indicated that some mothers view the decision to breastfeed as an option that they can either choose or reject.

Coping With Barriers and Concerns

Expressing and breastfeeding were demanding and unfamiliar tasks to cope with for the preterm infants' mothers. The birth of a preterm infant caused uncertainty in terms of the mothers' ability to achieve breastfeeding goals.^{13,23,30} The mothers assumed that their infants will be fed artificial milk¹⁸ and felt themselves as unconfident with breastfeeding.^{5,19,20,30} Furthermore, the mothers realized that their breastfeeding experience will be a complex, difficult process that will cause exhaustion.^{14,19,25,28} The findings suggest that the birth of a preterm infant drives a mother to reevaluate her breastfeeding goals^{5,13,18-20,23,30} and assumptions regarding her breastfeeding experience.^{14,19,25,28} Nyqvist and Kylberg,⁵ Swanson et al,²⁵ and Sweet¹⁹ indicated that a difference in breastfeeding experience was expected by mothers because they gave birth to a preterm infant; they therefore perceived breastfeeding as a practice that they needed to learn. Agreeing with these observations, Boucher et al,¹⁴ Flacking et al,^{26,28} and Swift and Scholten³¹ identified some of the important tasks that required learning, that is, the functions and limitations related to mothers' bodies and mindsets during this period. From a physical standpoint, for instance, mothers needed to understand the ability of their bodies to work under stress and exhaustion^{14,31}; in terms of psychology, they needed to isolate their emotions to maintain their ability to function.^{22,26} The studies also identified several special and unfamiliar skills, such as expressing,²⁵ applying specific breastfeeding techniques,¹⁴ being attuned to infant cues and behaviors,¹⁴ and holding a preterm infant.^{5,14} Flacking et al²⁶ found that multiparous women and mothers who trusted themselves and focused on their infants

*References 5, 13, 15, 16, 18, 20, 22, 24, 25, 27, 28.

†References 5, 13, 15-18, 20, 22, 24, 25, 27-29.

more quickly understood infant behaviors and cues. Flacking and Dykes³² also revealed that mothers who stayed in the rooming-in facility with their infants more easily dealt with the learning process.

Three major concerns related to the NICU environment were found: the objectification of breast milk, separation of mothers from infants, and lack of privacy. Rossman et al,¹⁸ Lee et al,²⁰ and Sweet^{19,23,24} found that mothers were confronted with a strongly conveyed and consistent message regarding the benefits of breast milk in the NICU. Flacking et al²⁶ added that because of the message, mothers learned that breast milk intake was strictly determined. Sweet²³ elaborated on this finding by explaining that breast milk became a measurable and comparable object for the mothers. Moreover, Swanson et al²⁵ described how the mothers received clear feedback on their efforts to produce adequate amounts of breast milk, and Björk et al²² discussed how the mothers compared the amounts that they produced with those generated by other mothers. To illuminate these issues further, Flacking et al²⁶ discussed the manner in which milk intake was strictly determined by the importance of breast milk. The authors discovered that under this situation, the natural process of breastfeeding was lost.^{26,28} As another concern that the mothers grappled with, separation from their infants, led to difficulties in expressing and breastfeeding, as well as to feelings of disconnection.^{5,13,16,22,28,29} Björk et al²² explained that the mothers missed their infants and were unaware of when the babies would need them. In contrast, Flacking and Dykes³² found that a mother who was able to stay with her infant more easily practiced cue-based breastfeeding. Flacking et al²⁸ indicated that separation caused a loss of natural connection, and the bond that starts when a term infant is breastfed right after birth was not experienced by preterm infants and mothers until after discharge. The separation was difficult, especially in families whose infants were hospitalized for a long period.¹⁶ In Nyqvist and Kylberg's study,⁵ mothers highlighted this concern by stating that avoiding separation is the most important requirement in a unit's breastfeeding policy. Björk et al²² emphasized the lack of privacy, regarded as unpleasant by mothers, during expressing and breastfeeding in traditional NICUs. Flacking et al,²⁸ Nyqvist and Kylberg,⁵ Sisk et al,²⁹ and Swanson et al²⁵ concretized the damage caused by such problem by stating that the lack of privacy inhibited interactions between mothers and infants, decreased expressing frequency, gave rise to difficulties with the let-down reflex, and encouraged preference for bottle-feeding. Björk et al,²² Nyqvist and Kylberg,⁵ and Sisk et al²⁹ explicitly stated that some mothers desired privacy during expressing and breastfeeding. Although Flacking et al²⁸ agreed with this observation, the authors also

revealed that expressing with other mothers was deemed a therapeutic experience. Similarly, Hurst et al¹⁵ found that some mothers preferred to express at their infants' bedside but others found it extremely uncomfortable. Flacking and Dykes³² suggest that the convenience attributed to public breastfeeding is related to maternal culture.

The studies consistently presented major concerns with expressing. Expressing and establishing lactation were seen as frustrating, demanding, inconvenient, physically painful, and exhausting.^{13-18,20,24,27,29,31} Flacking et al²⁸ and Swanson et al²⁵ agreed and added that expressing required perseverance, resilience, and motivation. Hurst et al¹⁵ indicated that expressing was so inconvenient for mothers that they were compelled to negotiate with themselves to be able to cope with expressing and to "get through" the ordeal as soon as possible. Several other practical problems were identified. First, expressing interfered with everyday life.^{18,30} Krouse¹⁶ and Sisk et al²⁹ stated that scheduling was difficult for mothers. Second, the transportation of milk from the home to the hospital was a barrier.^{13,29} Other obstacles included the non-availability of pumps and balancing employment and expressing.^{13,15,21,29} Mothers attempted to cope with these problems through distractions, such as watching TV and reading, as well as planning daily schedules around pumping sessions.^{15,29} In contrast to the previously discussed studies, Myers and Rubarth²¹ did not address such concerns, reporting that mothers were not apprehensive about expressing.

Expression depends on the amount of milk required by infants; success is therefore variable.^{25,29} Producing insufficient milk supply was a common concern in the NICU at discharge and postdischarge.^{13,16,27,33} Contrarily, Myers and Rubarth²¹ did not address this issue either given that the mothers in their study exhibited a "neutral" (3 of 5) attitude toward the adequacy of milk supply. Most of the studies reviewed described the negative outcomes of insufficient milk supply, such as feelings of failure, disappointment, guilt, and frustration.^{22,24,25,27,30} Bernaix et al,¹³ Boucher et al,¹⁴ and Rossman et al¹⁷ agreed and found that insufficient milk supply diminished maternal confidence and increased feelings of being less of a mother. On the contrary, Lee et al²⁰ and Swanson et al²⁵ found that some mothers felt good about themselves even when they produced only small amounts of breast milk. The perceived reasons for insufficiency in milk supply were anxiety, dependence on pumps, and mood swings.^{5,14,20} Mothers endeavored to cope with such deficiency by pumping more often, eating certain foods, persevering, and taking galactagogues.^{20,22,27} Nonetheless, mothers evaluated the advice that they received and the implemented interventions as ineffective.¹³ Other identified concerns are the predicted problems with milk sufficiency,^{14,20} and the lack of sensation of the

milk ejection reflex, regardless of the actual amount of milk produced.¹⁵

The findings suggest that mothers encounter several breastfeeding problems. The reported problems were difficulties with proper latching, positioning, and coordination at the breast,^{27,33} poor milk transfer,¹⁶ breast refusal,^{20,28} nipple and breast problems,³³ transition from tube to breast,^{20,28} slow progression of breastfeeding,³⁰ and monitoring of skin color while breastfeeding.²⁰ Bernaix et al,¹³ Krouse,¹⁶ and Flacking et al²⁶ identified coordinating everyday life with breastfeeding as another concern. Meanwhile, Boucher et al,¹⁴ Flacking et al,²⁸ Swanson et al,²⁵ and Swift and Scholten³¹ indicated that successful breastfeeding was a precondition for discharge, which made breastfeeding, weight gain, and discharge competing goals. Breastfeeding became “a training camp” for mothers attempting progress.^{28(p76)} Some mothers assumed that breastfeeding would be easier at home,¹⁴ but the results showed that such hope was unfulfilled. Hurst et al³⁴ reported concerns about the adequacy of milk intake and infant growth postdischarge. Flacking et al²⁶ agreed and found emotional challenges, such as emotional chaos, depression, and submission to infants. In addition, mothers were found to harbor feelings of disappointment, guilt, failure, shame, and frustration when breastfeeding problems occurred.^{26,27,30,31} Björk et al²² and Flacking et al²⁸ agreed by stating that mothers accused themselves of failure to address breastfeeding problems. Quantitative information about the prevalence of problems is incomplete, but 2 studies reported that 45% of mothers encountered problems in establishing breastfeeding,²⁷ experienced difficulties in breastfeeding techniques, and struggled with infant sleepiness as prevalent concerns from discharge to 3 months of corrected age.³³

Concerns regarding supplementation, such as uncertainty as to when and how to supplement,^{5,33,34} and in estimating the amount of breastfed milk^{22,23,26,34} were prevalent issues in the studies reviewed. Hurst et al,³⁴ Jones et al,²⁷ and Lee et al²⁰ discovered that uncertainty caused mothers to supplement and bottle-feed. In terms of test-weighing, the studies presented conflicting results; it was seen as irritating, stressful, and troublesome by some mothers^{5,22,34} but viewed as helpful by others.^{5,33} For example, Björk et al²² indicated that mothers perceived test-weighing as annoying but became, at the same time, addicted to scales. The results regarding mothers' experiences with supplementation methods are also incomplete. Nyqvist and Kylberg⁵ found that mothers disliked the feeding tube but enjoyed being in charge of feeding; the authors also revealed that the mothers found cup feeding easy. Some mothers complained that combining bottle-feeding and breastfeeding was difficult and exhausting.^{20,34} Sweet²³ agreed and described how bottle-feeding

contradicted mothers' breastfeeding goals. Flacking et al²⁶ described the satisfaction that mothers experienced when their infants preferred breastfeeding.

