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Title: Promoting Sensitive Mother-Infant Interactions in the Neonatal Intensive Care Unit: Development and Design of a Nursing Intervention Using a Theory and Evidence-Based Approach

Titre : Élaboration d'une intervention infirmière suivant une approche basée sur la théorie et les données empiriques pour promouvoir les interactions empreintes de sensibilité maternelle à l'unité de soins intensifs néonataux

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Abstract

Introduction: Sensitive mother-infant interactions are important predictors of long-term mother-infant relationship and infant development. Considering preterm infants' immaturity, mother-infant interactions and maternal sensitivity may not develop optimally. A systematic review showed that current evidence on the effectiveness of parent-infant interventions promoting parental sensitivity in the neonatal intensive care unit (NICU) is of low to very low quality.

Objective: The objective of this paper is to report the development process of a novel nursing intervention, using a theory and evidence-based approach, to enhance maternal sensitivity and preterm infant neurodevelopment in the NICU.

Methods: The Medical Research Council's guidance to develop and evaluate complex health interventions, that is an evidence and theory-based approach, was used for this study. Thus, based on the MRC framework, three main steps were conducted: 1- Identifying existing empirical evidence; 2- Identifying and developing theory; 3- Modeling processes and outcomes.

Results: We developed a guided participation intervention for mothers to participate in their preterm infant's care and positioning ('GP_Posit'). 'GP_Posit' is based upon the Attachment theory, the Guided Participation theory as well as the Synactive theory of development.

Conclusion: This novel intervention is being tested in a pilot randomized controlled trial (NCT03677752).

Keywords: Nursing science, Mother-Infant Interactions, Prematurity, Neurodevelopment, Theory



Résumé

Introduction : La relation mère-enfant, dont les interactions empreintes de sensibilité maternelle en sont l'un des principaux prédicteurs, figure parmi les facteurs pouvant améliorer le développement des nouveau-nés prématurés. En raison de l'immaturation des nouveau-nés prématurés, les interactions mère-enfant précoces et la sensibilité maternelle sont à risque de se développer de façon sous-optimale. Les résultats d'une revue systématique ont montré que les données actuelles sur l'efficacité des interventions parent-enfant favorisant la sensibilité parentale dès l'hospitalisation à l'unité de soins intensifs néonataux (USIN) sont de qualité faible à très faible.

Objectif : L'objectif de cet article est de rapporter le processus de développement d'une nouvelle intervention infirmière, en utilisant une approche basée sur la théorie et les données empiriques, pour améliorer la sensibilité maternelle et le développement neurologique des nouveau-nés prématurés à l'USIN.

Méthodes : Les lignes directrices du *Medical Research Council* pour le développement et l'évaluation d'interventions complexes en santé ont été suivies. Ainsi, trois principales étapes ont été suivies : 1- Identification des preuves empiriques existantes ; 2- Identification et développement théorique ; 3- Modélisation des processus et des résultats.

Résultats : Nous avons développé une intervention de participation guidée pour que les mères participent aux soins et au positionnement de leur nouveau-né prématuré ('GP_Posit'). 'GP_Posit' est basée sur la théorie de l'attachement, la théorie de la participation guidée ainsi que la théorie synactive du développement.

Conclusion : Cette intervention est mise à l'essai dans un essai contrôlé randomisé pilote (NCT03677752).

Mots clés : Sciences infirmières, Interactions mère-enfant, Prématurité, Neurodéveloppement, Théorie



INTRODUCTION

Maternal sensitivity is a predictor of long-term mother-infant attachment (Deans, 2018). It is defined as the mother's ability to recognize, interpret, and respond in an appropriate and timely manner to her infant's behavioral cues (Ainsworth et al., 1978).

Infant vocalizations and facial expressions are specific cues that trigger regions of the mother's brain to select appropriate caregiving behaviors (Young et al., 2017). For instance, maternal sensitivity is a dyadic component of mother-infant interactions that not only depends upon the mother's ability to detect and interpret infant cues but also depends on the infant's ability to demonstrate clear cues (Oxford & Findlay, 2015). Thus, being born preterm may affect maternal sensitivity as preterm infants use behavioral cues that may be difficult to interpret (Neuhauser, 2016). Current evidence points out that preterm infants may be more susceptible to low-sensitive parenting (Jaekel et al., 2015), as they may require higher levels of sensitivity from their mother (Bilgin & Wolke, 2015).

Preterm birth also disrupts the mother-infant closeness that usually occurs naturally after birth (Flacking et al., 2012). However, undisrupted mother-infant closeness after birth should be considered a priority in neonatal care. In fact, higher oxytocin levels during pregnancy, and most importantly early after birth, are associated with early maternal interactive behaviors (Feldman et al., 2007; Sammut et al., 2017). Oxytocin influences maternal sensitivity and attachment (Tharner et al., 2012). Thus, reinstating the mother-infant relationship by promoting closeness (Flacking et al.) and sensitive interactions through specific interventions following preterm birth is essential.

Systematic reviews have shown that mothers of preterm infants are as sensitive as those of term infants (Bilgin & Wolke, 2015) and that mother-preterm infant dyads are not at greater risk of developing an insecure attachment (Korja et al., 2012). Nevertheless, it appears there is no consensus regarding the latter statement as attachment is still reported to be less secure in preterm infants compared to term infants between the ages of 12 and 36 months (Ruiz et al., 2018). Moreover, the early quality of maternal caregiving and the mother-infant relationship have systematically been identified as significant predictors of preterm infants' development (Grunberg et al., 2019; Poehlmann et al., 2012; Stein et al., 2013; Treyvaud et al., 2009; Treyvaud et al., 2016; Wright et al., 2018). In a group of 134 infants, neurodevelopment was significantly better in preterm infants whose mothers were qualified as sensitive (Neri et al., 2017). More specifically, higher levels of maternal sensitivity have been identified as significant predictors of better reading

and performances in mathematics at ages seven and eight in children born preterm (Jaekel et al., 2015; Treyvaud et al., 2016). Higher levels of maternal sensitivity also significantly predict larger gray matter volumes and head circumference in preterm infants at the age of eight (Kok et al., 2015). Thus, maternal sensitivity seems to be an important factor having a direct effect upon preterm infants' short-term cognitive and brain development.

