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Informative title

Nurse's perception of preterm infants' pain and the factors of their pain assessment and management

Short running title

Nurses' practices regarding pain in preterm infants

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Nurse's perception of preterm infants' pain and the factors associated with their pain assessment and management

ABSTRACT

In the neonatal intensive care unit, preterm infants undergo many painful procedures. Although these can impair their neurodevelopment if not properly managed, only half of the painful procedures are optimally handled. This cross-sectional study aimed to evaluate nurses' perceptions of preterm infants' pain, nurses' pain assessment and management practices, as well as to identify the individual and contextual factors that influence nurses' assessments and interventions for pain management. Secondary analyses, including a mixed-model analysis, were performed with data from a larger study (n=202 nurses). Nurses were found to have attitudes and perceptions in favor of preterm infants' pain management, even though they reported using few standardized instruments to assess pain. Nurses stated that they widely used sucrose, non-nutritive sucking, and positioning as pain management interventions, while skin-to-skin contact was rarely practiced. Nurses' attitudes and perceptions influenced their pain assessment practices, which predicted their implementation of interventions. Several contextual (country, level of care, work shift) and individual factors (age, level of education, had a preterm infant, perceptions of family-centered care and skin-to-skin contact) also predicted nurses' pain assessment and management practices.

Introduction

During their hospitalization in the neonatal intensive care unit (NICU), preterm infants undergo many painful procedures.[1] Repeated and untreated pain in preterm infants can lead to hypersensitivity to pain[2] and neurological impairment, such as a decrease in white and grey subcortical brain matter as early as 40 weeks of corrected age [3] and a decrease in brain volume at seven years.[4,5] Although pain can lead to severe and undesirable long-term health consequences in preterm infants, it would seem that only half of pain-causing procedures during NICU hospitalization are managed with a pharmacological or non-pharmacological pain management intervention.[6]

It is the neonatal nurse's responsibility to assess and manage pain in preterm infants to prevent pain-related consequences. Such interventions are an integral and standard clinical nursing practice and nurses are accountable for non-pharmacological pain management.[7] According to Cong et al.,[8] nurses' perceptions of the quality of pain management in the NICU were positively correlated with continuous training, the use of standardized pain-assessment tools, and a practice guided by evidence-based protocols. Previous studies have identified the factors among nurses that negatively influence their management of pain in infants in the NICU: the absence of guidelines for clinical practice,[9] a lower level of pain they expect the infant will experience according to the procedure,[9] their lack of knowledge or negative attitude,[10] an insufficient use of standardized pain scales,[11] a lack of equipment and resources,[12] a less nursing experience and limited access to continuing education,[13] and a lower level of education.[14] Also, other demographic factors, such as age and gender, could have an influence on nurses' pain managementpractices.[14] Moreover, pain assessment and management is also influenced by developmental care practices,[7] such as family-centered care (FCC) in which parents are partners

in caregiving, or the implementation of skin-to-skin contact (SSC), an effective pain-management intervention.

Developed around the world for assessing preterm and full-term neonates' pain, more than 40 pain scales are available for use in the NICU.[15] Many standardized pain scales have been developed in Canada to assess acute pain. These include the Neonatal Infant Pain Scale (NIPS),[18] the Premature Infant Pain Profile (PIPP),[19,20] and the Neonatal Facial Coding System (NFCS).[21] In the Unites States, the Neonatal Pain Agitation and Sedation Scale (N-PASS) is commonly used to assess acute and prolonged pain in preterm and full-term infants.[22] Prolonged pain can also be assessed with the COMFORTneo, which is an the adaptation of the COMFORT scale for preterm infants.[23] In France, two scales for preterm infants have been developed. The Douleur Aiguë du Nouveau-Né (DAN) [newborn acute pain] measures acute pain,[24] while the Echelle Douleur Inconfort Nouveau-Né (EDIN) [newborn pain and discomfort scale] measures prolonged pain.[25] Lastly, there is also the Bernese Pain Scale for Neonates, a standard developed in Switzerland for assessing preterm and full-term infants' acute pain.[26] Some scales are unidimensional (i.e. the EDIN, DAN, and NFCS) and so only include behavioral indicators of pain, whereas other standardized pain scales (i.e. the NIPS, PIPP, N-PASS, and COMFORT) that include both physiological and behavioral indicators of pain facilitate multidimensional pain assessment.[27] The American Academy of Pediatrics[16] recommends the use of the NFCS, PIPP, N-PASS, and DAN because of their rigorous psychometrics tests. However, although international guidelines provide a list of standardized scales, no "gold standard" exists for clinicians and researchers in NICUs.[16,17].

Systematic and adequate pain assessment promotes the use of pain management interventions, including pharmacological and non-pharmacological interventions.[16]

. Pharmacological interventions for attenuating procedural pain in preterm infants are limited, due to their side effects;[16] however, nurses can use a variety of non-pharmacological interventions to manage infants' pain during routine painful procedures. Effective non-pharmacological interventions consist of SSC[28] and giving sweet solutions, like sucrose, which may be associated with non-nutritive sucking.[29,30] Other interventions, such as swaddling, touch-massage, odor stimulation, heel warming, and light and noise reduction also appear to be effective in decreasing preterm infants' pain, but further research is required to solidify the evidence.[29,31] The effectiveness of breastfeeding and breast milk,[32] music,[33] rocking,[29] and parental involvement[29] has not yet been established for preterm infants. However, breastfeeding has proven effective with full-term infants in the NICU.[32]

Despite the availability of pharmacological and non-pharmacological interventions to manage pain, such interventions are provided for only half of painful procedures.[34,35] A large study conducted in 18 European countries showed that continuous pain was assessed daily for only 10% of infants hospitalized in the NICU.[36] If the consequences of untreated pain on infants' futures are to be prevented, this gap between the nurses' clinical practices related to pain assessment and management and current knowledge must be understood and filled. Nurses' knowledge and attitudesabout pain in preterm infants, as well as their assessment and management of neonatal pain, have been evaluated around the world.[9-14] Although variations exist between countries, the studies did not assess the nurses with the same instrument and so different aspect of the nurses' perceptions and/or practice may have been evaluated. To our knowledge, little is known about nurses' attitudes about and perceptions of pain in preterm infants, about the behavioral and physiological indicators nurses use to assess pain, or about pain management interventions in Canada and France. Moreover, there is a need to understand the individual and contextual factors that may explain the observed differences between settings and

countries.[37] As part of an international multisite study, this study aims to evaluate nurses' perceptions of preterm infants' pain, their assessment practices and pain management interventions, as well as the individual and contextual factors related to their pain assessment and management.