The findings regarding mothers' experiences with scheduled breastfeeding were conflicting. On the one hand, the mothers felt that scheduled breastfeeding was not based on an infant's individual needs,^{14,20} thereby making breastfeeding more difficult.^{5,14,16,20,22} Flacking and Dykes³² stated that mothers felt free when they were able to engage in cue-based breastfeeding. On the other hand, some mothers evaluated feeding schedules as helpful.^{16,20,28,34} The reported negative outcomes of scheduled breastfeeding were attributed primarily to the quantity of breast milk,²³ difficulties in scheduling everyday tasks around feeding schedules,^{16,20,31} the complicated relationship between mother and infant and breastfeeding attempts,^{26,28} and difficulties in unscheduled breastfeeding after discharge.^{20,26,34} Conversely, Flacking et al²⁶ and Björk et al²² revealed that mothers felt safe when they successfully used infant cues as direction for breastfeeding, suggesting that the shift from controlled scheduled feeding to chaotic baby-led breastfeeding is a positive change.

The studies also described mothers' decisions to cease breastfeeding. When breastfeeding problems became unmanageable, mothers started to devalue the importance of breastfeeding for them.³⁰ The most common factors that drove mothers to discontinue breastfeeding were insufficient milk supply,^{16,20,30} frustration with breastfeeding,^{25,27,31} and exhaustion.³⁰ After deciding to cease breastfeeding, mothers experienced negative feelings, such as guilt, failure, and disappointment, as well as doubts regarding whether they exerted sufficient efforts.^{14,22,25} Krouse,¹⁶ Sweet,²⁴ and Flacking et al²⁶ reported the opposite; that is, they identified positive outcomes, such as feelings of freedom and satisfaction, improved relationship with infants, and the ability to resume a routine.

DISCUSSION

Coping is a cognitive and behavioral process aimed at reducing stress and facilitating adaptation to a situation through the creation of personal meaning and the regulation of emotions (emotion-focused coping), as well as through the derivation of information and the mobilization of actions (problem-focused coping) to maintain equilibrium.³⁵ Mothers of preterm infants are compelled to cope with 2 separate yet related stressors: the birth of a preterm infant⁷ and expressing and breastfeeding. The results of this review suggest that mothers use expressing and breastfeeding as emotion-focused coping methods.^{35,36} In this regard, they reappraise expressing and breastfeeding as ways to rebuild a connection

TABLE 4. Main Findings and Implications for Practice in Mothers of Very Preterm Infants (≤ 32 Weeks Gestational Age)

| Main Findings | Implications for Practice |
|--|---|
| <p>Theme: Coping with the birth of preterm infant</p> <p>Expressing and breastfeeding were integral part of motherhood^{13,19,23,24,26} and markers of good motherhood^{19,23,24,26,28}</p> <p>Expressing was a unique, gendered role for mothers^{17,24,28}</p> <p>A pump was a substitute for an infant and a wedge between the mother and her infant¹⁵</p> | <p>Expressing should be recognized as an important way to rebuild motherhood and strengthen contribution for the mothers of very preterm infants</p> <p>Kangaroo care, facilitated tucking, and other ways to contribute as a mother should be offered for the mothers of very preterm infants to avoid associating motherhood and contribution uniquely to expressing</p> |
| <p>Theme: Coping with barriers and concerns</p> <p>The mothers needed to isolate their emotions to maintain their ability to function^{26,28}</p> <p>Slow progression of breastfeeding and complicated breastfeeding attempts were concerns for the mothers^{26,28,30}</p> <p>A fixation on the quantity of breast milk was a outcome of scheduled breastfeeding²³</p> <p>Mothers' exhaustion was a reason for cessation³⁰</p> | <p>Mothers of very preterm infants should receive intensive emotional support</p> <p>Because of a long and complicated path to achieve direct-at-breastfeeding, evidence-based counseling, such as early initiation of direct-at-breastfeeding based on infants' cue and unscheduled breastfeeding is important, in addition to intensive practical and emotional support</p> <p>Because of extended time of expressing, mothers of very preterm infants should be offered possibilities to evaluate their managing with healthcare professionals, and cessation should be a neutral option for the exhausted mothers</p> |

with infants and develop motherhood.^{14-16,18-20,24-29} Breastfeeding also offers an opportunity for problem-focused coping^{35,36} through milk expression, given that this practice facilitates infant survival and compensation for the problems presented by preterm birth.^{13,14,16-20,22,25-29} In addition, mothers use many emotion-focused coping strategies to manage expressing and breastfeeding; these strategies include tolerating expressing by positively reappraising³⁶ its benefits to infants,¹³⁻²⁰ thinking wishfully³⁶ breastfeeding as pleasurable and easy,^{13,16,19,24,25,28,30} escaping from the situation³⁶ through distractions,^{15,29} and self-control³⁶ through disciplined expressing.^{15,25,28,29} Some problem-focused coping strategies were also identified, such as accepting responsibility³⁶ by regarding expressing as a gendered role^{15,17,24,28} and seeking help³⁶ for problems with milk supply.^{20,22,27} Previous studies suggest that a concept of adaptation can be used to describe the maternal experiences of expressing and breastfeeding.^{15,28} Another suggestion derived from this review is that coping, as a dynamic, multidimensional, and process-focused concept,^{35,36} could be useful for a theoretical framework.

The findings present implications for mothers of very preterm infants (≤ 32 weeks gestational age) (Table 4). Expressing and breastfeeding are important in rebuilding connections and developing motherhood for both mothers of very preterm infants and those of moderate preterm infants (33-37 week gestational age). Nevertheless, the findings suggest that

mothers of very preterm infants regard expressing and breastfeeding as unique roles and markers of good motherhood.^{13,17,19,23,24,26,28} The studies on mothers of moderate preterm infants did not address this issue. The results also suggest that managing emotions, slow progression of breastfeeding, and complicated breastfeeding attempts are concerns for mothers of very preterm infants.^{26,28,30} Mothers of very preterm infants should therefore receive intensive and long-term emotional support, be apprised of the possibilities to contribute to infant care in ways other than expressing, and be educated regarding evidence-based initiation of breastfeeding to achieve satisfying breastfeeding. No studies that concentrate on the breastfeeding problems encountered with late preterm infants who are hospitalized in neonatal units were found.

This study had 3 limitations. First, only 1 author reviewed and selected the studies, which could have generated systematic errors during the selection process.¹¹ To decrease this possibility, precise checklists were used. Second, only studies published in English were included, which may have led to bias.¹¹ Third, to capture a comprehensive picture of maternal experiences, studies that explored only mothers' and families' experiences related to lactation and breastfeeding were included in the review. In the latter category, the mothers' experiences were carefully separated from the fathers' experiences, which were excluded. For some studies, accomplishing this separation was impossible; thus, the results may have

Summary of Recommendations for Practice and Research

| | |
|----------------------------------|--|
| What we know: | <ul style="list-style-type: none"> • Breast milk is extremely important for the preterm infants. • Mothers of preterm infants can face several problems related to expressing and breastfeeding, in addition to an extremely stressful situation of the birth of preterm infant. • Evidence-based and sensitive counseling and support are important. |
| What needs to be studied: | <ul style="list-style-type: none"> • Experiences of preterm infants' mothers with regard to methods of estimating the need of supplementation and experiences with different supplementation methods. • Mothers experiences about breastfeeding when living with their infants in NICUs. • The validity of the concept of coping with this phenomenon. |
| What we can do today: | <ul style="list-style-type: none"> • Provide evidence-based and sensitive counseling and support for the mothers and families. • Recognize that expressing and breastfeeding are not the only pileup stressor for the mothers; healthcare professionals can maintain mothers' hope by breastfeeding counseling. • Ensure the inseparability of the mother and her infant and provide privacy during expressing and breastfeeding. • Provide intensive emotional support for the mothers who encounter expressing or breastfeeding problems and who had ceased expressing or breastfeeding. |

been influenced by the inclusion of the fathers' experiences.

Recommendations for Clinical Development

The findings of this review also present implications for practice (Table 3). Consistent evidence has shown that breast milk provision is both supportive and obstructive factor for mothers coping with the problems presented by the birth of preterm infants.^{13-20,22-26,28} The results indicated that expressing was simultaneously an extremely paradoxical experience and a route to achieving natural and pleasurable breastfeeding.^{13,15,16,19,24,25,28} A previous study showed that mothers of preterm infants experienced problems in establishing motherhood.⁶ This review suggests that expressing and breastfeeding are important factors for rebuilding motherhood and disrupted connections between mothers and infants.^{14,16,18-20,22,24-29} These results highlight the necessity of and the factors that drive sensitive and individualized counseling, as well as the essentiality of strong and consistent emotional support.^{1,9} However, expressing and breastfeeding should be viewed not only as a pileup stressor in a demanding situation but also as an important way of coping with the birth of a preterm infant. Therefore, healthcare professionals should maintain hope among mothers and facilitate the rebuilding of connections through evidence-based counseling. Such counseling includes kangaroo mother care,⁹ which enables mothers to avoid feelings of separation⁵ and promotes bonding with parents,³⁷ and facilitated tucking by parents³⁸ as important ways to contribute to the care of critically ill infants.