Regarding long-term neurodevelopment, impairments are still reported in children born preterm. For example, a recent meta-analysis outlined that preterm children, compared to term children, have significant deficits in mathematics and reading until at least 18 years of age (McBryde et al., 2020). Interestingly, this sample included infants born as late as in 2018, confirming that those deficits remain even in preterm infants who received modern neonatal care (McBryde et al.). Even adults born preterm still report having social difficulties (Pyhala et al., 2017) and score significantly lower at neuropsychological tests (O'Reilly et al., 2020). Thus, preterm infant long-term neurodevelopment is still a contemporary concern. Moreover, considering that early maternal sensitivity has a positive impact upon preterm infants' development, interventions promoting maternal sensitivity during Neonatal Intensive Care Unit (NICU) hospitalization seem necessary. In fact, evidence shows that early interventions implemented during NICU hospitalization enhancing parenting in mothers of preterm infants may act as leverage for plasticity of the preterm infant's brain to enhance neurodevelopmental outcomes (DeMaster et al., 2019).

Our systematic review (Lavallée et al., 2021) evaluating the effectiveness of parent-infant interventions in the NICU on sensitivity concluded that these interventions, compared to standard care, did not enhance short-term maternal sensitivity, that being when the preterm infant is at term equivalent age. Similar results were found at up to 6 months of corrected age (CA), and after 6 months of CA. Results were the same for preterm infant neurodevelopment at term equivalent age and after 6 months of CA. However, it is important to consider that these results are based on low to very low quality of evidence. In other words, these results may not entirely be due to the ineffectiveness of the interventions, but rather to implementation failure (i.e., interventions not delivered as planned to all participants, dose of the intervention insufficient, contamination between study groups). Qualitative studies and literature reviews have highlighted that nurses have a central role in guiding mothers to develop their relationship with their hospitalized preterm infant (Fernandez Medina et al., 2018; Fleck, 2016). It is also recognized by parents that nurses play a

key role in facilitating parenting in the NICU (Reid et al., 2019). In light of these results, it appears important to develop novel theory and evidence-based nursing interventions to add to this body of knowledge.

Therefore, the aim of this paper is to report the development process of a novel nursing intervention, using a theory and evidence-based approach, to enhance maternal sensitivity and preterm infant neurodevelopment in the NICU. The novel intervention was named ‘GP_Posit’ because, as it will be discussed below, it mainly focuses on **Guided Participation** of mothers to the **Positioning** of their preterm infant.

METHODS

‘GP_Posit’ was developed following a theory and evidence-based approach (O’Cathain et al., 2019) and more specifically using the Medical Research Council’s (MRC) Framework for developing and evaluating interventions (Craig et al., 2013; Craig et al., 2008). The MRC framework was selected because it offers guidance to develop interventions with a well-founded theoretical understanding to reasonably expect a positive effect on selected outcomes (Craig et al., 2013; O’Cathain et al.). The intervention development process is hereafter described following the MRC’s three main steps: 1- Identifying existing empirical evidence; 2- Identifying and developing theory; 3- Modeling processes and outcomes.

Intervention Development Process

Step 1 – Identifying Existing Empirical Evidence

Prior to the development of this intervention, we conducted a systematic review and meta-analysis evaluating the effectiveness of parent-preterm infant interventions, in the NICU, on parental sensitivity (Lavallée et al., 2021). The main conclusion was that there was no significant effect of parent-infant interventions over standard care or basic educational programs. However, we concluded that these results may not have been due to the ineffectiveness of the interventions, but rather due to implementation failure or high risk of bias of included studies. Based on this conclusion, a thorough secondary analysis of the components of the interventions (n=18) was conducted (see Table 1).

Table 1*Components and composition of interventions*

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
White-Traut and Nelson (1988)	Directly modifying the interaction between mother and infant via maternally administered intervention.	RISS (Rice Infant Sensorimotor Stimulation Technique): mothers provided tactile stimulation (touch or massage), vestibular stimulation (rocking), auditive and visual stimulation (eye-to-eye contact).	<ul style="list-style-type: none"> • First three days after birth. 	<ul style="list-style-type: none"> • Mothers administered RISS protocol four times • 15 min 	<p>Verbal instructions, pictures that illustrated the technique;</p> <p>Demonstration of the technique on a doll, were used for teaching the RISS.</p>	First author (nurse).	Educational and Active
Meyer et al. (1994)	Address the needs of parents and their high-risk infant and improve parenting and family factors likely to affect infant development.	<p>Individualized intervention based on initial interview to identify parent's needs on four domains:</p> <ul style="list-style-type: none"> ○ NBAS evaluation + strategies thought to parents to support development; ○ Family organisation; ○ Modification of 	<ul style="list-style-type: none"> • Started when infant health was stable and finished before discharge (2 to 8 weeks). 	<ul style="list-style-type: none"> • Number of sessions depended on family needs and duration of hospitalisation • 1 hr to 1 hr 30 min sessions 	Individualized family-based intervention.	Pediatrician, nurse and physical therapist.	Educational and Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
		care environment + guided interaction; ○ Care after discharge.					
Browne and Talmi (2005)	Increase knowledge and contingent mother infant interaction and decrease parental stress.	Individualized demonstration of preterm infant's reflexes, motor capacities and sleep-wake cycles using the APIB. Then, mothers were instructed to interact with their infant using the Mother's Assessment of the Behavior of her Infant (MABI).	• From NICU admission to the week before discharge.	• One session • 45 min	Individual session.	Not reported.	Active
Melnyk et al. (2006)	Strengthen parents' knowledge and beliefs about their preterm infants and their own parenting role and remove barriers that would inhibit them from	COPE – Information given on 1) the appearance and behavioral characteristics of premature infants (infant-behavior information) and how parents can participate in their infants' care, meet	• From first week after birth to first week post discharge.	• Content was given to parents in four phases • Duration not applicable	Educational-behavioral intervention through audio and written information given to parents.	Not applicable.	Educational

