An Evidence-based Guideline on Combined Use of Oral Sucrose and Non-nutritive Sucking in Relieving Pain from Heel Lance in Premature Infants

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The incidence rate of preterm birth is high across the globe. Preterm infants are often hospitalized in the neonatal intensive care unit (NICU) where they undergo various invasive procedures as part of management. Heel lance blood sampling is one of the most common invasive procedures in NICU. Heel lance creates repetitive or untreated pain which leads to adverse consequences for preterm infants. Yet, in Hong Kong, the practice in combating heel lance pain varies and is inconsistent among nurses.

Four high-quality research studies were retrieved from PubMed, CINAHL Plus, British Nursing Index and Cochrane Library electronic bibliographic databases. Critical appraisal had been done to determine the strengths and limitations of the selected studies, and evidence to support the practice of a synergistic effect utilizing both oral sucrose and non-nutritive sucking had been reviewed, with finding suggesting that the intervention is a safe and effective mean for relieving heel lance
pain. Evidence showed that a significant lower pain scores can be achieved. The potential of implementing the proposed innovation is explored in relation to the transferability of findings, the feasibility of implementation and the cost-benefit ratio of the innovation. Based on the evidence, an evidence-based practice guideline is developed. To facilitate the implementation of the innovation, stakeholders are identified. Communication plan as well as the pilot testing is discussed in details. Finally, the evaluation plan is developed. Aspects regarding the outcomes to be achieved, frequency of taking measurements, method of analysis are outlined.
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A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Nursing at The University of Hong Kong

August 2014
Declaration

I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualifications.

Signed___________________________________________________________

Leung Ka Yan
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<td>APN</td>
<td>Advanced Practice Nurse</td>
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<td>CG</td>
<td>Control Group</td>
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<td>COS</td>
<td>Chief of Service</td>
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<td>CSSD</td>
<td>Central Sterile Supply Department</td>
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<td>DOM</td>
<td>Department Operational Manager</td>
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<td>GA</td>
<td>Gestational Age</td>
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<td>HA</td>
<td>Hospital Authority</td>
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<td>IG</td>
<td>Intervention Group</td>
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<tr>
<td>NA</td>
<td>Not Applicable</td>
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<tr>
<td>NICU</td>
<td>Neonatal Intensive Care Unit</td>
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<td>NNS</td>
<td>Non-nutritive Sucking</td>
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<tr>
<td>NS</td>
<td>Nurse Specialist</td>
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<td>PIPP</td>
<td>Premature Infant Pain Profile</td>
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<td>RCT</td>
<td>Randomized Controlled Trial</td>
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<td>RN</td>
<td>Registered Nurse</td>
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<tr>
<td>SIGN</td>
<td>Scottish Intercollegiate Guidelines Network</td>
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<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<td>WM</td>
<td>Ward Manager</td>
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Chapter 1

Introduction

Preterm birth refers to all babies born before 37 completed weeks of gestation (World Health Organization, 2012). The incidence rate of preterm birth is high across the globe. It is estimated 15 million babies are born preterm every year, representing a preterm birth rate of 11.1% (World Health Organization, 2012). In Hong Kong, there were a total of 1809 preterm births in eight public hospitals under the Hospital Authority with gestation age (GA) less than 35 weeks in 2012 (Hospital Authority, 2012). Preterm birth is a major cause for neonatal mortality and morbidity, which includes a long term adverse outcome of health such as visual and hearing impairment.

Preterm infants are born too soon, before their organs are well-prepared for coping extra-uterine environment. Thus, they are often hospitalized in the neonatal intensive care unit (NICU) where they undergo various invasive procedures as part of management (Johnston, Fernandes & Campbell-Yeo, 2010).

Heel lance blood sampling is the most common invasive procedure during infant’s hospitalization in NICU (Gardner, Carter, Enzman-Hines & Hernandez, 2011). Heel lance creates repetitive, untreated pain to infants, which leads to adverse consequences for them (Walden & Carrier, 2009). In order to improve clinical practice and promote better infant’s health, pain relieving interventions are needed. Oral
sucrose and non-nutritive sucking (NNS) have been widely studied and found to provide calming and pain-relieving effects in neonates.