The consistent findings suggest that the problems encountered in traditional NICUs, such as objectification of breast milk, separation between mothers and

infants, and lack of privacy, are prevalent.* Mothers should be discouraged from criticizing their efforts and comparing amounts of milk produced. One measure for achieving this is to avoid collective-use refrigerators. Mothers and infants should not be separated, and even in traditional NICUs, privacy during expressing and breastfeeding should be guaranteed. Nevertheless, an important issue for consideration is that some mothers enjoy expressing with others; thus, rooms for such peer support activity should be provided. Expressing was extremely inconvenient for the mothers,^{13-18,20,25,27,31} and intensive informational, emotional, and practical counseling and support are needed.^{1,9} Healthcare professionals should be vigilant in recognizing signs of exhaustion in mothers and should be the primary personnel who highlight the necessity of practical help from family members. Evidence-based interventions⁹ in case of insufficient milk supply are necessary, but because of the negative feelings associated with inadequate milk supply,^{13,14,17,22,24,25,27,30} emotional support is also crucial. The results suggest that breastfeeding and supplementation concerns are prevalent[†] and stimulate unfavorable emotions among mothers.^{22,26-28,30,31} The review revealed controversial results regarding test-weighting^{5,22,28,34} and scheduled breastfeeding.^{5,14-16,20,22,28} Evidence-based counseling and emotional support for breastfeeding and supplementation are essential, especially at the postdischarge period.⁹ Furthermore, the decision to use test-weighting should be made individually. On the basis of recently proposed recommendations,⁹ unjustified breastfeeding schedules should be eliminated and cue-based breastfeeding should be established as soon as possible. Ceasing

*References 5, 13, 16, 18, 19, 22-26, 28, 29.

†References 5, 13, 16, 20, 22, 23, 26-28, 30, 33, 34.

breastfeeding should be recognized as a way of coping with an unmanageable situation,^{16,25,27,30,31} and emotional support is required after cessation because of the highly disharmonious emotions experienced by mothers.^{14,16,22,24-26}

In conclusion, expressing and breastfeeding are important for mothers to cope with the birth of preterm infants. Simultaneously, mothers have to engage in these practices in NICUs and during the postdischarge period. Evidence-based sensitive counseling and support are essential intervention measures for mothers. More evidence is needed on mothers' experiences with supplementation methods, scheduled breastfeeding, and test-weighing, as well as on the validity of the concept of coping with these phenomena. Studies that focus on the experiences of mothers who give birth to late preterm infants and those conducted in NICUs with rooming-in facilities are needed.

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*The studies included in the review.

Trying to Live With Pumping: Expressing Milk for Preterm or Small for Gestational Age Infants



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Abstract

Purpose: To describe mothers' experiences with expressing breast milk for preterm or SGA infants.

Study Design and Methods: This is a descriptive qualitative study involving 130 mothers of preterm or SGA infants admitted to a neonatal intensive care unit. Data were collected in collaboration with two Finnish peer support associations. An Internet-based questionnaire with open-ended questions was administered to respondents. Responses were analyzed with inductive content analysis.

Results: Mothers had to try to manage daily life and breast pumping. The combination of preterm birth and separation from the hospitalized infants served simultaneously as motivating factors and obstacles. Mothers tried to look beyond the unnatural and difficult process of milk expression, looking forward to eventual breastfeeding. Concerns about time and scheduling, equipment, environment, and sufficient milk supply were prevalent, as well as feelings of unfamiliarity, difficulty, frustration, and loneliness.

Clinical Implications: Expressing breast milk should be considered as a helpful factor for preterm or SGA infants' mothers. Separation between mother and infant should be avoided. Mothers need adequate equipment and a private space for expressing milk, in addition to assistance with their daily routines. For mothers to successfully manage expression, they also require an environment that fosters a sense of caring, normality, and hope, as well as frequent care for their emotional needs.

Key words: Breast milk expression; Infant premature; Mothers; Neonatal intensive care units.

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Having a preterm or SGA infant is a unique and demanding situation for parents. Separation between mother and infant, maternal stress and anxiety, and development and maintenance of a maternal identity have all been identified as problems encountered by mothers of preterm infants who are admitted to NICUs (Goutaudier, Lopez, Séjourné, Denis, & Chabrol, 2011; Rossman, Greene, & Meier, 2015). When a newborn



baby is hospitalized, one of the most important maternal tasks is breast milk expression. Breast milk is the gold standard for preterm infants' nutrition (American Academy of Pediatrics, 2012). For mothers, expressing breast milk is a means of compensating for preterm birth and reducing maternal feelings of guilt (Björk, Thelin, Peterson, & Hammarlund, 2012; Boucher, Brazal, Graham-Certosini, Carnaghan-Sherrard, & Feeley, 2011; Lee, Lee, & Kuo, 2009; Swanson et al., 2012); rebuilding the mother–infant connection (Björk et al.; Boucher et al.; Hurst, Engebretson, & Mahoney, 2013; Lee et al.; Rossman, Kratovil, Greene, Engstrom, & Meier, 2013; Sisk, Quandt, Parson, & Tucker, 2010; Swanson et al.; Sweet, 2008); developing feelings of hope; and contributing to infant care (Björk et al.; Hurst et al.; Lee et al.; Rossman et al., 2013; Sisk et al.; Swanson et al.; Sweet).

Despite the acknowledged importance of breast milk and benefits of expression, the actual process of expression is quite demanding for mothers. Expression is a means by which mothers can fulfill their obligation to provide vital breast milk for their infants and is a transitional step toward breastfeeding (Hurst et al., 2013; Rossman et al., 2013; Sisk et al., 2010; Sweet, 2008). Mothers are required to learn new skills, such as the ability to work under stress and exhaustion and maximize milk production (Boucher et al., 2011; Swanson et al., 2012), manage separation from their infants (Björk et al., 2012; Myers & Rubarth, 2013), and cope with the lack of privacy in NICUs, which reduces pumping frequency and presents difficulties with the let-down reflex (Björk et al.; Sisk et al.; Swanson et al.). Mothers find expression exhausting and scheduling their everyday lives around pumping difficult (Boucher et al.; Hurst et al.; Lee et al., 2009; Myers & Rubarth; Rossman et al., 2013; Sisk et al.; Swanson et al.; Sweet). Other practical problems encountered by mothers are lack of available pumps and insufficient milk supply (Hurst et al.; Myers & Rubarth; Sisk et al.).

Positive and negative maternal emotions, as well as practical issues, have been discussed in previous research. A thorough understanding of maternal issues, particularly facilitating factors for expression, is essential to provide adequate and accurate support for mothers. There are limited quantitative data on maternal concerns and contributory factors for expression. Therefore, the purpose of this study was to describe maternal experiences of expressing breast milk for preterm or SGA infants.

Study Design and Methods

Study Design

A qualitative descriptive approach was adopted in this study, with the goal of providing a detailed, data-near, and interpretative picture of the phenomenon under study

(Sandelowski, 2010). Data were collected through collaboration with the team in charge of a development project that enabled collection of a rich and heterogeneous sample and enhanced confidence in study credibility.

Sampling and Recruitment

Data were collected in Finland, in cooperation with the Unimpeded Breastfeeding project coordinated by the Finnish Breastfeeding Peer Support Association and with assistance from Finland's Association of Premature Babies' Parents. Permission to conduct the study was obtained from the chairpersons of the peer support associations. Study participants were selected by convenience sampling. Inclusion criteria were as follows: previous birth of a preterm or early term SGA infant (born at ≤ 36 6/7 gestational weeks or having a birth weight $< 2,500$ g);

infant admitted to an NICU; mothers required to express milk for infants; and mothers able to communicate in written Finnish. The aim was to choose participants with various experiences of giving birth to premature or SGA infants, as well as differences in elapsed time since the mothers' experience. This selection approach was adopted because heterogeneous data improve the prospects of illuminating a given phenomenon from a variety of perspectives, thus increasing credibility (Graneheim & Lundman, 2004).

Information about the project and the study was provided to the potential respondents through Facebook pages of Finnish Breastfeeding Peer Support Association and Finland's Association of Premature Babies' Parents. This neutral connection afforded prospective participants the opportunity to thoroughly evaluate their willingness to participate. The information included a link to an information sheet and the questionnaire. The information sheet contained a clear statement that responses would be used for purposes of the development project and research. Purpose and procedures of the study, potential risks, data confidentiality, the voluntary nature of the study, and the researchers' contact information were also provided.

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Data Collection

Data were collected from February to March 2013. The Internet-based questionnaire comprised the following open-ended questions concerning milk expression: How did you initiate pumping? How did you feel when pumping for the first time? How did the pumping continue? What kind of feelings did you experience during pumping? What kind of support motivated you to continue pumping? What was hard for you?

Previous studies were used as reference for the relevant aspects of expression (Björk et al., 2012; Lee et al., 2009; Sisk et al., 2010; Swanson et al., 2012; Sweet, 2008), but

Birth of preterm or small for gestational age infants can make milk expression difficult but necessary because breast milk facilitates recovery of infants undergoing intensive care.

questions were kept general to enable mothers to freely recount their experiences. Demographic data were obtained with closed-ended questions. The short data collection period and fixed nature of the questionnaire reduced the possibility of inconsistency in data collection, thereby improving dependability (Graneheim & Lundman, 2004). Respondents were allowed to review the questionnaire before deciding to participate and respond to the questions at their own pace. On each questionnaire there was the link through which the respondents could return their uncompleted forms. These features enabled respondents to regulate the data collection situation. Data collection was not performed in association with healthcare organizations. Data were collected anonymously. To minimize participant fraud, the link to the survey was accessible only to closed Facebook groups and no compensation was provided to participants (Wilkerson, Iantaffi, Grey, Bockting, & Rosser, 2014). We used the ZEF tool, an Internet-based software program designed to collect quantitative and qualitative information. Despite the surprisingly prompt accumulation of data, the questionnaire was kept accessible for a month because single responses to questions were short and therefore small sample size could be a threat to credibility.