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
	participating in their infants' care and interacting with them in a developmentally sensitive manner.	their infants' needs, enhance quality of interaction with their infant, and facilitate their infant's development (parent-role information) and 2) activities that assist parents in implementing the experimental information.					
Glazebrook et al. (2007)	Enhance parents' observations of their baby and sensitivity to cues through a series of activities which follow the progression of care from incubator to home.	Parent Baby Interaction Program (PBIP): Tactile, discussion, verbal, observation and developmental care activities.	<ul style="list-style-type: none"> From NICU admission to discharge. Option to continue six weeks after discharge. 	<ul style="list-style-type: none"> Weekly sessions 1 hr 	Individual sessions.	Neonatal nurse.	Active
Chiu and Anderson (2009)	Enhance mother-preterm infant interaction.	Preterm infants placed in skin-to-skin contact (SSC) after birth. SSC was encouraged as long as	<ul style="list-style-type: none"> From birth to NICU discharge. 	<ul style="list-style-type: none"> One session + guidance during SSC Not reported 	At birth mothers are encouraged to begin SSC as early,	Nurse.	Active

References	Intervention aims	Intervention description	When?	How much? <ul style="list-style-type: none"> Number sessions Length of sessions 	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
		possible and as frequently as possible. Guidance provided to recognize hunger cues.				as often, and for as long as possible.	
Newnham et al. (2009)	Enhance the quality of mother–infant interaction by teaching the mothers of low-birth-weight infants to be more sensitive and responsive to their babies’ physiological and social cues.	Modified Mother-Infant Transaction Program (MITP): psychoeducational intervention on five main topics: 1) becoming acquainted, 2) Recognizing infant disorganisation/stress and availability and then applying those principles during care and play, 3) bath session, where mothers (who bathed their infants) were helped to recognize, and appropriately respond to infant disorganisation and stress, 4) regulate infant responses through play in home setting, and 5)	<ul style="list-style-type: none"> Weeks before discharge to 3 months CA. 	<ul style="list-style-type: none"> Nine sessions 30 min to 1-hr 	Verbal instruction, infant observation, practical experience in handling infants and modeling, as well as written materials.	First author (psychologist).	Educational and Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
		Recognizing temperamental characteristics in infants and parenting to different temperaments					
Teti et al. (2009)	Promote parents' awareness of infant bodily and social cues and parents' sensitivity and confidence in handling their infants. Provide parents with information, via instruction and demonstration, about premature infants' capacities for interacting with the world, how to recognize and respond appropriately to infant cues, and	Parentally administered infant massage designed to promote infant development and, in this case, parental knowledge of subtle infant cues and feeling of intimacy toward their infants.	• 20-week intervention from NICU to post-discharge.	• Eight sessions • 1 hr	Not reported.	Not reported.	Educational and Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
	the role of parent–infant interaction in optimizing infant development.						
Ravn et al. (2011)	Help parents appreciate their infant’s unique characteristics, temperament, and developmental potential, make the parents more sensitive and responsive to their infants’ physiological and social cues, particularly those that signal stimulus overload.	MITP: Interaction guidance focusing on teaching the parents to understand the individuality of an atypical child, to establish a good pattern of interaction and to encourage the parents to enjoy their infants.	<ul style="list-style-type: none"> Last week before discharge to 3rd month after discharge. 	<ul style="list-style-type: none"> Eleven sessions 1 hr 	Individualized interaction guidance.	Neonatal nurses.	Active
Zelkowitz et al. (2011)	Reduce maternal anxiety and enhance maternal sensitivity by intervening at the level of both	CUES: educational intervention for mothers to <ul style="list-style-type: none"> recognize signs of their anxiety/distress; 	<ul style="list-style-type: none"> Starting ~33 days after birth until 6-8 weeks of CA. 	<ul style="list-style-type: none"> Six sessions 1 hr 	Individual sessions of teaching and one individual of video interaction guidance.	Nurse or psychologist.	Educational and Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
	maternal distress and maternal interactive behavior to promote a better parenting environment and thereby optimize the child's cognitive and social development.	<ul style="list-style-type: none"> ○ use various strategies to alleviate their distress; ○ read their infant's communication cues; ○ respond sensitively to their infant's cues and distress. 					
Milgrom et al. (2013)	Enhance the quality of mother–infant interaction by teaching the mothers of low-birth-weight infants to be more sensitive and responsive to their babies' physiological and social cues.	<p>Enhanced MITP (PremieStart program).</p> <p>Mothers trained to increase their sensitivity in recognizing signs of infant stress including “shut-down” mechanisms, alert-available behavior, facial expressions, quality of motor behaviors, posture and muscle tone; how to provide graded stimulation; and how</p>	<ul style="list-style-type: none"> • From first week after birth to first week post discharge. 	<ul style="list-style-type: none"> • Nine weekly sessions and one session post-discharge • 1 hr 	Individual psychoeducational intervention.	Psychologists.	Educational