Sucrose is a disaccharide composed of $\alpha$-glucose and fructose (Pasek & Huber, 2012). The mechanism of action involves the activation of endogenous opioid system for release of endorphin through orogustatory pathways (Gibbins & Stevens, 2001; Mitchell & Waltman, 2003; Naughton, 2013; Stevens, Yamada & Ohlsson, 2004). Its effects rely on its sweet taste rather than systemic absorption. Non-nutritive sucking (NNS) is also well known to produce calming effects through stimulation of orotactile when introducing a pacifier into infant’s mouth (Mokhnach et al., 2010). It can potentiate the analgesic effect of oral sucrose. Yet, the effect is lost once the pacifier is removed (Walden, 2009). Literature shows that the combined use of oral sucrose and NNS is more superior and effective in relieving heel lance pain in preterm infants than using sucrose or NNS alone. Thus, the combination of orogustatory effects of sucrose and orotactile effects of NNS is hypothesized to provide the most efficacious pain relief in neonates (Cooper & Petty, 2012; Naughton, 2013).

**Significance**

Heel lance is the most frequent performed painful procedures in NICU (Pasek & Huber, 2012). Yet, health care providers may disregard the pain, which may due to preterm infants’ incapability of expressing pain in preterm infants and the short
duration of heel lance (Liaw, Yang, Ti, Blackburn, Chang & Sun, 2010).

Preterm infants do feel pain. The belief that preterm infants do not feel pain due to immature central nervous system is outmoded (Walden & Carrier, 2009). Infants are unable to verbalize pain and their pain response may also be subtle or brief. There is little energy for mounting a behavioral response such as motor arousal or facial expression to painful stimuli in preterm infants (Walden & Carrier, 2009). Indeed, they do feel pain as all neurological structures necessary for nociception are developed by 24 weeks gestational age (Storm, 2000). Infant’s pain receptors, or nociceptors, are the A-delta firers and C fibers which are widely spread in the superficial layers of skin, joints, and muscles. In addition, preterm infants are even more sensitive to pain than term infants. Cutaneous flexion reflex in exaggerated in preterm infants in which thresholds to mechanical skin stimulation are lower, and at the same time, their responses last longer. Meanwhile, inhibitory neurotransmitters present in the spinal cord which reduce the intensity of pain transmission, forming as pain modulation system. In preterm infants, this system is less developed than the pain transmission system, resulting in higher sensitivity to pain (Gardner, Carter, Enzman-Hines & Hernandez, 2011). Besides, repeated exposure to painful stimuli may alter infants’ physiological processes and lead to changes in pain sensitivity (Liaw, Yang, Ti, Blackburn, Chang & Sun, 2010). The low pain threshold of the
preterm infants is further decreased by repeated exposure. After repeated exposure to the same painful stimuli, preterm infants exaggerate and present similar pain responses when exposed to other care such as handling. This altered pain responses lead to adverse consequences, including perceiving non-noxious tactile stimuli as noxious and lower tenderness thresholds and more tender points in adolescence (Buskila, Neumann, Zmora, Feldman, Bolotin & Press, 2003).

Pain is harmful to preterm infants. Repetitive or untreated pain in preterm infants results in adverse consequences (Benis, 2002; Walden & Carrier, 2009). Exposure to pain can result in decreased oxygen saturations and increased heart rates, which creates an increased demand on cardiorespiratory system. It also contributes to increased risk of intraventricular hemorrhage due to elevated intracranial pressure.

Furthermore, becoming parents to a premature child often feel helpless as this is different from what they would have anticipated. The stress may come from the unknown outcomes of the infant’s illness, prolonged hospitalization and separation from their baby (Pinelli, 2000). Thus, parents often rely on nurses to protect their infants from unnecessary suffering. Nurses are the one who safeguard the preterm infants. Nurses have the responsibility to act as pain advocates and promote the well-being of neonates (Pasek & Huber, 2012).
**Affirming needs**

In the neonatal intensive care unit where I work, almost all the preterm infants are exposed to heel lance blood sampling since admission. They suffered from pain and stress in this tissue-breaking procedure.

There is no guideline or protocol available in this NICU in pain management for preterm infants undergoing heel lance procedure and thus the nursing practice on tacking heel lance pain vary and is consistent among nurses. In current practice, some nurses may offer either sucrose or NNS to the baby after the procedure started. Some nurses may give multiple doses of sucrose if the baby cries a lot. Some nurses do not provide any interventions because they believe heel lance is just of short duration.

In fact, a commercial ready-to-use oral sucrose, TootSweet, is already available in the NICU. It is individually packaged for single patient use. It can be directly applied to the tongue of infant’s mouth without the need of using a syringe to aspirate the solutions from a container or bottle. It is more hygienic and easy to use. However, Tootsweet is underutilized due to the belief that heel lance is just a short duration procedure and due to heavy workload of nurses. Thus, there is still room for improvement in our current practice. To achieve the best nursing practice, it is essential to identify the best evidence of the intervention in relieving heel lance pain so as to facilitate the uptake of evidence and close the evidence practice gap.
Introducing an evidence-based guideline is therefore essential, not only to standardize practice, but also improve the pain management for preterm infants in this NICU and to promote the best possible patient outcome.