Methods

Design and Sample. Secondary analyses were conducted with the data collected from a larger international comparative cross-sectional study to compare developmental care nursing practices.[38] A total of 202 nurses were recruited in the larger study from NICUs in four Level III university-affiliated hospitals, two in France and two in Canada. All nurses recruited for the larger project were included in this secondary analysis. To be eligible to participate in this study, nurses had to: a) have at least six months of experience in the NICU; b) speak, read, and write French and/or English; and c) be 18 years of age or older. Ethics approval was obtained in both Canada (MP-21-2018-1854) and France (CNIL 2211490).

Setting. Each NICU admitted preterm between 24 to 40 weeks of gestational age. Site 1 has 65 beds (only single-family rooms), 40 beds for site 2 (pods in intensive and intermediate care, and single-family rooms in step-down unit), 54 beds for site 3 (pods and single-family rooms in different units) and site 4 has 26 beds (pods and single-family rooms in different units). Parents had the opportunity to be present 24 hours a day at all sites. Developmental care champions and practical guideline on pain management were available in all sites except site 2.**Instruments**. The English and French versions of the Nurses' Attitudes and Perceptions of Pain Assessment Questionnaire (NAPPAQ-FIPM) were used.. [14, 39] The questionnaire is composed of 45 items divided into three parts. Part 1 of the NAPPAQ-FIPM includes 14 items, scored from "strongly disagree" to "strongly agree" on a 5-point Likert-style scale, with total scores ranging from 14 to

70 including 5 reversed-scored items. This first part assesses nurses' attitudes and perceptions of preterm infants' pain. Part 2 of the NAPPAQ-FIPM includes 15 items, scored from ""not at all" to "always" on a 5-point Likert-style scale, with total scores ranging from 15 to 75. This second part refers to the indicators to assess pain and includes three sub-scales: 1) Physiological indicators (4 items); 2) Behavioral indicators (5 items); and 3) Facial expressions indicating pain (6 items). Part 3 of the NAPPAQ-FIPM includes 16 items, scored from "never" to "always" on a 5-point Likert-style scale, with total scores ranging from 16 to 80. This third part addresses the non-pharmacological interventions nurses perform during painful procedures. These interventions were classified into subscales: maternal-driven interventions (subscale 1) include breastfeeding, SSC, breast milk in mouth, rocking, and odors; nurse-driven interventions (subscale 2) group the use of sucrose, non-nutritive sucking, positioning, swaddling, and hand containment. Moreover, nurses were asked in an open question what standardized tools they were familiar with and used to assess preterm infants' pain. The tool showed limited-to-adequate internal consistency with Cronbach's coefficients for each subscale, ranging from 0.58 to 0.90 for the English version[14] and 0.64 to 0.79 for the French version, developed for and validated with neonatal nurses. [39] For the analyses, Part 1 and Part 2 total scores and Part III subscales were used as continuous variables.

As part of the larger research project, nurses' sociodemographic information and data about their perceptions of FCC, SSC, and control of the NICU environment were collected. The Family Centered Care Questionnaire (FCCQ) assesses nurses' perceptions of their provision of FCC in the NICU and includes 20 questions (four-point Likert scale). The FCCQ has adequate psychometric properties with an acceptable Cronbach's alpha for the total score for the English (0.81) and French (0.77) versions.[40,41] To evaluate SSC practices, we used the 20-item questionnaire about SSC. Developed by Vittner et al[42] on a five-point Likert scale, this questionnaire had internal consistency of between 0.79 and 0.90 for each subscale. The SSC

questionnaire is composed of four subscales: knowledge (5 items), attitudes and beliefs (4 items), education (5 items), and implementation (6 items). We performed a validation and initial psychometric evaluation of the SSC questionnaire (SSC-F) in French, arriving at an internal consistency of between 0.61 to 0.77 for each subscale.[43] This questionnaire had adequate psychometric properties for both the French and English versions.[42,43] Finally, nurses' perceptions regarding the NICU environment (light, noise, and safety) were assessed with the light and noise questionnaire developed by Walsh-Sukys.[44] This questionnaire is composed of a total of 13 items on a five-point Likert scale: the environment's light (4 items), noise (3 items), and safety (6 items). We used the version of this questionnaire translated in French by Feeley et al.[41] The light and noise questionnaire has sufficient psychometric properties in the English version (Cronbach's α 0.77 to 0.85) and in the French version (Cronbach's α 0.61 to 0.79).

Data Collection. Data were collected between October 2017 and July 2018 for the international comparative study. In each site, a research assistant (RA) recruited nurses and answered their questions. After signing the consent form, the nurses filled out the questionnaire either online via SurveyMonkey or by hand on paper (30 minutes, at work or home). The RA collected the completed questionnaires directly from the nurses or from locked boxes located in the NICU. The RA manually transcribed all paper versions into SurveyMonkey.

Data Analysis. Analyses were performed using IBM SPSS Statistics 26 software. Descriptive analyses were conducted for Part I, II, and III of the NAPPAQ-FIPM questionnaire. Mixed models with Bonferroni adjustment were conducted to identify individual and contextual factors related to each of the NAPPAQ-FIPM's three parts, namely attitudes and perceptions (Part I), pain assessment practices (Part II), and pain management interventions (Part III). Separate models were used for each variable and subscale of the NAPPAQ-FIPM. Variables were separated into continuous and categorical variables for the analyses. Continuous variables include

age, years of experience, total FCC score, each subscale of SSC, the light, noise and safety of the environment, and total score of each Part of the NAPPAQ-FIPM. The categorical variables were having had a child, had a preterm infant, having a child who had been hospitalized at some point in the past, as well as the nurses' level of education, country, level of care, and work shift. Gender differences were not analyzed as men made up only 2.48% of the sample. Since four sites were included in the international study, the mixed model was adjusted to control for the differences between sites. All analyses were performed with a two-sided alpha of 0.05.