References	Intervention aims	Intervention description	When?	How much? <ul style="list-style-type: none"> Number sessions Length of sessions 	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
		to avoid overwhelming infants; focus on touch, movement and massage; SSC; multi-sensory stimulation; debriefing and normalizing parental feelings; challenging dysfunctional thoughts, and parental diary keeping.					
White-Traut et al. (2013)	Not reported.	H-HOPE (Hospital to Home: Optimizing the Infant's Environment) – combination of guided participation of mothers to Auditory Tactile, Visual and Vestibular-rocking stimulation (ATVV)	From 32 weeks of GA to 1-month CA.	ATVV: <ul style="list-style-type: none"> Twice daily 15 min per session Maternal sessions: <ul style="list-style-type: none"> 6 sessions 	Mothers were thought to administer the ATVV during the maternal sessions. Otherwise, mothers administered ATVV.	Nurse advocate team.	Active
Borghini et al. (2014)	Enhance the quality of parental caregiving as a support to the infant's global development by	<u>At 33 weeks of GA:</u> joint observation of infant's reactions to various stimuli during standard care procedures.	<ul style="list-style-type: none"> First session at 33 weeks of GA. Three sessions one-week apart during 4th month CA. 	<ul style="list-style-type: none"> Four sessions 30-60 minutes 	Individual sessions of interaction guidance and video interaction guidance.	Nurse and therapist.	Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
	improving parents' observation and understanding of the specific competencies of their preterm infant (particularly interactional competencies) and promote parents' sensitivity and responsiveness towards their infant's behavioral characteristics.	At 4 months CA: 10-min mother-infant free play videotaped followed by video interaction guidance.					
Hane et al. (2015)	Establish an emotional connection and a Calming Cycle routine between the mother and her premature infant.	Family Nurture Intervention (FNI): mothers are involved in calming interventions which is facilitated by a nurture specialist. ○ Scent cloth exchange; ○ Vocal soothing and emotion	• From NICU admission to discharge depending on availabilities of mothers.	• Average of 3.5 sessions/week • ~6hr/week	Guided individual sessions.	Nurture specialists (former nurses).	Active

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
		expression; ○ Eye contact; ○ Skin-to-skin and clothed holding.					
Hoffenkamp et al. (2015)	Facilitate parental bonding, to enhance the quality of parental interactive behavior, and to promote parental well-being using edited video recordings of parent-infant interactions.	Parent-infant interaction videotaped during daily moments of caregiving such as bathing, changing and feeding. Video is then reviewed and discussed with the parents.	<ul style="list-style-type: none"> • During first week after birth. 	<ul style="list-style-type: none"> • Three sessions • Duration not reported 	Individual sessions of video interaction guidance.	Trained nurses and pedagogic workers.	Active
Evans et al. (2017)	Prevent severe emotional, behavioral and developmental problems in both children and adolescents.	Triple P is an educational intervention covering four main topics: 1) survival skills, 2) partner support, 3) positive parenting, and 4) responding to your baby.	<ul style="list-style-type: none"> • From NICU hospitalisation to 12 months CA. 	<ul style="list-style-type: none"> • Four sessions • 2 hr • Four post-discharge phone calls • 30 min 	Not reported.	Trained facilitators.	Educational

References	Intervention aims	Intervention description	When?	How much? • Number sessions • Length of sessions	Modes of delivery	Professional delivering intervention	Presence of Educational component and Active Parental role
Sahlen Helmer et al. (2019)	Increase time spent in SSC to improve mother-infant interaction.	Continuous skin-to-skin contacts between mother and infant.	• First seven days of life.	• Continuously (>20-hr/day)	Not applicable.	Not applicable.	Active
Twohig et al. (2019)	Not reported.	Reflective interview, observation of infant cues and video interaction guidance.	Not reported.	• Three sessions • 1 hr to 1 hr 30min	Individual sessions.	First author (clinician/researcher)	Active

This analysis revealed that both educational and active components seem to have their importance in parent-infant interventions with a predominance of a combination of the two components (Meyer et al., 1994; Newnham et al., 2009; Teti et al., 2009; White-Traut & Nelson, 1988; Zelkowitz et al., 2011), or an active component alone (Borghini et al., 2014; Browne & Talmi, 2005; Chiu & Anderson, 2009; Glazebrook et al., 2007; Hane et al., 2015; Hoffenkamp et al., 2015; Ravn et al., 2011; Sahlen Helmer et al., 2019; Twohig et al., 2019; White-Traut et al., 2013). The educational component usually encompasses different topics, and the active-participatory component relates to maternal participation in various caregiving activities of their preterm infant with direct guidance from a healthcare professional. In the studies including an educational component, most parent-infant interventions were centered around teaching mothers about care activities that may enhance their preterm infant's neurodevelopment. Some interventions aimed at teaching mothers about sensorimotor stimulation (White-Traut & Nelson), multisensorial stimulation (Hane et al.; Milgrom et al., 2013; White-Traut et al.), massage (Teti et al.), developmental care (Glazebrook et al.), or skin-to-skin (Chiu & Anderson; Sahlen Helmer et al.). On the other hand, 50% of the parent-infant interventions included active parent-provided care, and in 75% of those, parents were given specific guidance to do so (Borghini et al.; Hoffenkamp et al.; Meyer et al.; Newnham et al.; Ravn et al.; Twohig et al.; White-Traut et al.). In other words, parents participated in caregiving activities of their preterm infant, while being guided by a nurse or another professional.

Step 2 – Identifying and Developing Theory

Knowledge from three theories, i.e. the Attachment Theory (Ainsworth et al., 1978; Bowlby, 1982, 1988), the Synactive Theory of Development (Als, 1982) and the Guided Participation theory (Pridham et al., 1998), was integrated to design this intervention. Each theory contributes to the theoretical foundations of the intervention: the attachment theory offers a comprehensive understanding of the mother-infant relationship which encompasses maternal sensitivity; the Synactive Theory of Development contributes to the conceptualization of the infant's behavior and development as being influenced by its environment; the Guided Participation theory circumscribes the nursing role regarding promotion of the mother-infant relationship.