Data Analysis

Data were analyzed using qualitative inductive content analysis, with the aim of organizing the data into a structured description of the phenomenon (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004). Written data were extracted from ZEF, imported to MS Word, and checked for accuracy. A mother's response to a question was regarded as the meaning unit, which is constituted by statements conveying the same central meaning (Graneheim & Lundman). This unit ranged from two words to six sentences. Size of the meaning unit in this work was sufficiently small to be manageable but at the same time, enabled consideration of the contextual information to be included in the analysis; this characteristic also added to the credibility of the results (Graneheim & Lundman). Codes were extracted from the meaning units by the first author, who then discussed the codes with the other authors to enhance validity. The codes ($n = 768$) were then classified into internally homogeneous and externally heterogeneous subcategories, categories, and main categories, and finally, the underlying meaning, the theme, was identified (Elo & Kyngäs; Graneheim & Lundman). To further reinforce credibility (Graneheim & Lundman), the first author presented and discussed results of the analysis, together with raw data, with the other authors. The analysis was corrected until a consensus was reached. Data saturation was achieved (Elo & Kyngäs). After the qualitative phase was completed, categories were quantified using the present/absent method, and frequencies were analyzed in relation to the total number of respondents. Demographic variables and quantification were analyzed using SPSS 21.0.

Results

Altogether, 150 mothers answered the questionnaire, with 130 of them meeting inclusion criteria. Reasons for

exclusion were as follows: infants were not admitted to an NICU ($n = 6$), mothers had no pumping experience ($n = 8$), and mothers stopped answering the questionnaire before they reached the open-ended section ($n = 16$).

Mothers' ($n = 130$) mean age was 33.8 years ($SD = 5.6$, range = 21–50), and they had given birth at an average of 31 gestational weeks ($SD = 3.7$, range = 23–38). Infants' mean birthweight was 1,642 g ($SD = 721.9$, range = 550–3,550). Infants who were born at 37 to 38 gestation weeks weighed less than 2,500 g, or vice versa, meeting the other inclusion criteria. Infants were hospitalized in a neonatal unit for 53.2 days ($SD = 57.3$, range = 1–476). The previously preterm infants were on average preschoolers (mean 3.9 years, $SD = 4.3$, range 0–20) at the time of data collection. Table 1 (available as supplemental digital content, <http://links.lww.com/MCN/A27>) displays demographic characteristics of mothers and infants. Because of a malfunction in the data collection software, information on infant gestational age at birth and birthweight for 38 respondents was not obtained. There was missing information of several infants' demographic characteristics because the questions were left blank by the respondents.

Mothers' experiences with expressing breast milk were dualistic. They described factors that helped or hindered them in managing the situation, looking forward to easier breastfeeding, and managing daily life and feelings. Ultimately, the mothers had to "try to live with pumping," or, in other words, try to combine their daily life and pumping in a manageable way. The following categories were identified.

Managing the situation. Most of the mothers deemed expression helpful in their attempts to manage the circumstances arising from preterm birth and subsequent intensive care, as well as with their own compromised physical condition ($n = 90$, 69.2%). Mothers believed that their breast milk, especially the first drops of colostrum, were extremely valuable. As one mother stated, "*At the beginning, there were only a few drops, but I was told that they are extremely valuable, like medicine for my baby, so I should continue.*" Given these benefits, expression was considered a mother's duty and an act performed for the benefit of the infant. At this stage, milk was the only thing to be givable, and providing milk reflected a sense of caring and contribution on the part of the mothers: "*In this situation, this [expressing] was the only thing that I could give to him, in addition to my touch and voice.*" Expression was the mothers' unique way of helping their infants and saving them, and breast milk was, "*in the beginning, a lifeline for the baby.*" While expressing milk, the mothers visualized their infants by imagining or looking at pictures of their babies. For some mothers, however, viewing pictures was deemed unfavorable. Such is the case of a mother whose infant was extremely ill. She stated that "*looking at the baby's picture was not beneficial because in that picture, the baby was in a respirator.*" The image served as a reminder of the critical condition of the infant rather than of the infant himself.

Although expression was generally regarded as a helpful factor in the situation, the mothers' physical condition and fatigue, as well as worries over the infants and

separation, impeded expression ($n = 55$, 42.3%). Preterm birth can cause devastating and terrifying thoughts about infant survival. Mothers therefore perceived expression as an additional unwelcome demand at a period when they would have preferred to concentrate on their infants and their survival. As one mother described, *“It felt horrible because the baby’s life was in danger. The expression itself was a side issue.”* In addition, separation from their infants adversely affected the mothers, thus exacerbating the difficulties in expression and lactation: *“As a first-time mother, it felt horrible to sit alone in the maternity ward when everyone else had their babies with them.”*

Looking forward to easier breastfeeding. Mothers tried to view the future with optimism by being strongly confident in their success at expression ($n = 63$, 48.5%). Mothers described themselves as resolved, persevering, and goal-oriented, essentially according priority to expression in their daily lives. One of the mothers recounted her determination thus: *“I’m stubborn and I’ve decided to breastfeed, even if this is the only thing I’m able to cope with.”* The mother also recounted how the hope of eventually transitioning to breastfeeding was a source of encouragement for her. Another mother shared how she perceived expression as a temporary process that, in due course, will lead her to the ultimate reward: *“Beginning by expression was worth it. I was able to breastfeed when the time came for me to do it.”*

Conversely, almost one third of the mothers ($n = 42$, 32.2%) regarded expression as unnatural and difficult. One mother viewed it as unusual and challenging *“...because it was kind of unnatural to express in an empty room while the baby was elsewhere. It was very difficult to get milk out.”* Mothers felt ashamed that they were unable to breastfeed their infants; distress that provoked strong negative emotions: *“In the pumping room, I felt like I was a cow.”* Despite these problems, mothers considered expressing an obligation, aware that giving up will increase risk of mastitis and that it is akin to letting their infants down. Expression was undertaken because no other options were available to them, as one mother described: *“I have to do this. I can make this work. Every drop is important.”*

Managing daily life. Mothers ($n = 40$, 30.8%) identified several factors that helped them manage daily life. An important element of this process was having sufficient time for expression. As one mother wrote, *“Actually, there were no hindering factors, and because the baby was our firstborn, I was able to concentrate solely on him and on pumping.”* Functional and easy-to-use equipment, such as portable and comfortable breast pumps, and a peaceful and comfortable environment for pumping were important aids to success. Increased or adequate milk supply was an encouraging aspect of their experience. Recording and observing the increase in milk supply motivated them to continue expressing. As declared by one of the respondents, *“My milk supply was good, which motivated me to continue.”*

Almost three-quarters of the mothers ($n = 109$, 83.8%) shed light on some obstacles. Expression as a scheduled

Unawareness of and unfamiliarity with milk expression, as well as exhaustion, are common problems among mothers.

and binding responsibility was restrictive, and therefore, an obstacle to effortless daily living, and to being with her infant. One mother resented the need for scheduling and planning: *“Daily life revolved around pumping, and I had to schedule all my plans according to it. It was also taxing on my sleep routine.”* Expression was arduous for the mothers. A mother lamented that the demands of extreme hygiene increased her workload: *“Maintaining equipment, boiling bottles, sterilization—these took hours and I was constantly extremely tired.”* Flawed equipment resulted in more difficult expression. One of the respondents shared the following experience: *“I had kind of a huge and outdated pumping machine. It would have been easier if I had something small and handy that I could easily move, for example, next to my bed.”* Another issue related to equipment was the availability of pumps. Even though most of the hospitals in Finland either rent or provide a pump free of charge, mothers have to wait for pumps to be available or are required to return them as quickly as possible. Lack of suitable and comfortable pumping rooms hindered expression. As described by one of the mothers:

In the NICUs, there was no peaceful location, nowhere that a mom can feel safe and secure. In [university hospital], the pumping machine was in the parents’ recreation room, and if someone was already occupying the room, you had to a) ask that person to move to another area, b) watch the room until it becomes vacant, or c) leave and endure having swollen breasts.

Inadequate milk supply was an equally prevalent issue. Insufficiency of milk ejection reflex was a problem both in the beginning of expression and throughout the process. Mothers compared amounts of milk that they expressed with those extracted by other mothers, so that monitoring milk volume became a stressful task. One mother stated that she felt she was a failure when she *“brought 20 ml doses of milk to the NICU and saw how the other mothers brought 3×200 ml of milk.”*

Managing feelings. Familiarity with expression, the neutrality of the process, and successful milk extraction reinforced the mothers’ perseverance in the activity ($n = 62$, 47.7%). Mothers familiarized themselves with expression by recalling how other mothers engaged in this practice or by remembering their own previous experiences with expressing or breastfeeding. *“I was already used to expressing when my firstborn was a baby, so the second time around, it became ‘routine’ for me.”* Mothers with

previous experience believed that knowledge of the manner by which their bodies function facilitated expression. Some mothers regarded expression as a neutral and normal process: “I didn’t see it [expressing] as weird. Instead, it was the most suitable method for us.” Other mothers deemed expression easy, comfortable, achievable, and a source of pride. As indicated by one respondent, “It [expressing] went right. I was proud of my milk supply. I knew it was important for my baby.”