Results

Sample Characteristics. The mean age of all nurse-participants (n=202) was 33.90 years ± 9.135. Most were women (97.03%) (Table 1). Years of experience in nursing varied from six months to 40 years (mean=10.22 ± 8.37). Moreover, 47.03% (n=95) had children and, of these parents, 20% (n=19) had a preterm infant, while 42.11% (n=40) had experienced the hospitalization of their child at some point in the past. The nurses had different levels of educational training; in both countries, most held a bachelor's degree. In Canada, nurses rotated between the intensive and intermediate neonatal units, while nurses from the two French sites worked only in the same unit (i.e. intensive care or intermediate care). Nurse-participants were recruited among workers on the day, evening, or night shifts in France, while their Canadian peers worked either day, evening, night or rotated among the three shifts.

*** Insert Table 1

NAPPAQ-FIPM Part I: Attitudes About and Perceptions of Preterm Infants' Pain

Descriptive Results. Nurses' perceptions of preterm infants' pain are reported in Table 2. While most nurses (97%, n=196) agreed that assessing neonatal pain was important and 90.6% (n=183)

responded that scales were important to this pain assessment, 48% (n=97) of nurse-participants thought they could reliably assess pain without using a scale.

*** Insert Table 2

Individual and Contextual Factors Related to Attitudes about and Perceptions of Pain.

According to the mixed-model analysis for continuous and categorical variables (Tables 3 and 4, respectively), nurses' attitudes about and perceptions of preterm infants' pain were associated with their work shift, level of education, knowledge and attitudes about SSC, and the indicators they observed in their assessment of infants' pain (NAPPAQ-FIPM Part II), as well as the frequency they reported using nursing interventions for pain management (NAPPAQ-FIPM Part III-subscale 2). However, nurses' attitudes about and perceptions of neonatal pain were not related to their age, years of experience, having children, having had a preterm infant, having a child hospitalized, level of care, or perceptions of FCC and the NICU's physical environment (noise, light, and safety) (Tables 3 and 4).

A significant difference was found for the work shift variable: Nurses working the day shift scored higher on the NAPPAQ-FIPM Part I than others. Furthermore, the higher level of education was also associated with perceptions more in favor of neonatal pain management (NAPPAQ-FIPM-Part I). In addition, their perceptions of preterm infants' pain were related to their knowledge of and attitudes about SSC; indeed, the scores for their perception of pain significantly increased with knowledge and more favorable attitudes toward SSC (Table 3). Similarly, pain assessment and the frequency of the nursing intervention influenced nurses' perception of preterm infants' pain. Thus, the nurses' score on their attitudes about and perceptions of preterm infants' pain significantly increased when they more thoroughly assessed pain and performed nursing interventions more frequently.

*** Insert Table 3 and 4

NAPPAQ-FIPM Part II. Pain Assessment

Descriptive Results. Physiological indicators are the most used by nurses to assess pain, followed by behavioral indicators (Table 2). The indicators nurses report using least ("not at all" and "very rarely") were blood pressure (34.1%, n=69) and tongue protrusion (21.8%, n=44).

Standardized Pain Scales Used by Nurses. The scales used by nurses differed by country. For the two French sites (n=93), 69 nurses responded to this item, of which 64 were "very familiar" with the EDIN and DAN scales (92.53%) and 17 were "very familiar" with the Comfort-B scale (24.64%). In Canada, for the two sites (n=109), only 32 nurses responded to the item. All nurses responded that they were very familiar with the N-PASS scale. Nurses at Site 1 reported that the tool was used in their neonatal unit, while nurses at Site 2 noted the lack of guidelines indicting the use of a specific pain assessment tool. **Individual and Contextual Factors Related to Pain Assessment.** The following continuous and categorical variables (see Tables 3 and 4) were significantly associated with higher scores in pain assessment: level of care, work shift, level of education, perception of FCC, perception of SSC, attitudes about and perceptions of pain in preterm infants (NAPPAQ-FIPM Part I), as well as the frequency they reported using maternal-driven interventions for pain management and nurse-driven interventions (NAPPAQ-FIPM Part III). Conversely, the total score for Part II of NAPPAQ-FIPM on the behavioral and physiological indicators nurses use to assess neonatal pain was not related to the following factors: age, years of experience, having children, or physical environment (noise, light, and safety). Level of care was a contextual factor associated with nurses' pain assessment, with nurses in intensive care units scoring higher in their assessment of pain. For the work shift variable, nurses working the day or evening shift more frequently reported observing infants'

signs of pain during their assessments. Level of education is a significant individual factor: nurses with the highest average scores for pain assessment were nurses with undergraduate degrees and specialized pediatric nurses (1500 hours training).

Since nurses' perception of FCC was associated with their pain assessment, more favorable perceptions of their ability to provide FCC is associated with increased observation of indicators of infants' pain. Nurses' score on pain assessment significantly increased with greater knowledge, more favorable attitudes, more training and education, and a greater implementation of SSC (Table 3). Similarly, nurses' attitudes about and perceptions of neonatal pain, as well as the frequency of their interventions, was associated with nurses' assessment of pain. Indeed, nurses' scores were significantly correlated with their attitudes about and perceptions of preterm infants' pain (NAPPAQ-FIPM Part I), their use of maternal-driven pain-management interventions (NAPPAQ-FIPM Part III Subscale 1), and of nurse-driven pain management interventions (NAPPAQ-FIPM Part III Subscale 2). Therefore, greater perception of preterm infants' pain was related to a better pain assessment reflected by nurses assessing more indicators of pain. Furthermore, more frequent use of maternal or nurse-driven interventions was associated with more exhaustive pain assessment.

NAPPAQ-FIPM Part III. Pain Management Interventions

Descriptive Results. Nurses stated that, when performing a painful procedure, they "almost always" or "always" applied four nursing-driven interventions: sucrose (94.5%), non-nutritive sucking (94.6%), positioning (93.1%), and swaddling (85.2%) (Table 2). For mother-driven interventions, only a few nurses reported that they "almost always" or "always" utilized SSC (12.4%) and breastfeeding (10%). Several maternal-driven interventions were "never" or "very rarely" performed; these include odor stimulation (68.3%) and rocking (38.6%).