Attachment Theory

The attachment theory was originally introduced by John Bowlby (1982). Bowlby's ideas originated from animal naturalistic observations that he applied to human infants and their mothers. Bowlby first postulated that attachment encompassed a set of intrinsic behaviors in infants that aimed at maintaining proximity with the mother (Bowlby, 1982). Before the infant has gained mobility and can demonstrate approaching behaviors, i.e., behaviors where the infant reaches proximity with their mother, they will first demonstrate signaling behaviors such as crying, smiling and babbling, that normally bring the mother to the infant (Bowlby, 1982). Additionally, Bowlby (1988) suggested that the mother-infant relationship acts as the base for infant development. Our modern conception of the attachment theory is also influenced by Mary Ainsworth's (Ainsworth et al., 1978) work. Ainsworth later worked on the mother-infant relationship where she was able, following observational studies of human infants and their mothers (Ainsworth, 1963, 1967), to define different patterns of attachment and components of the mother-infant relationship (Ainsworth et al., 1978). In fact, Ainsworth introduced the concept of sensitivity where she observed that infants of highly sensitive mothers were more likely to have a secure attachment (Ainsworth, 1963) and a more harmonious mother-infant relationship (Bell & Ainsworth, 1972). Highly sensitive mothers are attuned to their infant's cues, respond promptly and appropriately, and understand the meaning of their most subtle signals (Ainsworth et al., 1978). Infants who have a mother who responds to their needs in such a contingent way feel secure to develop an attachment and to explore their environment (Ainsworth et al., 1978). The attachment theory oriented the aim of the intervention as it was designed to propose mother-infant sensitive interactions during the first months of the infant's life, such as during NICU hospitalization.

Synactive Theory of Development

The Synactive Theory of Development was introduced by Als (1982) to allow an understanding of each infant's individuality. Infants' organisms develop according to five subsystems: 1) Autonomic system, 2) Motor system, 3) State-organizational system, 4) Attention and interaction system, and 5) Self-regulatory system. Each of these five subsystems is in interaction with each other and with the environment to reach and maintain a state of stability in the infant's organism. In fact, even preterm infants have the capacity to interact with their social environment, and this interaction is essential for an optimal development as sensitive caregivers

may help preterm infants reach a state of stability. Infants interact using cues that are classified in two categories: stress and stability cues. Stress cues translate a state of instability and call for interventions that may help the infant regain a stability state. On the other hand, stability cues call for minimal handling to maintain this state. The main behavioral stress and stability cues, which are most recognizable for mothers, are presented in Table 2. In other words, the Synactive Theory of Development stresses the importance for mothers and nurses to continuously read infant's behavioral cues as they have the ability of communicating their needs with their environment.

Table 2

Main stress and stability behavioral cues¹

Sub-system	Stress	Stability
Autonomic	Hiccupping Sneezing Yawning Coughing	Smooth respiration Stable color
Motor	Flaccidity of the trunk and/or extremities Hyperextension of arms and/or legs and/or trunk Finger splays Facial grimacing Tongue extensions	Hand and/or foot claspings Hand-to-mouth Grasping Handholding Sucking
State	Crying Irritability Staring	Consolability Clear sleep state Focused alertness

¹Based on Als et al. (1986)

Note: The absence of one of the stress cues listed in this table does not necessarily mean the presence of stability; and the absence of the stability cues listed in this table does not necessarily lead to stress.

Guided Participation Theory

Guidance is the most frequent mode of delivery of mother-infant interventions to enhance maternal sensitivity in previous studies (See Table 1; Borghini et al., 2014; Hoffenkamp et al., 2015; Meyer et al., 1994; Newnham et al., 2009; Ravn et al., 2011; Twohig et al., 2019; White-

Traut et al., 2013). Guidance is based on the Guided Participation theory, specific on parenting, which has its origins from the Experiential Learning theory (Pridham et al., 1998). Guidance is more than coaching as it aims to achieve a meaningful goal, or to bring the mother to acquire an autonomous caregiving practice for her preterm infant (Pridham et al., 1998). Experiential learning is based upon pragmatist philosophers including mainly Dewey, Lewin and Piaget's ideas (Miettinen, 2000). Among the pragmatist philosophers, Dewey's strong epistemological foundation is, to its simplest expression, the conception of *knowing* and *doing* as being indissociable concepts (Talisso & Aikin, 2011). Dewey gave particular importance to experience as situations where individuals are subject to the requirements of the environment and plan and adapt their actions according to these environmental conditions (Dewey, 2013). Thus, the Guided Participation theory integrates these postulates to support the idea that mothers may gain their maternal role and develop their relationship with their preterm infant while experiencing caregiving activities (Pridham et al., 2018). Caregiving activities are a set of activities relevant to five main categories: 1) being with the baby, 2) knowing the baby as a person, 3) giving care to the baby, 4) communicating and engaging with others about infant and parental needs, and 5) problem-solving/decision-making/learning (Pridham et al., 1998). Thus, guided participation is defined as the dyadic process where a novice (mother) engages in a relationship with an expert (nurse), where the former brings the latter to participate in caregiving activities using guidance, over a period of time (Pridham et al., 1998; Schroeder & Pridham, 2006). Ultimately, mothers develop their relationship with their infant through this caregiving practice (Schroeder & Pridham, 2006).

Step 3 - Modeling processes and outcomes

Based on the theories and empirical evidence, two main intervention components were identified: 1- an educational component, and 2- an active-participatory component (see Table 3). These two components are interconnected and both essential. The intervention developed is hence multifaceted as it includes both educational and active components, the former being educational activities where mothers receive information and the latter where mothers actively participate in caregiving activities.

Table 3*GP_Posit intervention components*

1. Educational	
Topics	Stress and stability behavioral cues of preterm infants
	Supine, lateral and prone positioning
2. Active-Participatory	
Caregiving activities	Diapering
	Positioning (supine, lateral and prone)
	Bottle-feeding and/or breastfeeding (optional)

Educational Component

The educational component includes teaching mothers the stress and stability behavioral cues of preterm infants, which is supported by both theory (Ainsworth et al., 1978; Als, 1982) and empirical evidence (Borghini et al., 2014; Browne & Talmi, 2005; Evans et al., 2017; Melnyk et al., 2006; Milgrom et al., 2013; Newnham et al., 2009; Ravn et al., 2011; Teti et al., 2009; Twohig et al., 2019; Zelkowitz et al., 2011). In fact, if mothers are expected to detect and interpret their infant's cues (Ainsworth et al.), and preterm infants interact with cues that are difficult to understand (Neuhauser, 2016), it becomes evident that those specific cues should first be thought to mothers before they may interpret and respond in an appropriate manner. In 'GP_Posit', mothers are additionally being taught how to position their preterm infant in their incubator or crib. Positioning is a central part of preterm infants' care while in the NICU intended to improve their neuromotor development (Lavallée et al., 2018).