Many mothers ($n = 108$, 83.1%) reported experiencing expression-related emotions that hindered success. Mothers were unaware of lactogenesis, how much milk is considered adequate, and their infants’ ability to receive their milk. Expressing was a completely new experience for them, with some describing it as strange, uncomfortable, and frightening: “Expressing was weird, especially when it was done with the hospital’s strange and huge machine.” Mothers blamed themselves for inadequacies, often crying and feeling depressed. The relationship between these feelings and inadequate milk supply was twofold: Mothers believed that negative feelings prevented the expression of adequate milk but also that inadequate milk gave rise to these feelings. Two of the respondents explained as follows: “Stress and worrying about the baby...and my milk dried up temporarily.”; “The irregularity of milk supply was troubling, and I was immediately afraid that the milk would dry up when it decreased from time to time.” Mothers felt lonely and alienated from other mothers because they were required to express milk instead of proceeding immediately to breastfeeding. Expression was perceived as frustrating, foolish, oppressive, infuriating, and demanding. Mothers were often concerned about exhaustion: *Expressing was frustrating because the milk did not even come out properly. I was severely stressed out and depressed. [...] I would have stopped expressing earlier if I knew how hard it was and how the milk kept on decreasing.*

Nursing Implications

Our study explored experiences of mothers of preterm or SGA infants with breast milk expression, as well as contributory factors and impediments to the process. Of note, the study describes the maternal experiences when significant time has elapsed from such experience, and the mothers have had time to reflect their experiences. Mothers of preterm infants live under stressful conditions (Goutaudier et al., 2011; Rossman et al., 2015), during which offering their infants valuable breast milk can assist mothers in coping with the problems related to preterm births (Björk et al., 2012; Hurst et al., 2013; Lee et al., 2009; Rossman et al., 2013; Sisk et al., 2010; Swanson et al., 2012; Sweet, 2008). In this work, 70% of mothers felt expression was a helpful factor in their situation, indicating the significance of this activity for the mothers. Counseling mothers on expression should be a nursing priority.

The infants’ fragile condition was both a facilitating and hindering factor for managing the situation. The illness and the need for valuable “medicinal” milk made expression an obligatory task. In conjunction with sensitive and individualized counseling on expression, more research

is needed to disentangle the contradictions found in this work. Because of mother–infant separation and passive role of mothers during this period, milk was considered the only value that the mothers could offer. Separation of mother and infant should be avoided, and the mothers’ unique role as a primary caregiver should be secured. Maternal experiences with expression during hospitalization in single-room NICUs are worth further study.

Practical obstacles such as insufficiency of time, flawed equipment, unfavorable environments, difficulties of daily life, arduous nature of expression, and inadequacy of milk supply were common. These findings are supported by previous studies (Boucher et al., 2011; Hurst et al., 2013; Lee et al., 2009; Myers & Rubarth, 2013; Rossman et al., 2013; Sisk et al., 2010; Swanson et al., 2012; Sweet, 2008). Our results emphasize importance of simple measures designed to help mothers manage expression. Milk expression is time consuming; assistance from family members would be very helpful. Efficiently and simultaneously pumping both breasts can save valuable time (Nyqvist et al., 2013). Equipment is an equally essential matter in successful expression; complementary hospital-grade pumps should be available and covered by health insurance. An additional helpful measure would be for pump cleaning to be accomplished by hospital personnel. Private and comfortable pumping locations should also be provided to enable mothers to maintain sufficient pumping frequency and facilitate the let-down reflex.

Concerns about milk amount were noted in this study and in previous works (Hurst et al., 2013; Myers & Rubarth, 2013; Sisk et al., 2010). Mothers should be afforded privacy during milk expression and provided individual refrigerators or opaque containers to prevent a comparison between milk amounts. Sufficient milk supply was a source of encouragement for the mothers. Early initiation of expression and evidence-based interventions are essential to optimizing milk supply (Nyqvist et al., 2013). Because of the twofold relationship between inadequate milk supply and maternal emotions, emotional well-being of the mothers should be evaluated in cases of insufficient milk supply.

Most mothers shared negative feelings regarding expressing; however, almost half of the respondents indicated that familiarity with expression and the neutrality of the activity helped them cope with their situations. Further exploring the apparent mood shifts experienced by mothers would be favorable in obtaining a comprehensive understanding of maternal experiences with expression. Mothers described how expression was shaming for them. Mothers need to sense that they are capably caring for their infants. Mothers need normality and hope. Nurses can foster such an environment by frequently checking on mothers about their milk supply and about their overall well-being.

Limitations

Our study has several limitations. Data were collected through peer support associations that may have influenced selection of participants and may therefore diminish credibility (Graneheim & Lundman, 2004). Data collection

Suggested Clinical Nursing Implications

Breast milk expressing should be considered as a helping factor for a mother who has given birth preterm and has a baby in the NICU.

Mother–baby separation should be avoided, and the mothers' role as a primary caregiver should be secured. Otherwise obligatory and difficult expression may be the only thing the mother can do to perform motherhood.

Supporting mothers' confidence in succeeding and reminding them of their goal of breastfeeding may give hope for the mothers.

Help with daily routines, adequate equipment, and suitable rooms for pumping should be provided for mothers who need to pump.

Evidence-based interventions should be provided to prevent insufficient milk supply. Mothers' emotional well-being should be evaluated in the case of insufficient milk supply.

via the Internet may have also influenced the selection, although the large sample size may refute this (Whitehead, 2007). Because of a malfunction in the data collection software and because questions were left blank by respondents, there were considerable amount of missing data of infants' demographic characteristics. Although likelihood of fraudulent responses can be considered low in anonymous data collection via the Internet (Whitehead), subject credibility cannot be fully guaranteed. Respondents were heterogeneous in terms of current age of their children, which may be a threat to dependability (Graneheim & Lundman). Our study presents mothers' experiences after significant time has passed since they were involved in milk expression.

Conclusion

Mothers tried to cope with their shifting emotions while balancing expression and daily life in a manageable way. Participants voluntarily shared their pumping experiences, although many years have elapsed since their experience. Results highlight the substantial and long-lasting effects of milk expression-related experiences on mothers' lives. Results challenge us to recognize mothers as the primary caregivers of babies, to avoid separation of mother and baby, and to provide practical help and emotional support to new mothers trying to be successful at pumping and breastfeeding. ❖

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ORIGINAL ARTICLE

Preterm infants' mothers' initiation and frequency of breast milk expression and exclusive use of mother's breast milk in neonatal intensive care units

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Aims and objectives: To describe preterm infants' mothers' expressing practices and exclusive use of mother's breast milk in neonatal intensive care settings, as well as to explore whether mothers' and infants' characteristics are predictors of the mother's inadequate expressing practices and nonexclusive use of mothers' breast milk.

Background: Use of their own mother's milk decreases preterm infants' mortality and morbidity, but expression is exhausting for the mothers. Mothers' and infants' characteristics are associated with milk output and exclusive breastfeeding at discharge, as well as later in infancy.

Design: Cross-sectional study.

Methods: The data were collected through questionnaires in two neonatal units. Multiple logistic regression was used to determine whether mothers' and infants' characteristics are predictors of late expression initiation (>6 hr from birth), inadequate expression frequency (≤ 6 times per a day) and nonexclusive use of own mother's milk.

Results: The sample consisted of 129 mothers. One-third of the mothers had adequate expression practices. Half of the infants exclusively received their mother's own breast milk. Previous neonatal intensive care unit experience, poor psychological well-being, an infant's male gender, caesarean section and high gestational birth age were significant predictors of late expression initiation. None of the studied variables were significant predictors of inadequate expression frequency. Furthermore, lack of previous expression experience, financial woes and high gestational age were predictors of nonexclusive use of own mother's milk.

Conclusions: Expression practices, as well as use of own mother's milk, were suboptimal. High gestational age was associated with both late expression initiation and nonexclusive breast milk use. The mothers maintained expression regardless of their well-being.

Relevance to clinical practice: Counselling and support are needed to avoid suboptimal expression practices. Special attention should be paid to mothers with moderately preterm infants, caesarean delivery, poor psychological well-being and financial woes.

KEYWORDS

breast milk expression, breastfeeding, neonatal intensive care units, preterm infants

1 | INTRODUCTION

In high-income countries, 8.6% of infants are prematurely born before 37 completed gestational weeks (Blencowe et al., 2013). Despite the highly developed medical care in such countries, preterm birth is a leading cause of child mortality (Blencowe et al., 2013). The survival rates have increased during the last decades, and along with active risk pregnancy management, ventilation therapy, surfactant use and infection prevention, the use of human milk has been detected as a reason for this advancement (Stoll et al., 2015). Exclusive use of human milk is highly recommended for preterm infants due to its advantages to the infant's health and development (Edmond & Bahl, 2006). The lack of breast milk increases the rates of sepsis and necrotising enterocolitis (NEC), which are both life-threatening conditions (American Academy of Pediatrics, 2012). Furthermore, breast milk absence increases the risk of retinopathy of prematurity, in addition to cognitive problems later in childhood (American Academy of Pediatrics, 2012). Exclusive use of the infant's own mother's breast milk (OMM) is particularly important in the neonatal intensive care unit (NICU), as pasteurised donor milk lacks important bioactive anti-infective components, such as secretory immunoglobulin A and lactoferrin (Heiman & Schanler, 2006), which play essential roles in controlling the gut's early colonization and protecting against NEC (Kim, 2014). In addition, inadequate milk supply in the early lactation phase is associated with the use of artificial milk at week 12 postpartum (Hill, Aldag, Zinaman, & Chatterton, 2007), exposing the infant to artificial milk feeding risks, such as increased risks of common childhood infections, allergic diseases, diabetes, leukaemia and lymphoma (American Academy of Pediatrics, 2012) later in childhood.