Factors in Implementing Maternal-Driven Interventions. Many continuous and categorical variables were significantly associated with a higher score in nurses' maternal-driven pain management interventions: age, years of experience, level of care, work shift, level of education, perceptions of FCC, perceptions of SSC (training and education as well as implementation), assessment of pain in preterm infants (NAPPAQ-FIPM Part II), and nurse-driven interventions (NAPPAQ-FIPM-Part III) (see Tables 3 and 4). However, maternal-driven interventions scores were not significantly associated with the following factors: gender, having children, having had a preterm, having had a hospitalized child, physical environment (noise, light, and safety), attitudes about and perceptions of preterm infants' pain, and country.

Specifically, age and years of experience as a nurse were significantly associated with a higher score for maternal-driven interventions. Also, the level of care intensity was significantly correlated to higher mean scores of maternal-driven interventions for nurses working in intermediate care units (see Table 4). For the work shift variable, a significant effect with a higher mean score was found to be associated with the day and night shift (Table 4). The nurses' level of education is also a significant individual factor, where training as a pediatric nurse was correlated with a higher score for maternal-driven interventions.

Our findings show that nurses' perceptions of FCC were associated with their score for maternal-driven interventions. This can be interpreted that more favorable perceptions of FCC significantly increase the frequency of nurses' use of maternal-driven interventions for managing pain. In addition, training, and education as well as the implementation of SSC also promote nurses' use of maternal-driven interventions, i.e., nurses' scores for maternal-driven pain-management interventions significantly increase when they have more SCC training and education, and a better implementation of SSC. Similarly, pain assessment and the frequency of nursing intervention influenced the use of maternal-driven interventions for pain. Thus, the

nurses' scores of maternal-driven interventions for pain management significantly increased with better pain assessment and higher frequency of nursing interventions.

Factors in Implementing Nurse-Driven Interventions. Country, level of care, work shift, level of education, having had a preterm infant, perceptions of FCC, perceptions of the environment (light), perceptions of SSC (knowledge and attitudes), attitudes about and perceptions of preterm infants' pain, and assessment of pain in preterm infants were all significantly associated with a higher score in nurse-driven pain management interventions (Tables 3 and 4). However, there were no significant association between the scores for nurse-driven interventions and age or years of experience.

A significant difference was found for the country variable: Working in France was associated with higher scores for nurse-driven interventions. Also, an overall effect of level of care was found: Nurses working in intermediate care scored significantly higher for nursing interventions for pain relief than the nurses rotating between different care intensities. An overall significant difference was found among nurses according to work shift. Indeed, there was a significant difference between those working the day shift and those on rotating shifts (i.e., day-shift nurses used more interventions to manage pain than nurses on a schedule rotating between day, evening, and night shifts). Nurses' level of nurse education was also a significant individual factor. Pediatric nurses had the highest average score, indicating that this group performs more nursing interventions than others. Nurses who had a preterm child scored significantly higher for the implementation of interventions to relieve infants' pain. More favorable perceptions of FCC were also significantly related to a higher score of nurse-driven interventions for pain management and scores for nurse-driven interventions significantly increased when nurses had more knowledge and more favorable attitudes about SSC. Similarly, attitudes and perceptions in

favor of neonatal pain management as well as higher scores in pain assessment seemed to encourage nurses to implement nurse-driven pain-management interventions.

Discussion

Our results show that nurses held perceptions in favor of preterm infants' pain management, even though they reported using few standardized instruments and basing their assessment on neonates' behavioral indicators. Nurses listed sucrose, non-nutritive sucking, and positioning as the interventions they tended to favor to control infants' pain during routine procedures; conversely, they rarely used SSC and breastfeeding. Furthermore, we found a significant association between nurses' attitudes about and perceptions of preterm infants' pain, their assessment practices, and the pain-management interventions these care providers tended to implement. Several factors were related to nurses' attitudes and perceptions, assessment practices, and pain management, namely their country, the unit, the level of care, their work shift, their age, their level of education, and their family situation (having children, personal experience of having a preterm child or a hospitalized child).

PART I

The nurses had highly perceptions in favor of preterm infants' pain management. Nurses working at Site 4 showed less perceptions in favor of neonatal pain management than their peers at the other sites. This may be explained by the lack of clinical-practice guidelines for pain management in that NICU.[38] Our results support existing knowledge, which shows that units with clinical practice guidelines, and nurse training in the use of validated pain scales are all essential elements for nurses to effectively manage infant pain in the NICU.[8] Moreover, systematic pain assessment at each clinical round has been shown to encourage nurses to use of pain management

interventions,[15] indicating that it is crucial for NICUs nurses to have a framework for assessing and managing both procedural and continuous pain.[17]

PART II

The American Academy of Pediatrics[16] advocates use of validated tools (i.e. EDIN, DAN, N-PASS), given that all such tools employ rigorous psychometrics tests. In our study, standardized pain-assessment tools used in France, the EDIN and the DAN, were developed in this country. In Canada, however, nurses use the N-PASS scale, a more recent tool developed in the United States and available only in English. The EDIN and the DAN are unidimensional pain measures, i.e. tools that integrate only behavioral indicators; the N-PASS's physiological and behavioral indicators make it possible for nurses to conduct a multidimensional evaluation of pain.[27] The nature of the tools used may therefore explain why French nurses had higher mean scores for behavioral indicators of pain than their Canadian peers. Even if the tools used in France do not account for physiological indicators, nurses reported that they nonetheless consider these indicators when assessing procedural pain in infants. Assessing pain in preterm infants is therefore a concern that requires the use of validated tools and adequate documentation in care records.[50]

All nurses in our study mainly used behavioral signs to assess pain in preterm infants. This finding is not surprising since these are also the most easily observed indicators, although it is important to note that signs of pain are more subtle and difficult to identify in preterm infants than in full-term newborns.[45] Indeed, the more premature the infant, the fewer the observable crying, motor responses, and facial expressions.[46,47] Extremely preterm infants (born before 28 weeks of gestation) may not visibly respond to pain at all. Although the reasons for this are currently unknown,[48] such an absence of reaction means that infants do not express pain, not that

they do not feel pain.[49] The four sites at which we recruited nurse-participants admit preterm infants younger than 28 weeks of gestation.