Active-Participatory Component

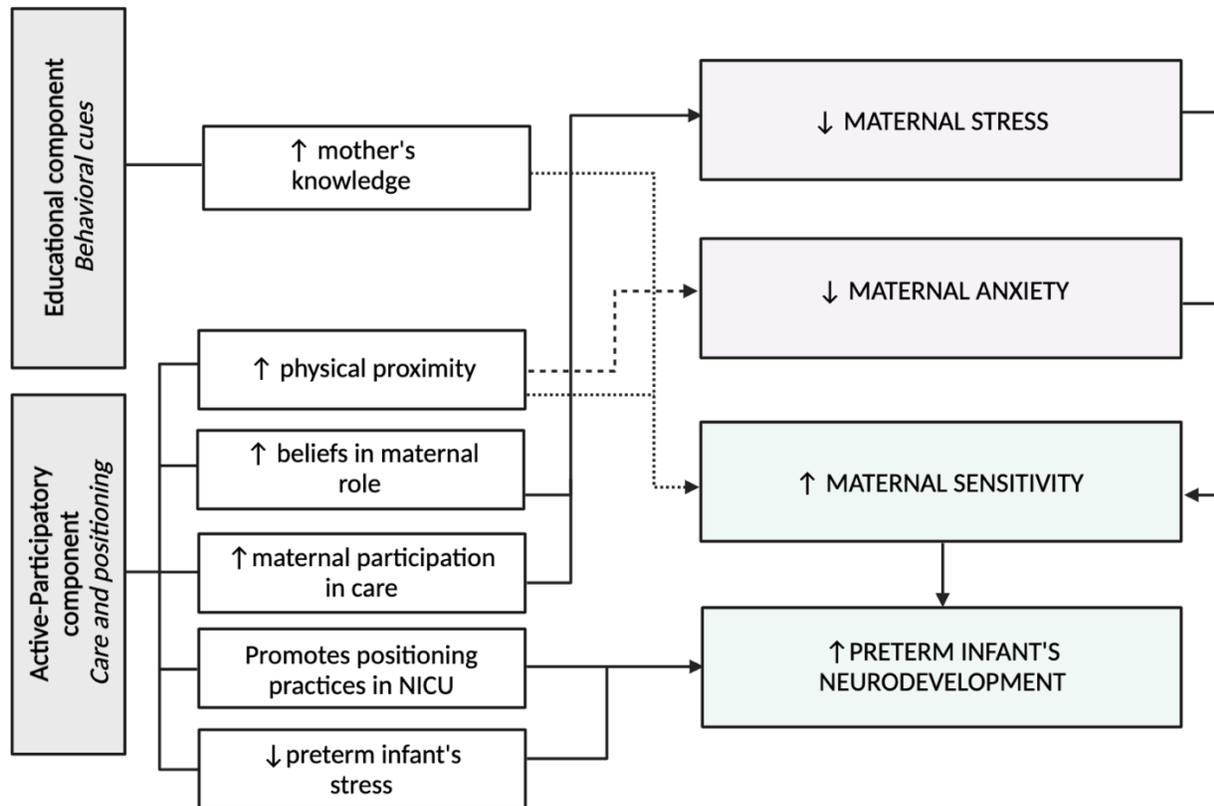
In addition to the educational component, the emphasis of the intervention is on the active-participatory component (Pridham et al., 1998).

In 'GP_Posit', mothers actively participate in caregiving activities with their preterm infants while being also guided by a nurse. It is of importance to note that caregiving activities are only the context provided to mothers so they can learn how to interact with their preterm infant

with sensitivity. Thus, while providing care to their infant, guidance is given to mothers so they can learn to detect, interpret and respond to their infant's behavioral stress and stability cues. In fact, for preterm infants, caregiving activities are recognized as being stressful (Peng et al., 2014; Pereira et al., 2013), so care should be provided in accordance with their behavioral cues (Lavallée et al., 2019b). In other words, the nurse's role during the sessions is to provide guidance to mothers by encouraging, praising, and supporting them in recognizing behavioral cues when they did or did not recognize or respond to a cue. As stated in Table 3, caregiving activities include diapering, positioning and feeding (optional). When providing care to preterm infants in the NICU, diapering is usually the first manipulation done, followed by positioning. Thus, throughout the intervention sessions, mothers progressively participate in their infant's diapering, then supine, lateral and prone positioning. This progression is based both on the mothers' ability and level of confidence as well as the nurse's judgment. Nevertheless, the aim is to focus on sensitive mother-infant interactions while doing the caregiving activity and not necessarily go through every caregiving activity during the sessions. However, if both the mother and the nurse consider that the mother easily recognizes, interprets, and responds to most behavioral cues of her infant while doing a specific caregiving activity, they may move onto the next caregiving activity. For infants nearing home discharge and who are learning to feed orally, the caregiving activity could be adapted to bottle or breastfeeding if mothers are already comfortable with positioning.

Logic modelling

Figure 1 exposes the intricate links between intervention components, mechanisms of action, mediators as well as expected outcomes of 'GP_Posit', based on theories and empirical evidence. These links are described hereafter.

Figure 1*GP_Posit logic model*

Educational component. The educational component should increase mothers' knowledge about their infant's behavioral cues as well as their beliefs about their competence in recognizing these cues (Als, 1982, 1986; Melnyk et al., 2014; Neuhauser, 2016). Mothers of preterm infants verbalize the need to be educated about these cues (Lee et al., 2009).