Despite breast milk's advantages, breastfeeding rates are lower among preterm infants than term infants in Finland (National Institute for Health and Welfare, 2012) and in Europe (Bonet et al., 2011). Lactation initiation and maintenance is more complicated for preterm infants' mothers. Milk production (lactogenesis II) has to be initiated by the expression, because at-breastfeeding is not possible due to infants' immaturity and medical condition (Nyqvist et al., 2013). The mothers should initiate expression within 6 hr of delivery and express frequently (Nyqvist et al., 2013). Time of expressing initiation (Hill, Aldag, Chatterton, & Zinaman, 2005; Maastrup et al., 2014; Parker, Sullivan, Krueger, Kelechi, & Mueller, 2012) and early frequency of stimulation (Hill, Aldag, & Chatterton, 1999, 2001; Hill et al., 2005) have both been associated with milk output, adequate milk amount and exclusive breastfeeding.

2 | BACKGROUND

Expressing is an unexpected and new thing for mothers (Swanson et al., 2012). The mothers have to re-evaluate their breastfeeding goals (Lee, Lee, & Kuo, 2009; Rossman, Kratovil, Greene, Engstrom, & Meier, 2013), as well as learn several specific and unfamiliar practical skills (Swanson et al., 2012). Expressing supports the sense of

What does this paper contribute to the wider global clinical community?

- The associations between mothers' and infants' characteristics and breastfeeding are described in previous studies. The findings of this study suggest that, in order to avoid delays in expression initiation, special attention should be paid to mothers with moderately preterm infants and male infants, as well as mothers with a caesarean section, poor psychological well-being and previous neonatal intensive care unit (NICU) experience.
- Despite the well-established exhausting nature of expression, this study indicates that mothers maintain expression frequency despite their well-being or expression-related stress.
- Parallel to previous studies, mothers' previous expression experience was associated with exclusive use of their own breast milk in the NICU. Although the NICU environment can diminish the differences between socioeconomic classes, the family's financial woes predicted the nonexclusive use of the infants' own mothers' milk.

motherhood in stressful situation, is important in establishing the connection between the mother and her infant and is an important way to contribute to the NICU care (Ikonen, Paavilainen, & Kaunonen, 2016; Lee et al., 2009; Swanson et al., 2012), but the strong link between mothering and expression also leads to perceiving expression as an obligatory task (Ikonen et al., 2016). Exhaustion is a common barrier to expression (Hurst, Engebretson, & Mahoney, 2013; Lee et al., 2009; Rossman et al., 2013; Swanson et al., 2012). Furthermore, the transitions between home and the NICU impede staying in expression schedules (Sisk, Quandt, Parson, & Tucker, 2010), and mothers' compromised physical condition is another obstacle (Ikonen et al., 2016). Previous NICU experience and the presence of a family partner are detected as helpful factors for expression (Ikonen et al., 2016; Lee et al., 2009; Sisk et al., 2010).

Some studies have examined factors associated with milk output and breastfeeding in preterm infants' mothers. The mothers' age (Hill et al., 2007), education level (Hill et al., 1999, 2005), annual income (Hill & Aldag, 2005; Hill et al., 1999, 2005) and previous breastfeeding experience (Hill et al., 1999; Maastrup et al., 2014) have all been found to associate with increased milk output and exclusive breastfeeding. However, these results are controversial, as other studies have not found such associations between breastfeeding and the mothers' education (Hill & Aldag, 2005; Hill et al., 2007; Maastrup et al., 2014), income (Hill et al., 2007) and previous breastfeeding experience (Hill & Aldag, 2005; Hill et al., 2005, 2007). Marital status and the mothers' mood states have not been found to be associated with milk output (Hill & Aldag, 2005; Hill, Aldag, Demirtas, Zinaman, & Chatterton, 2006; Hill et al., 2007), although maternal psychological stress and anxiety have been found to be risk factors for

breastfeeding failure (Zanardo et al., 2011). The infant's gestational birth age is also associated with milk output (Hill et al., 2005) and breastfeeding at discharge (Maastrup et al., 2014), but again, the results are not uncontested (Hill et al., 1999, 2007). The infants' gender (Maastrup et al., 2014) and multiple births (Hill et al., 2007; Maastrup et al., 2014) are associated with breastfeeding at discharge and 12 weeks postpartum, whereas delivery type is not (Hill et al., 2007; Maastrup et al., 2014). Although there is a well-established association between adequate expression practices and adequate milk supply, the associations between socioeconomic factors and breastfeeding are not harmonious among preterm infants' mothers. Previous studies have described breastfeeding at discharge and later in infancy, but there is an information gap about factors related to exclusive use of OMM in NICU settings. Furthermore, the association of mother's and infant's characteristics with milk expression practices has not been investigated.

To conclude, the importance of early initiation and frequent expressing to adequate milk production has been demonstrated (Hill et al., 1999, 2001, 2005; Maastrup et al., 2014; Parker et al., 2012), as well as sociodemographic factors' relationship to milk production and breastfeeding (Hill & Aldag, 2005; Hill et al., 1999, 2005, 2006, 2007; Maastrup et al., 2014). However, the predictors for milk expressing practices and the exclusive use of OMM in NICU settings have not been described. Therefore, the objective of this study was to describe preterm infants' mothers' expressing practices and exclusive breast milk use in NICU settings. Furthermore, the objective was to explore whether mothers' and infants' characteristics increase the odds for inadequate expressing practices and partial use of OMM in the NICU.

3 | METHODS

3.1 | Study design

This is a cross-sectional quantitative study.

3.2 | Data collection

The sample size was determined with power analysis. For two-tailed independent samples *t* test, $n = 128$ is needed to achieve a power of 0.80 (Cohen's $d = 0.50$, $p = .05$) (Munro, 2005). For multiple logistic regression, established guidelines for an adequate sample size do not exist (Munro, 2005). It has been suggested that 10 events per covariate are a sufficient sample size, and in general, acceptable confidence interval (CI) coverage can be achieved using 5–9 events per covariate (Hosmer, Lemeshow, & Sturdivant, 2013). In this sample, 45 mothers had the outcome event. This sample allows to add 4.5 variables to the model to avoid overestimation (Hosmer et al., 2013).

The data were collected in two NICUs between June 2015–September 2016. One NICU provides intensive (12 beds) and intermediate care (17 beds) for sick and preterm infants without limits on gestation weeks. This NICU provides intensive-level care for its special responsibility area, which covers three special care nurseries in

Southern Finland. The distance between the patient's home and the hospital can be nearly 300 km. Another participating unit is a level II special care nursery with 10 beds. It provides care for moderately sick and preterm infants born later than 30 gestation weeks. Furthermore, very preterm infants are admitted to the unit after the intensive care phase. Both of the NICUs were open wards, only allowing the parents' presence during the daytime. Donor milk was available in both NICUs in case of insufficient milk supply, and the use of artificial milk was avoided during the hospitalization.

The inclusion criteria were as follows: a Finnish-speaking mother (≥ 18 years) with singleton or twin preterm infant(s) (gestation age < 37 weeks at birth or birthweight $< 2,500$ g) admitted to the NICU. The infant(s) were more than 6 days old at the time of data collection, so daily expressing and lactogenesis II had been initiated. The presence of major crisis (related or nonrelated to the infant's medical status) was used as exclusion criteria; however, the mother could be eligible to participate later.

The data were collected through questionnaires. The primary investigator visited in the NICUs twice a week and identified the eligible mothers with a nurse's assistance. The questionnaire was administered to a nurse who was taking care of the family. The nurse recruited the mothers after receiving personal instructions from the primary investigator. This strategy was selected because the hospital administration and institutional review board did not recommend direct contact between a mother and the researcher. However, the investigator was available for further questions during the visits and was reachable by e-mail and phone. The mothers returned the filled consent forms and questionnaires in closed envelopes to the NICU nurses' stations, from where the researcher reclaimed them.

The potential predictors of inadequate expression practices and nonexclusive OMM use in the NICU were selected based on previous findings. Based on the previous quantitative findings, it was suggested that mothers' age, education, financial situation and previous NICU or expressing experience may predict inadequate expression practices. The rationale for this hypothesis is that these sociodemographic factors are associated with milk output and breastfeeding (Hill & Aldag, 2005; Hill et al., 1999, 2005, 2006, 2007; Maastrup et al., 2014), which, in turn, are strongly associated with adequate expressing practices. Furthermore, based on qualitative findings, the absence of a family partner, transitions between home and hospital and compromised physical and psychological well-being and expression-related stress are major burdens for expressing mothers (Hurst et al., 2013; Ikonen et al., 2016; Lee et al., 2009; Rossman et al., 2013; Sisk et al., 2010; Swanson et al., 2012). Therefore, it was reasonable to hypothesise that these factors may interfere with optimal expression practices and predict nonexclusive OMM use. The mothers' sociodemographic factors included age, marital status, education, the one-way distance from home to hospital (kilometres), previous NICU experience and previous expression experience. The family's financial situation was measured with a self-rated five-point semantic differential scale from 1 = very poor–5 = very good. This approach was selected because we wanted to measure the family's perceived financial woes, rather than the family's socioeconomic

class. The mother's physical and psychological well-being were also measured with single self-rated questions using a semantic differential scale from 1 = very poor–5 = very good. Expression-related stress was measured with a visual analogue scale from 0 = extremely stressful–10 = not at all stressful. Single question was selected because no scales measuring expression-related stress were available.

The infants' demographical factors were also selected based on quantitative and qualitative findings. Infants' gender, gestation birth age and multiple births have been associated with milk output or breastfeeding (Hill et al., 2005, 2007; Maastrup et al., 2014). Furthermore, despite the previous evidence (Hill et al., 2007; Maastrup et al., 2014), delivery type was included as a potential predictor because recovery from major surgical operation may harden expression through different postpartum care practices and compromised physical health. Infants' age at the time of participation has been identified as a potential predictor because maintaining expressing frequency and adequate milk supply may be challenging due to its very exhausting nature (Hurst et al., 2013; Lee et al., 2009; Rossman et al., 2013; Swanson et al., 2012). Therefore, infants' demographical factors included gender, gestation birth age, delivery type, singleton/twin gestation and age at the time of participation. Table 1 presents a dichotomization of the independent variables.