PART III

The interventions known to effectively manage infants' pain are sucrose, which can be combined with non-nutritive sucking, and SSC.[51] Our findings show that sucrose and non-nutritive sucking are well-established practices in all the NICUs studied, while SSC is underused. Existing knowledge on what keeps nurses from using SSC as a pain-management intervention suggest that the time this practice requires to set up, nurses' comfort during the painful procedure and maternal absence are the barriers most frequently reported by nurses.[52] SSC should be better utilized by nurses, especially given that undesirable effects of repeated administration of sucrose are reported, including neurological impacts.[53] In addition, we found that training (Subscale 3 of the SSC questionnaire) and implementation (Subscale 4 of the SSC questionnaire) for another purpose than pain promote nurses' pain assessment and management interventions. A possible explanation for this finding is that, for infants' safety during SSC, nurses are trained to recognize signs, which are the same as those utilized to assess pain, though their meaning is different.

As for the interventions that would appear to be effective for reducing infants' pain but that require further research, only swaddling was reported to be widely used by nurses. Swaddling is a developmental care practice that has grown in recent years with the implementation of swaddling baths, now a standard of care in many NICUs.[54] This may explain why nurses reported using swaddling more frequently for pain relief than other procedures. - Furthermore, our findings show a significant correlation between the nurses' total FCC score and pain management interventions. This could be explained by parental involvement in pain care.[55]

CONTEXTUAL AND INDIVIDUVIAL FACTORS

Our results indicate that nurses' attitudes and perceptions (NAPPAQ-FIPM Part I), assessment practices (NAPPAQ-FIPM Part II), and pain management interventions (NAPPAQ-FIPM Part III) were related to contextual factors, such as country, level of care, work shift, and individual factors, such as age, years of experience, level of education, and had a preterm infant.

Compared to Canadian nurses, nurses in France reported more frequently using nurse-driven interventions to manage infants' pain. The differences between countries can be explained by distinct healthcare cultures and differences in the standardized tools used to assess pain. Moreover, the NICU Site 2 in Canada did not have practice guidelines.[38] Sites' use of practice guidelines or lack thereof influenced nurses' pain assessment and management practices.[15] Our findings show that intensive care nurses observed more infants' pain assessment signs than those working in the intermediate care level unit. Paradoxically, our findings show that nurses working in the intermediate care level unit reported performing more frequently pain management interventions than those working in the intensive care units. The nature of the population in the unit could be a potential explanation for these findings. Preterm infants hospitalized in the intensive care units have lower gestational age and weight which may influence their health status and request nursing advanced skills for evaluation, which could explain why nurses in the intensive care reported observing more pain signs. Other factors which might have influenced our results, consist of the workload in the neonatal unit, that may affect the time allocated to pain management and interdisciplinary collaboration.[45] For example, for an intubated preterm infant, the collaboration and availability of a respiratory therapist is required to place the infant in SSC for pai management. Further research is needed to better understand these findings.

As their individual factors of age and years of experience increased, the nurses in our study performed more pain management interventions. Our results are consistent with those of

Polkki et al.[14] who identified age as a factor influencing pain perception. These authors also found a correlation between nursing practice in pain management and professional experience that was similar to our results and indicates that years of nursing experience are associated with more perceptions in favor of preterm infants' pain management. Our results indicate further that pediatric nurses, who have higher educational level, hold more perceptions in favor of preterm infants' pain management, realize extensive pain assessment, and report more frequently using interventions for pain management compared to other nurses. The influence of a higher level of education on attitudes about and perceptions of preterm infants' pain has been previously reported.[14]

Nurses who have had the personal experience of giving birth to a preterm child may be more sensitive to infants' pain, resulting in their more frequent use of nursing interventions to manage this pain. As Waxman et al[57] point out, healthcare professionals' sensitivity could increase their involvement in pain assessment and management. In addition, our study identified that working the day shift is associated with a higher score for nurses' perceptions, assessments, and interventions. According to Latimer et al,[56] nurse-physician collaboration, which is facilitated by the day shift, was a significant predictor of evidence-based care during painful procedures.

Interestingly, we found that each part of the NAPPAQ-FIPM was significantly associated with the others. These results suggest interdependence between nurses' perceptions of neonatal pain, pain assessment, and pain management. Indeed, a dynamic process is involved during pain assessment and interventions that is influenced by nurses' perceptions of preterm infants' pain.

Conclusion

This study assessed nurses' perceptions of pain, assessment practices, and pain-management interventions. Since repeated and untreated pain has major consequences on

preterm infants' development, it is crucial nurses be skilled in assessing pain and that they intervene adequately to manage pain. In the NICU, better pain management begins with utilizing regularly updated clinical practice guidelines and interprofessional collaboration. Each NICU should indeed implement validated pain assessment scales and train nurses both to better recognize preterm infants' signs of pain and to assess and respond to this pain. It is crucial that education and pain guidelines to encourage the use of effective interventions, like sucrose and SSC, improving nurses' management of preterm infants' pain. Since level of education influence nurses' pain care, continuous training on pain assessment and management used in conjunction with SSC and FCC could improve their management of preterm infants' pain. Furthermore, considering factors that were associated with the assessment and implementation of interventions, namely country, level of care, work shift, age, level of education, personal experience, perception of pain, SSC, and FCC, would be a starting point for developing educational interventions for nurses.