Active component. As for active participation in care facilitated by guided participation, this should trigger five mechanisms of action. First, in interventions where touch is involved, the feeling of physical proximity within the dyad increases (Feeley et al., 2016). This also reinstates mother-infant closeness. Guided participation as well as maternal active participation in care increase the feeling of gaining confidence in maternal role and lowering maternal stress (Cleveland, 2008; Smith et al., 2012). Moreover, having mothers participate in their preterm infant's positioning should promote optimal positioning practices for the preterm infant throughout the

NICU stay. Finally, as the emphasis in guided participation is primarily to support mothers in interacting with their preterm infant with sensitivity, this entails that they give importance to recognizing in addition to interpreting the stress and stability cues. Respecting preterm infant cues while providing care helps them to co-regulate with their mother and keep their stress to a minimal level (Als, 1982). Also, appropriate positioning of the preterm infant in the NICU allows them to improve autoregulation (Jarus et al., 2011; King & Norton, 2017).

Increasing mother's knowledge. Mothers being more knowledgeable about their preterm infant's behavioral cues should allow them to be better prepared to detect and interpret these cues which is central to maternal sensitivity (Ainsworth et al., 1978) and to reduce their stress and anxiety (Melnik et al., 2006).

Increasing physical proximity. Physical proximity between mother and her infant is the base of the attachment theory and contributes to maternal sensitivity (Bowlby, 1982). Mother-infant interventions in the NICU where maternal participation is promoted have been successful in reducing maternal stress (Melnik et al., 2006). On the opposite, when physical proximity is limited, maternal anxiety increases (Vazquez & Cong, 2014).

Targeting maternal role and participation. Maternal role adjustment is one of the most important sources of stress for mothers in the NICU (Govindaswamy et al., 2019; Roque et al., 2017). Having mothers participate in their infant's care has been identified as an intervention promoting mother's confidence in her maternal role (Govindaswamy et al.) and thus reduces maternal stress and anxiety (Melnik et al., 2007).

Promoting positioning practices. Preterm infant positioning is an integral part of preterm infant care in the NICU (Lavallée et al., 2019a) for its benefits on neuromotor development (Blauw-Hospers et al., 2007; King & Norton, 2017; Sweeney et al., 2010).

Lowering infant stress. Stress in the NICU is detrimental for the preterm infant's neurodevelopment (Graven & Browne, 2008), so promoting preterm infants' positioning and reducing their stress is expected to enhance this outcome.

Lowering maternal stress and anxiety. A concept analysis of maternal sensitivity identified maternal anxiety as a negative factor hampering maternal sensitivity (Shin et al., 2008). Lowering maternal stress has systematically been identified as favorable to improve maternal sensitivity (Booth et al., 2018; Neuhauser, 2016; Shin et al.). NICU mothers reporting higher levels of stress and anxiety also report lower levels of attachment with their infant (Bonacquisti, Geller & Patterson, 2020) which is why tackling both these outcomes should contribute to increasing maternal sensitivity.

Increasing maternal sensitivity and infant development. Many studies have linked a higher level of maternal sensitivity to improved preterm infant neurodevelopment. For example, enhanced maternal sensitivity predicts larger gray matter volume and head circumference (Kok et al., 2015), improved mental development (Treyvaud et al., 2009), more consistent and symmetric cortical thickness across brain hemispheres (Frye et al., 2010), improved cognitive performances (Banerjee, 2018; Jaekel et al., 2015; Treyvaud et al., 2016) and improved cerebral white matter micro-structural development (Milgrom et al., 2010).

Intervention Structure

Hereafter, we present the intervention structure as per the Better reporting of interventions: template for intervention description and replication (TIDieR) by Hoffmann et al. (2014). The intervention structure includes the name of the intervention, the materials, the procedures, the provider(s), the modes of delivery, where, when and how much (frequency, duration and dose) as well as possibilities for tailoring the intervention.

Materials

‘GP_Posit’ mainly relies upon the relationship developed between the nurse and the mother which requires no material. However, to support the educational component of the intervention, an informative booklet and web-based modules are used.

Firstly, the informative booklet, developed by the first author, contains pictures of various stress and stability cues so mothers can refer to it between intervention sessions. The booklet also contains pictures of appropriately positioned preterm infants to support mothers if they participate in their preterm infant’s positioning in between intervention sessions.

Secondly, the nurse also has access to web-based modules developed by a multidisciplinary team that provides written information as well as pictures and videos adapted for parents of preterm infants that demonstrate appropriate techniques of positioning in the NICU (Luu et al., 2015). The web-based modules were previously pilot tested, and results showed that parents were satisfied, and the positioning module was most liked by parents (Luu et al., 2017). The advantage of the online modules is that mothers may refer to it at any time.

Procedures

The structure and procedures of the ‘GP_Posit’ intervention sessions are presented in Table 4.

Table 4

GP_Posit intervention structure

Sessions	Educational and active intervention components	Content of session
Session 1	Education	Preterm infant development Stress and stability behavioral cues
	Participation	Diapering
Session 2	Education	Supine positioning
	Participation	Diapering + supine positioning
Session 3	Education	Lateral positioning
	Participation	Diapering + lateral positioning
Session 4	Education	Prone positioning
	Participation	Diapering + prone positioning
Session 5+	Participation	Diapering + positioning Feeding (optional)

Provided by Who

‘GP_Posit’ intervention is meant to be administered by trained neonatal registered nurses as they have the expertise to work with preterm infants and their mothers. In fact, in our systematic



review, $\geq 55\%$ of parent-infant interventions were provided by nurses (Lavallée et al., 2021). For the purposes of ‘GP_Posit’, nurses should be able to educate mothers about the behavioral cues of their preterm infants and about the appropriate positioning techniques. So, if neonatal nurses have not received training on those topics, they should receive appropriate teaching prior to providing the intervention. Additionally, neonatal nurses should receive training regarding what guided participation entails, their role as expert nurses, as well as how to implement guided participation. Most importantly, the same nurse should always meet with the same mothers throughout the sessions as guided participation is based on the mother-nurse relationship developed over time (Pridham et al., 1998).