The outcomes were initiation (hours from delivery) and frequency (times per a day) of expressing. Inadequate expression practices were determined to be expressing initiation >6 hr after delivery and ≤6 times per day, based on previous literature (Hill et al., 1999, 2001; Nyqvist et al., 2013). Furthermore, exclusive use of breast milk was measured with the Index of Breastfeeding Status (IBS) (Labbok & Krasovec, 1990). The IBS scale measures the amount of the mother's own breast milk in relation to the total amount of the infant's enteral nutrition. The scale consists of seven points: (i) exclusive breastfeeding, no other milk; (ii) high, over 80% of OMM; (iii) medium high, 50%–80% of OMM; (iv) medium low, 20%–50% of OMM; (v) low, <20% of OMM; (vi) minimal or occasional use of OMM; and (vii) none, no use of OMM at all. The mothers were asked to evaluate the current amount of their own breast milk and the total amount of milk needed daily. Vitamins, minerals, medications, human milk fortifiers and parenteral nutrition were excluded. The first class (no other milk) was defined as those with exclusive use of OMM.

3.3 | Statistical analysis

The data were manually typed into SPSS 23.0 and checked for accuracy. Descriptive quantitative methods were used for frequencies, mean and median values for central tendency measures, and standard deviation and percentiles for variation measures. Means and standard deviations were used for normally distributed variables, while medians and percentiles were reported if a variable was skewed (Munro, 2005). Normal distribution was examined using Fisher's measure of skewness and Kolmogorov–Smirnov, while variables were determined to be skewed if $z < -1.96$ or >1.96 , with $p < .05$ (Munro, 2005). Multiple logistic regression analysis (Harrell,

TABLE 1 Characteristics of participants ($n = 129$)

| Variable | Descriptive statistics |
|---|------------------------|
| Mothers | |
| Age, years, <i>M</i> (<i>SD</i>) | 31.3 (5.2) |
| Marital status, <i>n</i> (%) | |
| In relationship | 119 (92.2) |
| Single | 10 (7.8) |
| Completed degree, <i>n</i> (%) | |
| College or university | 72 (55.8) |
| Vocational school or less | 57 (44.2) |
| Hospital–home distance, kilometres, <i>Md</i> (Q_1 – Q_3) | 20.0 (8.0–51.5) |
| Previous NICU experience, <i>n</i> (%) | |
| No | 114 (88.4) |
| Yes | 15 (11.6) |
| Previous expression experience, <i>n</i> (%) | |
| No | 75 (58.1) |
| Yes | 54 (41.9) |
| Financial woes <i>n</i> (%) | |
| No (3.1–5) | 73 (56.6) |
| Yes (1–3.0) | 56 (43.4) |
| Physical well-being, <i>n</i> (%) | |
| Good (3.1–5) | 80 (62.0) |
| Poor (1–3.0) | 49 (38.0) |
| Psychological well-being, <i>n</i> (%) | |
| Good (3.1–5) | 79 (61.7) |
| Poor (1–3.0) | 49 (38.3) |
| Expression-related stress, <i>M</i> (<i>SD</i>) | 6.2 (2.7) |
| Infants | |
| Pregnancy, <i>n</i> (%) | |
| Singleton | 102 (79.1) |
| Twin | 27 (20.9) |
| GA at birth, <i>M</i> (<i>SD</i>) | 32.6 (3.1) |
| Delivery type, <i>n</i> (%) | |
| Vaginal | 65 (50.4) |
| Caesarean | 64 (49.6) |
| Gender, <i>n</i> (%) | |
| Female | 58 (45.0) |
| Male | 71 (55.0) |
| Age, weeks, <i>M</i> (<i>SD</i>) | 1.8 (1.1) |

NICU, neonatal intensive care unit.

2001; Hosmer et al., 2013; Munro, 2005) was performed to estimate odds ratios (OR) and 95.0% CI for inadequate expressing initiation and frequency, as well as the risk of nonexclusive OMM use (dependent variables). The independent variables were the mother's age (ratio), intimate relationship (yes/no), college or university level education (yes/no), hospital–home distance (ratio), previous NICU experience (yes/no), previous expression experience (yes/no), presence of financial woes (yes/no), good physical well-being (yes/no),

good psychological well-being (yes/no), expression-related stress (ratio), infant's female gender (yes/no), gestational age at birth (ratio), vaginal delivery (yes/no), singleton infant (yes/no) and infant's age at the time of participation (ratio). The data consisted of six pairs of twins with different genders, with infant A's gender being used among these. The forward stepwise (likelihood ratio) method was used in order to achieve the data's most suitable model, in which several covariates are expected to associate together. This strategy was selected because it allows for building models sequentially, for eliminating redundant covariates and for examining collections of models, rather than basing on binary covariate selection (Hosmer et al., 2013). As described earlier, the number of initial independent variables ($n = 15$) was large compared to the number of events ($n = 45$). However, because of strong support from previous qualitative and quantitative findings and recommendations to avoid binary covariate selection (Harrell, 2001), all variables were included to the analysis. After adding significant variables in forward stepwise regression, the results of the analysis were checked to identify potential errors in models due to overestimation. In these analyses, multiple logistic regression with backward stepwise method was used. Backward stepwise elimination of nonsignificant variables resulted in consistent models with forward stepwise regression (data not shown), which supports the adequacy of the models.

The association of expression initiation with expression frequency and breastfeeding status, as well as expression frequency's association with breastfeeding status, was studied with Mann–Whitney U test (Munro, 2005). A statistical significance level of 5.0% was used in all analyses.

3.4 | Ethical aspects

The Declaration of Helsinki ethical guidelines (World Medical Association 1964) has been followed. The study was approved by the Regional Ethics Committee of the Expert Responsibility area of Tampere University Hospital (R15100H). Written information was provided for all potential participants, and the opportunity to ask for additional information was offered prior to their decision to participate. Written consent was obtained from the participants. The participants' anonymity and confidentiality were protected. The mothers had daily contact with health care via their infants in NICU, and therefore, their psychological well-being was routinely monitored after the participation.

4 | RESULTS

4.1 | Demographic characteristics

In total, 133 questionnaires were returned, with a response rate of 61.6%. Participants were further excluded ($n = 4$) if the mother's infant was <6 days old ($n = 2$), or if a substantial amount (>50%) of data were missing in the questionnaire ($n = 2$). The mothers ($n = 129$) were, on average, 31.3 years old ($SD = 5.2$) and mainly primiparous (54.3%, $n = 70$). The infants were born at 32.6 gestational weeks ($SD = 3.1$), and they were 1.8 weeks old ($SD = 1.1$) at

the time of data collection. The data consisted of 27 pairs (20.9%) of twins. Demographic characteristics are presented in Table 1.

4.2 | Expressing initiation, expressing frequency and breast milk use

The median expression initiation time was 9.0 hr (Q_1 – $Q_3 = 5.0$ – 24.0), while median expression frequency was 6.0 times per a day (Q_1 – $Q_3 = 5.0$ – 7.0). Overall, 36.0% ($n = 45$) of mothers initiated expression with 6 hr from birth, and 33.3% ($n = 43$) of mothers expressed more than six times per day. Half of the mothers (49.2%, $n = 63$) offered their own breast milk exclusively.

4.3 | Predictors for inadequate expression practices and nonexclusive breast milk use

Independent significant predictors for late expression initiation (i.e., >6 hr from birth) were the mother's previous NICU experience, the infant's male gender, the mother's poor psychological well-being, caesarean section and the length of gestation at the time of birth ($p < .05$, Table 2). None of the predictors were significantly associated with adequate expression frequency. Furthermore, three covariates were independently associated with nonexclusive OMM use: lack of previous expressing experience, poor economic status and higher infant's gestation birth age ($p < .05$, Table 3).

4.4 | Associations between expression practices and breast milk use

Mothers who initiated expression within 6 hr of birth offered a significantly higher amount of breast milk for their infants than mothers who initiated expression later ($Md = 1.0$, Q_1 – $Q_3 = 1.0$ – 2.0 vs.

TABLE 2 Predictors of late expression initiation (>6 hr from delivery) – results of regression modelling ($n = 125$)

| Variable | Reference category | OR ^{adjusted} | 95% CI | p |
|---------------------------------------|-------------------------|------------------------|------------|------|
| Previous NICU experience ^a | Previous experience, no | 4.52 | 1.01–20.36 | .049 |
| Infant's gender ^a | Female | 3.29 | 1.39–7.82 | .007 |
| Delivery type ^a | Vaginal delivery | 3.06 | 1.28–7.31 | .012 |
| Psychological well-being ^a | Good (score > 3.0 of 5) | 3.03 | 1.21–7.60 | .018 |
| Gestational age at birth ^b | For one more day | 1.29 | 1.11–1.50 | .001 |

Variables not in equation after forward elimination: Mother's age^b, marital status^a, education^a, hospital–home distance^b, previous expression experience^a, financial woes^a, physical well-being^a, expression-related stress^b, multiple birth^a, infant's age^b.

Goodness of fit (Hosmer and Lemeshow test) $p = .778$; Nagelkerke $R^2 = 0.246$.

OR^{adjusted}, adjusted odds ratio, 95% CI, 95% confidence interval for adjusted odds ratio.

^aBinary variable.

^bRatio variable.