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Legends for Tables and Figures

Table 1. Nurses' sociodemographic data

Table 2. Nurses' perceptions, assessment, and interventions regarding procedural pain in preterm infants

Table 3. Mixed model (continuous variables)

Table 4. Mixed model (categorial variables)

Table 1. Nurses' sociodemographic data

Variables	Site 1 (n=56)	Site 2 (n=53) Mean ± SD	Site 3 (n=49) Mean ± SD	Site 4 (n=44) Mean ± SD	Total (n=202)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (y)	31.52 ± 8.347	33.92 ± 10.086	35.22 ± 9.659	35.41 ± 7.878	33.90 ± 9.135
Years of experience as a nurse	9.38 ± 7.731	11.72 ± 9.871	11.53 ± 8.939	10.64 ± 7.327	10.22 ± 8.37
Years of experience in the NICU	7.80 ± 7.14	9.33 ± 8.342	9.30 ± 6.569	10.95 ± 15.156	8.14 ± 6.95
Years of experience in this NICU	6.66 ± 7.44	9.13 ± 8.221	9.67 ± 14.874	10.12 ± 15.516	7.14 ± 6.93
	n (%)	n (%)	n (%)	n (%)	n (%)
Gender *					
Women	56 (100%)	51 (96.23%)	45 (91.84%)	44 (100%)	196 (97%)
Men	0	1 (1.89%)	4 (8.16%)	0	5 (2.5%%)
Level of care †					
Intensive care (level 3)	0	0	18 (36.73%)	18 (40.91%)	36 (17.8%)
Intermediate care (level 2)	0	0	13 26.53%)	25 (56.82%)	38 (18.8%)
Step-down unit (level 1)	0	0	17 (34.96%)	0	17 (8.4%)
Rotations accross level of care	56 (100%)	53 (100%)	0	0	109 (54%)
Work shift ‡					
Day	16 (28.57%)	29 (54.72%)	25 (51.02%)	24 (54.55%)	94 (46.5%)
Evening	14 (25%)	1 (1.89%)	0	0	15 (7.4%)
Night	16 (28.57%)	3 (5.66%)	19 (38.78%)	13 (29.55%)	51 (25.2%)
Rotations	10 (17.86%)	19 (35.85%)	0	0	29 (14.4%)
Level of education §					
College diploma	8 (14.29%)	7 (13.21%)	0	0	15 (7.4%)
College-Bachelor	18 (32.14%)	14 (26.42%)	0	0	85 (42.1%)
Bachelors	19 (33.93%)	26 (49.06%)	24 (48.98%)	16 (36.36%)	32 (15.8%)
Pediatric nurse	9 (16.07%)	0	24 (48.98%)	28 (63.64%)	61 (30.2%)
Master	1 (1.79%)	5 (9.43%)	0	0	6 (3%)
Having a child					
Yes	19 (33.93%)	18 (33.96%)	28 (57.14%)	30 (68.18%)	95 (47%)
No	37 (66.07%)	35 (66.04%)	21 (42.86%)	14 (31.82%)	107 (53%)
Having given birth to a preterm infant *					
Yes	0	3 (5.66%)	1 (2.04%)	9 (20.45%)	13 (6.4%)
No	19 (33.93%)	14 (26.42%)	27 (55.10%)	21 (47.73%)	81 (40.1%)
Having had one of their children hospitalized at some point in the past ‖					
Yes	6 (10.71%)	7 (13.21%)	15 (30.61%)	12 (27.27%)	40 (19.85)
No	9 (16.07%)	10 (18.87%)	13 (26.53%)	18 (40.91%)	50 (24.8%)

* 1 missing †2 missing; ‡ 13 missing; § 3 missing; ‖ 5 missing

Table 2. Nurses' perceptions, assessment, and interventions regarding procedural pain in preterm infants

ATTITUDES AND PERCEPTIONS ON PRETERM INFANTS' PAIN						
	Totally agree n (%)	**Aree to some extent n (%)**	**Don't know n (%)**	**Disagree to some extent n (%)**	**Totally disagree n (%)**	**Missing n (%)**
1. Pain assessment of the preterm infant is not important.	3 (1.5%)	0	0	9 (4.5%)	187 (92,6%)	3 (1.5%)
2. Pain scales are important to use in preterm infants' pain assessment.	154 (76.2%)	29 (14,4%)	2 (1%)	4(2%)	10 (5%)	3 (1.5%)
3. I can assess preterm infants' pain reliably without pain scales.	18 (8.9%)	79 (39.1%)	16 (7.9%)	63 (31.2%)	21 (10.4%)	5 (2.5%)
4. Systematic documentation in pain assessment is a prerequisite for implementing good pain management of preterm infants.	111 (55%)	60 (29.7%)	15 (7.4%)	6 (3%)	7 (3.5%)	3 (1.5%)
5. Nervous system in a preterm infant is mature enough to be able to sense pain.	151 (74.8%)	35 (17.3%)	1 (0.5%)	5 (2.5%)	7 (3.5%)	3 (1.5%)
6. Preterm infants are able to sense pain, even if they could not express it.	158 (78.2%)	26 (12.9%)	3 (1.5%)	7 (3.5%)	4 (2%)	4 (2%)
7. A preterm infant is more sensitive to sense pain than a full-term infant is.	79 (39.1%)	53 (26.2%)	47 (23.3%)	17 (8.4%)	2 (1%)	4 (2%)
8. A preterm infant's pain expression is influenced by infant's age and developmental factors.	91 (45%)	80 (39.6%)	20 (9.9%)	7 (3.5%)	1 (0.5%)	3 (1.5%)
9. A preterm infant's pain expression is influenced by infant's health.	90 (44.6%)	83 (41.1%)	15 (7.4%)	10 (5%)	1 (0.5%)	3 (1.5%)
10. A preterm infant's pain expression is influenced by other stress factors (e.g. hunger, cold).	99 (49%)	78 (38.6%)	17 (8.4%)	4 (2%)	1 (0.5%)	3 (1.5%)
11. A premature infant's pain expression is influenced by several factors at the same time	89 (44.1%)	95 (47%)	8 (4%)	5 (2.5%)	1 (0.5%)	4 (2%)
12. Physiological changes (i.e. blood pressure, heart rate) tell always about the infant's pain	27 (13.4%)	85 (42.1%)	14 (6.9%)	62 (30.7%)	11 (5.4%)	3 (1.5%)
13. Behavioral changes tell always about the infant's pain.	22 (10.9%)	94 (46.5%)	9 (4.5%)	63 (31.2%)	11 (5.4%)	3 (1.5%)
14. Hormonal changes tell always about the infant pain.	6 (3%)	31 (15.3%)	106 (52.5%)	46 (22.8%)	9 (4.5%)	3 (1.5%)
ASSESSMENT: SIGNS OF PAIN USED BY NURSES						
When I assess premature infant´s pain in neonatal intensive care unit (e.g. during the heel stick), I observe the following parameters:	No at all n (%)	Very seldom n (%)	Sometimes n (%)	Nearly always n (%)	Always n (%)	Missing n (%)
Physiological parametres						
15. heart rate	0	6 (3%)	23 (11.4%)	50 (24.8%)	118 (58.4%)	5 (2.5%)
16. respiratory rate	2 (1%)	15 (7.4%)	32 (15.8%)	57 (28.2%)	92 (45.5 %)	4 (2%)
17. blood pressure	32 (15.8%)	37 (18.3%)	59 (29.2%)	41 (20.3%)	28 (13.9%)	5 (2.5%)
18. oxygen saturation	1 (0.5%)	9 (4.5%)	19 (9.4%)	40 (19.8%)	129 (63.9%)	4 (2%)
Behavioral parametres						
19. crying/moaning	0	0	2 (1%)	23 (11.4%)	174 (86.1%)	3 (1.5%)
20. state of arousal/alertness	0	1 (0.5%)	12 (5.9%)	40 (19.8%)	145 (71.8%)	4 (2%)
21. arm movements	0	4 (2%)	17 (8.4%)	41 (20.3%)	137 (67.8%)	3 (1.5%)
22. leg movements	1 (0.5%)	3 (1.5%)	17 (8.4%)	38 (18.8%)	140 (69.3%)	3 (1.5%)
Facial expressions						
23. facial expressions in general	0	0	2 (1%)	31 (15.3%)	166 (82.2%)	3 (1.5%)
24. browbulge	0	2 (1%)	7 (3.5%)	34 (16.8%)	156 (77.2%)	3 (1.5%)
25. eye squeeze	1 (0.5%)	1 (0.5%)	26 (12.9%)	44 (21.8%)	127 (62.9%)	3 (1.5%)
26. naso-labial furrow	11 (5.4%)	20 (9.9%)	49 (24.3%)	43 (21.3%)	76 (37.6%)	3 (1.5%)
27. mouth strech	9 (4.5%)	11 (5.4%)	58 (28.7%)	51 (25.2%)	68 (33.7%)	5 (2.5%)
28. lip pursing	4 (2%)	17 (8.4%)	46 (22.8%)	53 (26.2%)	78 (38.6%)	4 (2%)
29. taut tongue	15 (7.4%)	29 (14.4%)	61 (30.2%)	39 (19.3%)	48 (23.8%)	10 (5%)
30. chin quiver	7 (3.5%)	13 (6.4%)	43 (21.3%)	51 (25.2%)	84 (41.6%)	4 (2%)
PAIN INTERVENTIONS REALIZED TO MANAGE PRETERM INFANTS' PAIN AS REPORTED BY NURSES						
When I perform a painful procedure, I perform non-pharmacological interventions:	Never n (%)	Very seldom n (%)	Sometimes n (%)	Nearly always n (%)	Always n (%)	Missing n (%)
Maternal-driven interventions						