Modes of Delivery

‘GP_Posit’ is meant to be delivered through individual sessions, between the nurse and the mother. More than 60% of parent-infant intervention were provided through individual sessions (Table 1). Also, guided participation entails that sessions should be individualized (Pridham et al., 1998).

Where

‘GP_Posit’ will be implemented in a level III NICU of a university hospital center. Sessions are provided at each infant’s bedside, in single-family rooms (SFRs) to ensure privacy and a calmer environment (Winner-Stoltz et al., 2018). This is to take into consideration since it has been demonstrated that SFR provide more privacy, promote family-centered care, and ensure a more favorable environment to build trust between nurses and mothers (Doede & Trinkoff, 2020; Winner-Stoltz et al.).

When and How Much

In our systematic review, 11 out of the 18 identified interventions were mainly conducted during NICU hospitalization and finished, at the latest, one week after discharge (Browne & Talmi, 2005; Chiu & Anderson, 2009; Glazebrook et al., 2007; Hane et al., 2015; Hoffenkamp et al., 2015; Melnyk et al., 2006; Meyer et al., 1994; Milgrom et al., 2013; Sahlen Helmer et al., 2019; Twohig et al., 2019; White-Traut & Nelson, 1988). Moreover, the average number of sessions that were delivered was 5 sessions throughout the intervention, varying from one to 11 sessions. As for the

length of each session, the average reported in interventions from the systematic review was of 62 minutes per sessions, varying from 15 minutes to 2 hours.

Thus, ‘GP_Posit’ is meant to be implemented as soon as possible after birth and should be performed until the infant reaches 35 weeks of gestational age (GA) or until discharge home. The intervention will be offered to mothers of preterm infants born at 28 weeks of GA or more, as preterm infants start showing behavioral cues around that age (Fern, 2011). The number of sessions will depend on the age of the infant at birth and age at discharge. For example, mothers of infants born at 31 weeks of GA would participate in four sessions and mothers of infants born at 28 weeks of GA would participate in seven sessions. The sessions should take place weekly, with a duration of 30 to 45 minutes or more depending on time needed for the completion of care. If possible, these sessions should be timed with each preterm infant’s care plan in the NICU and should be clustered with other care as suggested (Lavallée et al., 2019b), so that they are not awakened uniquely for the intervention’s purposes. Also, for pragmatic considerations, the schedule for the individual sessions should be determined with the mother, according to her availabilities.

Tailoring

Considering the importance of individualizing interventions for preterm infants (Als et al., 1986), the care used to contextualize the mother-infant interaction, essential to elicit maternal sensitivity, could be tailored based on the mother’s needs, abilities and level of confidence. For example, the content of each session is planned (see Table 4), but nurses are free to adapt this content depending on specific infant and maternal needs at time of the session.

DISCUSSION

In this paper we presented the development process of a nurse-led guided participation intervention in the NICU designed to enhance maternal sensitivity and preterm infant neurodevelopment. The development of this intervention is novel as it is anchored in an integration of theory and empirical evidence based on the MRC framework and thus brings a unique contribution to the neonatal body of knowledge. The strength of this approach is that it allowed to follow a systematic methodology to develop a thorough understanding of the underpinning processes that predict the effectiveness of the intervention components on selected and meaningful

outcomes. Theories to support ‘GP_Posit’ were identified for their relevance to optimally understand the nurse’s role to contribute to maternal sensitivity in the context of NICU hospitalization of preterm infants. In addition to grand theories (Ainsworth et al., 1978; Als, 1982; Pridham et al., 1998), we were also able to build upon strengths and limitations of previous interventions evaluated in randomized controlled trials (RCTs) and identified through our systematic review (Lavallée et al., 2021). Compared to other studies evaluating a parent-infant intervention in the NICU, very few (n=10/18) based their intervention on a theoretical framework, let alone on a thorough intervention development process. This paper is a contribution to the field of nursing interventions by virtue of documenting the entire process, from identification of theories and evidence to intervention modelling.

The nursing intervention ‘GP-Posit’ is also novel as it incorporates maternal participation to preterm infant positioning in the NICU. Maternal participation to a motor intervention has only been evaluated in one RCT (Øberg et al., 2012) where, compared to standard care, preterm infants who received the motor intervention from their mothers had a significantly better motor performance at term equivalent age (Ustad et al., 2016). Mothers in this study also noted that it empowered them to become competent in providing care and enhanced their feeling of attachment to their preterm infant (Øberg et al., 2018).

CONCLUSION

In the NICU, parents should be recognized as being the primary caregivers of their preterm infant. ‘GP_Posit’ is a novel multifaceted nursing intervention aiming at building a stronger partnership between mothers and nurses to guide mothers in gaining their maternal role through mother-infant closeness. In other words, based on empirical and theoretical evidence, we hypothesize that mothers participating in ‘GP_Posit’ will develop stronger maternal sensitivity and that preterm infants will demonstrate enhanced neurodevelopment. Thus, this intervention has the potential to enhance neonatal nursing care and optimize both mothers’ and preterm infants’ short- and long-term outcomes. ‘GP_Posit’ intervention is being piloted according to a prospectively published protocol to evaluate mother’s acceptability and satisfaction with the intervention as well as preliminary effects on maternal sensitivity and preterm infant neurodevelopment (Lavallée et al., 2020).



Authors' contributions:

AL led this intervention development project as part of her doctoral comprehensive examination. The theoretical underpinnings and components of the novel intervention were then modulated as per MA, JC and LB's expertise both in intervention development (MA, JC, LB) and in the field of mother-infant attachment (LB, MA). BG contributed to the refinement of the intervention's components based on her clinical expertise as a neonatal nurse and clinical nurse specialist. AL wrote the manuscript. MA, JC, LB and BG reviewed, critically appraised and approved the manuscript.

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Statement of conflict of interest:

The authors declare that they have no competing interests.

Ethics certificate number:

Not applicable.



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