TABLE 3 Predictors of nonexclusive use of OMM – results of regression modelling ($n = 127$)

| Variable | Reference category | OR ^{adjusted} | 95% CI | <i>p</i> |
|---|--------------------------|------------------------|-----------|----------|
| Financial woes ^a | No (score > 3.0 of 5) | 2.96 | 1.36–6.43 | .006 |
| Previous expression experience ^a | Previous experience, yes | 2.54 | 1.16–5.59 | .020 |
| Gestational age at birth ^b | For one more day | 1.22 | 1.07–1.39 | .002 |

Variables not in equation after forward elimination: Mother's age^b, marital status^a, education^a, hospital-home distance^b, previous NICU experience^a, physical well-being^a, psychological well-being^a, expression-related stress^b, infant's gender^a, delivery type^a, multiple birth^a, infant's age^b.

Goodness of fit (Hosmer and Lemeshow test) $p = .852$; Nagelkerke $R^2 = 0.203$.

OMM, own mother's breast milk, OR^{adjusted}, adjusted odds ratio, 95% CI, 95% confidence interval for adjusted odds ratio; NICU, neonatal intensive care unit.

^aBinary variable.

^bRatio variable.

Md = 2.0, Q_1 – Q_3 = 1.0–3.0, $p = .020$, respectively). Adequate and late expression initiation was not found to be associated with expression frequency (Md = 6.0 Q_1 – Q_3 = 5.0–7.0 vs. Md = 6.0 Q_1 – Q_3 = 5.0–7.0, $p = .122$, respectively). Among the mothers who expressed six or more times per day, the milk amount was greater than mothers who expressed less frequently, but the difference was nonsignificant (Md = 1.0, Q_1 – Q_3 = 1.0–3.0 vs. Md = 2.0 Q_1 – Q_3 = 1.0–3.0, $p = .161$, respectively).

5 | DISCUSSION

This study was conducted in order to describe preterm infants' mothers' expressing practices and exclusive use of breast milk, as well as to explore whether socioeconomic factors, the family's life burdens and the infants' characteristics are risk factors for inadequate expressing practices and nonexclusive breast milk use in NICU settings. The study reveals that the expression initiation time, expression frequency and mother's breast milk use were suboptimal. To the authors' knowledge, this is the first study that has examined the predictors for inadequate expression practices and NICU breast milk use.

Associations between expression initiation, frequency and milk output have been established in previous studies. Initiation of expression is associated with milk output and breastfeeding (Hill et al., 2005; Maastrup et al., 2014; Parker et al., 2012). Similarly, in this study, early expression initiation was associated with exclusive OMM use. In this study, only one-third of the mothers expressed more than six times per day, which is indicated to be the minimal frequency for adequate milk supply (Hill et al., 1999, 2001, 2005; Nyqvist et al., 2013). The expression frequency, however, was not significantly associated with exclusive OMM use. The most apparent

reason for this is that the participation time was <2 weeks postpartum. The milk amount is hormonally controlled during this phase, and autocrine control transfer (demand based) occurs at 6 weeks after delivery (Riordan, 2010). However, early expression frequency is associated with milk output and adequate milk amount at 2–6 weeks (Hill et al., 2001, 2005). In addition, half of the mothers had an inadequate milk supply to fulfil their infant's requirements in the early lactation phase. This is identified as a risk factor for inadequate milk output later (Hill et al., 2005).

Infants' high gestational birth age increased the risk for late expression initiation and nonexclusive breast milk use. This finding is contrary to previous studies' findings, which have shown that preterm infant's low gestational age is associated with milk output (Hill et al., 2005) and exclusive breastfeeding (Maastrup et al., 2014), although some studies did not find such association (Hill et al., 1999, 2007). One explanation for this finding is that mothers of preterm infants are counselled to initiate expression immediately after delivery due to trophic feeding advantages (i.e., administration of very small OMM doses from day one) (Edmond & Bahl, 2006). Contrarily, such importance might not have been seen among moderately preterm infants, which are not generally in critical condition. However, the findings of this study indicate that moderately preterm infants had greater risk of nonexclusive OMM use, emphasising the importance of early expression initiation in moderately preterm infants' mothers.

Infant's male gender was a strong and significant predictor for late expression initiation. Interestingly, this finding is supported by findings from other Nordic countries, as Maastrup et al. (2014) found that male gender is a risk factor for nonexclusive breastfeeding at discharge. Other previous studies (Bonet et al., 2011; Hill et al., 2007) have not investigated the association between infant's gender and breastfeeding. The results suggest that infant's gender could be associated with expression initiation and breastfeeding, but the underlying reasons are unknown.

Findings regarding the mother's previous experience were controversial. The mother's previous NICU experience was a risk factor for late expression initiation, which was contrary to previous qualitative findings indicating that previous experience is a helpful factor for the mothers (Ikonen et al., 2016). One possible explanation for this finding could be inadequate counselling and unjustified reliance on mother's previous experience by the healthcare staff. However, parallel to previous qualitative findings (Ikonen et al., 2016), previous expression experience was associated with exclusive OMM use. This finding is further supported by Hill et al. (1999) and Maastrup et al. (2014), although opposite findings have also been reported (Hill & Aldag, 2005; Hill et al., 2005, 2007).

The birth of a preterm infant, NICU admission and expression are stressful demands on the mothers (Ikonen et al., 2016; Lee et al., 2009; Swanson et al., 2012). In this study, the mother's poor psychological well-being was a risk for late initiation. However, the results indicate that mothers maintain their expression frequency despite their poor physical or psychological condition, or their expression-related stress. Despite the exhausting nature of

expression (Hurst et al., 2013; Ikonen et al., 2016; Lee et al., 2009; Rossman et al., 2013; Swanson et al., 2012), expression is viewed as an obligation (Ikonen et al., 2016), and mothers decrease frequency and cease expression as the final coping strategy in an unmanageable situation (Lee et al., 2009; Swanson et al., 2012). Similarly, poor psychological condition or expression-related stress was not associated with exclusive OMM use. Neuroendocrine responses to stress and lactation are related (Hill, Chatterton, & Aldag, 2003), and psychological stress has been found to associate with breastfeeding failure (Zanardo et al., 2011). Despite these findings, the mother's mood states are not associated with milk output (Hill et al., 2006), supporting this study's findings.

Socioeconomic differences were partly apparent in this study. The family's financial woes increased the risk of nonexclusive OMM use in NICU settings, which is also supported by previous studies (Hill & Aldag, 2005; Hill et al., 1999, 2005). However, the mother's education was not associated with exclusive OMM use, as supported by Maastrup et al. (2014). Notably, Hill et al. (1999, 2005, 2007) have presented opposite findings in the United States. Although high maternal education is associated with breastfeeding in the Finnish population (National Institute for Health and Welfare, 2012), the NICU environment and counselling could diminish this association.

This study has some limitations. All of the participants were Caucasian and relatively highly educated, which limits the results' transferability. The presence of a major crisis was used as exclusion criteria due to ethical reasons. These exclusion reasons were related to the infant's extremely critical condition, but in order to protect the patient's privacy, exact diagnoses were not collected from excluded mothers. However, for this reason, the results are not representative for mothers with extremely critically ill infants. Furthermore, donor milk availability in NICUs limits the results' transferability to NICU settings without such an advantage. Long maternity leaves and extensive welfare benefits in Finland further limit the results' transferability to different societies. Some compromises had to be done in selecting covariates. Previous qualitative and quantitative findings indicated that a large amount of independent variables are potentially related to outcome variables. Therefore, forward addition in logistic regression was applied in this relatively small sample, despite the presented recommendations (Harrell, 2001; Hosmer et al., 2013). This limitation was partly diminished by testing the regression models using backward stepwise method. Physical well-being and psychological well-being were measured with single self-rated questions rather than validated scales, which is a threat to validity.

6 | CONCLUSION

The study indicates that only one of the three mothers initiated expression within the recommended time and maintained adequate expression frequency. Furthermore, nonexclusive OMM use was common. Mothers with a moderately preterm infant, male infant, poor psychological condition, previous NICU experience and a caesarean section have increased the risk of inadequate expression

initiation. Furthermore, the infant's high gestational age was also a predictor for nonexclusive OMM use. The results suggest that inadequate expression frequency is not explained by the mother's or the infant's characteristics, or by the mother's well-being and stress. Socioeconomic differences are partially apparent in the NICU, as financial woes predicted nonexclusive OMM use. Furthermore, previous expression experience was a predictor for exclusive OMM use. Further studies are needed for detecting the controversial associations between the mothers' previous experiences and expression initiation, as well as their exclusive OMM use. Furthermore, this study found an interesting association between male gender infants and suboptimal expression initiation, which should be studied further.

7 | RELEVANCE TO CLINICAL PRACTICE

The preterm infants' mothers' expression practices, as well as exclusive OMM use in NICU settings, were suboptimal in this study. Counselling and support are needed (Nyqvist et al., 2013) to diminish the differences in breastfeeding rates among term and preterm infants (Bonet et al., 2011; National Institute for Health and Welfare, 2012). More specifically, the nurses should encourage the mothers to initiate expression within 6 hr of birth, as well as to express frequently (Nyqvist et al., 2013). According to the results of this study, special attention should be paid to mothers with previous NICU experience and compromised psychological well-being, as well as to mothers whose infant is born via caesarean section, is moderately preterm and is a boy. Although qualitative studies have indicated that the mother's exhaustion and stress are expression barriers (Hurst et al., 2013; Lee et al., 2009; Rossman et al., 2013; Swanson et al., 2012), the results of this study suggest that mothers maintain expression regardless of their physical or psychological well-being, or their expression-related stress. Nevertheless, the mother's emotional well-being should be routinely monitored and supported by the NICU staff. In addition, close collaboration with social work is needed, as socioeconomic differences in breastfeeding are also apparent in NICU settings.

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DISCLOSURE

The authors confirm that all authors meet the ICMJE criteria for authorship credit, as follows: (1) Substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content and (3) final approval of the version to be published.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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