42. breastfeeding	22 (10.9%)	59 (29.2%)	96 (47.5%)	10 (5%)	9 (4.5%)	6 (3%)
43. skin-to-skin contact	12 (5.9%)	34 (16.8%)	126 (62.4%)	15 (7.4%)	10 (5%)	5 (2.5%)
44. maternal milk (in the mouth)	5 (2.5%)	18 (8.9%)	117 (57.9%)	44 (21.8%)	12 (5.9%)	6 (3%)
46. rocking	21 (10.4%)	57 (28.2%)	79(39.1%)	3 (14.9%)	11 (5.4%)	4 (2%)
54. odors	92 (45.5%)	46 (22.8%)	36 (17.8%)	14 (6.9%)	9 (4.5%)	5 (2.5%)
Nurse-driven interventions						
39. sucrose	0	0	8 (4%)	79 (39.1%)	112 (55.4%)	3 (1.5%)
40. non nutritive sucking	0	0	8 (4%)	67 (33.2%)	124 (61.4%)	3 (1.5%)
41. positioning	1 (05%)	0	10 (5%)	62 (30.7%)	126 (62.4%)	3 (1.5%)
45. swaddling	1 (0.5%)	4 (2%)	20 (9.9%)	82 (40.6%)	90 (44.6%)	5 (2.5%)
48. hand containment	9 (4.5%)	6 (3%)	55 (27.2%)	81 (40.1%)	46 (22.8%)	5 (2.5%)
Parental involvement						
49. involve the mother	2 (1%)	4 (2%)	89 (44.1%)	67 (33.2%)	36 (17.8%)	4 (2%)
50. involve the father	2 (1%)	6 (3%)	93 (46%)	62 (30.7%)	34 (16.8%)	5 (2.5%)
Environemental interventions						
52. decrease the light	14 (6.9%)	42 (20.8%)	59 (29.2%)	55 (27.2%)	25 (12.4%)	7 (3.5%)
53. decrease the noise	16 (7.9%)	35 (17.3%)	54 (26.7%)	67 (33.2%)	25 (12.4%)	5 (2.5%)
Sensorial interventions						
47. music	75 (37.1%)	52 (25.7%)	50 (24.8%)	17 (8.4%)	3 (1.5%)	5 (2.5%)
51. heel massage	77 (38.1%)	44 (21.8%)	35 (17.3%)	25 (12.4%)	14 (6.9%)	7 (3.5%)

Table 3. Mixed model (continuous variables)

	NAPPAQ-FIPM-Part I			**NAPPAQ-FIPM-Part II**			**NAPPAQ-FIPM-Part III**					
	Pain perception			**Pain assessment** (total score)			**Maternal-driven interventions**			**Nurses-driven interventions**		
Indiviudal and contextual factors	Estimate	95% CI	*p* value	Estimate	95% CI	*p* value	Estimate	95% CI	*p* value	Estimate	95% CI	*p* value
Sociodemographics factors												
Age	.026	-.055, .108	.524	.026	-.096, .147	.679	.055	.006, .104	**.028**	.002	-.032, .036	.911
Years of experience as a nurse	.035	-.053, 0.124	.432	.056	-.075, .187	.401	.057	.004, .110	**.035**	.014	-.023, .051	.448
Years of experience in a NICU	.006	-.102, .112	.920	.048	-.110, .207	.548	.038	-.027, .102	.251	.009	-.035, .053	.691
Years of experience in this NICU	.002	-.106, .111	.971	.047	-.112, .207	.560	.019	-.046, .084	.563	.003	-.049, .0147	.898
Other questionnaires												
Family centered care (total score)	.109	-.023, .242	.106	.334	.131, .528	**.001**	.087	.007, .167	**.034**	.096	.042, .150	**.001**
Knowledge on skin-to skin contact (SCC)	.665	.316, 1.015	**<.001**	.825	.296, 1.353	**.002**	.176	-.043, .394	.115	.217	.070, .363	**.004**
Attitude toward SSC	.511	.072, .951	**.023**	.947	.297, 1.598	**.005**	.256	-.012, .523	.061	.248	.065, .431	**.008**
Training and education on SSC	.059	-.158, .276	.595	.596	.282, .901	**<.001**	.315	.190, .439	**<.001**	.081	-.008, .170	.075
Implementation of SSC	.042	-.166, .249	.692	.564	.268, .860	**<.001**	.209	.087, .332	**.001**	.049	-.035, .134	.248
Sound	.051	-.245, .346	.736	.237	-.206, .680	.292	.109	-.071, .288	.236	.086	-.037, .209	.170
Environnent security	-.053	-.232, .126	.563	-.055	-.323, .213	.685	.064	-.044, .173	.244	.068	-.006, .142	.070
Light	.143	-.149, .435	.334	.263	-.172, .699	.234	.055	-.122, .232	.540	.152	.032, .273	**.014**
NAPPAQ-FIPM												
Part I -Pain perception	-	-	-	.333	.130, .537	**.001**	.053	-.031, .138	.217	.082	.024, .139	**.005**
Part II -Pain assesment	.149	.057, .231	**.002**	-	-	-	.112	.058, .167	**<.001**	.087	.050, .124	**<.001**
Part III – subscale 1 – Maternal-driven interventions	.155	-.075, .384	.185	.692	.350, 1.013	**<.001**	-	-	-	.305	-.824, 1.433	.136
Part III – subscale 2 Nurses-driven interventions	.454	.125, .783	**.007**	1.087	.612, 1.562	**<.001**	.617	.434, .801	**<.001**	-	-	-

Table 4. Mixed model (categorial variables)

	NAPPAQ-FIPM-Part I			**NAPPAQ-FIPM-Part II**			**NAPPAQ-FIPM-Part III**					
	Pain perception			**Pain assessment** (total score)			**Maternal-driven interventions**			**Nurse-driven interventions**		
Individual and contextual factors	Means	CI	P value	Means	CI	P value	Means	CI	P value	Means	CI	P value
Having a child (Ref = No)			.667			.457			.090			.151
Yes	53.16	51.15, 55.18		68.60	63.17, 74.03		13.93	12.33, 15.52		21.98	21.35, 22.61	
No	52.83	50.80, 54.86		67.08	62.73, 71.44		13.13	11.52, 14.74		21.52	20.88, 22.16	
Having given birth to a preterm infant (Ref = No)			.526			.664			.129			**.008**
Yes	54.63	51.44, 57.82		65.66	61.27, 70.05		14.77	12.70, 16.85		23.58	23.33, 24.83	
No	53.00	51.12, 54.89		68.42	64.06, 72.78		13.84	12.32, 15.35		21.72	21.10, 22.33	
Having had one of their children hospitalized at some point in the past (Ref = No)			.888	13.76	12.37, 15.15	.191			.091			.256
Yes	53.09	50.87, 55.31		12.87	10.92, 14.81		13.39	11.76, 15.02		22.14	21.38, 22, 91	
No	53.27	51.14, 55.41		13.52	12.13, 14.91		14.37	12.76, 15.97		21.94	21.39, 22.65	
				12.52	10.93, 14.11							
Level of education			**<.001**			**<.001**			**<.001**			**<.001**
College diploma	52.28	49.24, 55.31		71.36	66.40, 76.31		13.60	11.77,15.43		21.22	20.13, 22.32	
College Bachelor	52.54	50.13, 54.95		66.09	61.87, 70.30		12.80	11.32, 14.29		21.47	20.74, 22.20	
Bachelor	52.84	50.84, 54.85		67.05	63.15 70.96		13.14	11.85, 14.43		21.33	20.88, 21.77	
Pediatric nurse	53.33	51.19, 55.48		68.84	64.89, 72.79		14.36	13.01, 15.70		22.67	22.14, 23.19	
Master	54.44	49.93, 58.95		66.46	59.53, 73.39		13.30	10.62, 15.97		20.97	19.22, 22.72	
Country (Ref = Canada)			.157			.467			0.106			**0.003**
France	54.03	51.41, 56.65		69.00	60.08, 77.93		14.44	12.57, 16.31		22.16	21.77, 22.56	
Canada	51.10	49.03, 54.94		66.32	57.16, 75.48		12.61	10.58, 14.64		21.35	20.99, 21.71	
Level of care			.212			**<.001**			**<.001**			**<.001**
Intensive care	53,86	51.85, 55.87		70.29	62.44, 78.14		12.89	11.32, 14.46		21.95	21.26, 22.64	
Intermediate care	54,73	52.71, 56.76		69.00	61.11, 76.89		15.75	14.16, 17.34		22.65	21.99, 23.32	
Step-down unit	52,29	49.48, 55.11		65.48	58.20, 72.75		14.85	12.97, 16.74		21.34	20.67, 22.37	
Rotation across level of care	51,98	49.35, 54.62		66.32	56.68, 75.96		12.61	10.45, 14.77		21.45	20.67, 29.34	
Work shift			**<.001**			**<.001**			**<.001**			**<.001**
Day	53.57	52.32, 54.81		68.51	64.39, 72.63		13.76	12.37, 15.15		22.12	21.63, 22.61	
Evening	50.24	47.44, 53.04		67.31	62.06, 72.56		12.87	10.92, 14.81		20.89	19.74, 22.05	
Night	52.56	51.05, 54.12		66.80	62.76, 70.85		13.52	12.13, 14.91		21.53	20.91, 22.14	
Rotations	51.23	49.14, 53.32		65.62	61.17, 70.06		12.52	10.93, 14.11		20.54	19.68, 21.39	