**Research question**

Is combined use of oral sucrose and non-nutritive sucking effective in relieving heel lance pain in premature infants?

**Objectives**

The objectives of the dissertation are:

1. To conduct a literature review on the effectiveness of combined use of oral sucrose and non-nutritive sucking in relieving heel lance pain in premature infants

2. To perform a quality assessment of the selected studies and generate a table of evidence

3. To summarize and synthesize data from the selected studies

4. To develop an evidence-based guideline on combined use of oral sucrose and non-nutritive sucking in relieving heel lance pain in premature infants

5. To assess the implementation potential of the innovation in the proposed NICU in Hong Kong
6. To develop an implementation plan and evaluation plan for the guideline of combined use of oral sucrose and non-nutritive sucking in relieving heel lance pain in premature infants in the local NICU
Chapter 2

Review of evidence

In this chapter, the method to select the studies is shown in light of search strategies, keywords search and inclusion criteria. The quality of the selected studies is appraised, the result of the effectiveness of the intervention is summarized and synthesized, and with a conclusion on the implications to nursing practice.

Selecting studies for review

Search strategies

The study search was performed on 7th July, 2013. Four electronic databases were utilized, namely PubMed, CINAHL Plus, British Nursing Index and Cochrane Library. The keywords used in the searching process included “premature”, “preterm”, “neonate”, “infant”, “sucrose”, “nonnutritive sucking”, “sucking”, “pacifier”, “heel lance”, “heel prick”, “heel stick”, and “pain”. Further keywords search was performed with different combinations of the above keywords (Appendix 1). Sixty abstracts were found with 26 from PubMed, 2 from CINAHL Plus, 1 from British Nursing Index and 31 from Cochrane Library. Thirty-five studies have been retrieved after limited to randomized controlled trials. After screening the title and abstract, 24 potential studies were remained and after eliminating the duplicated studies, there were 16 studies proceeded to the screening of full text in accordance to the inclusion and exclusion
criteria mentioned in the following part. Gradually, four studies were chosen for review. No additional studies were found eligible for selection through manual searching from reference lists of the relevant studies. Figure 1 shows the flow chart for searching process.

**Inclusion criteria**

Studies to be selected for review were randomized controlled trials (RCTs), and preterm infants hospitalized in NICU with gestational age less than 37 weeks. The preterm infants in these studies were receiving heel lance procedure and were using oral sucrose and NNS as an intervention for pain relief.

**Exclusion criteria**

Studies that were not related to human studies were excluded. For those studies that included preterm infants born with any congenital abnormalities or required intermittent positive pressure ventilation via endotracheal tube, they were excluded.
60 abstracts from PubMed, CINAHL Plus, British Nursing Index & Cochrane Library

25 studies were excluded (not randomized control trials)

Initial screening of title and abstract

24 potentially relevant studies

7 studies were excluded due to duplication

Full text screening in accordance to inclusion criteria

Reasons for exclusion:
- Type of study: Non-RCT studies
- Type of participants: Term infants only
- Type of intervention: Oral glucose
- Pain-causing procedures: retinopathy of prematurity, insertion of oro-gastric tube, intramuscular injection
- Outcome measures: Sleep pattern

4 studies met the inclusion & exclusion criteria

No additional studies found from reference lists

4 randomized controlled trials were selected for review
Methods of review

Data extraction

The four RCTs studies retrieved were reviewed. In order to present and analyze the findings systematically, all relevant data from the four selected studies were extracted and prepared in the form of an evidence table for intervention studies in accordance to the Scottish Intercollegiate Guidelines Network (SIGN). The table was composited with seven columns: bibliographic citation, the setting of the studies conducted, participant’s characteristics, interventions, comparison, pain evaluation and results (Appendix 2).

Description of studies

The year of publication was between 1999 and 2009 and they were all published in English. The study in 1999 was selected because it was the first RCT study to investigate the effectiveness of the oral sucrose and NNS in combating heel lance pain in premature infants. Moreover, this study was unique in a sense that each infant served as its own control so that individual differences were removed from the treatment effect. In addition, many studies were likely to look at premature infants’ experience in procedural pain while they were stay in the NICU, but not many RCTs investigate the related topic.

All of the four studies studied the synergistic effect of oral sucrose and NNS in
combating heel lance pain in preterm infants. Three studies were conducted in developed countries, including Canada (Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005), with one of the three conducted in both Canada and United States (Stevens et al., 1999). The fourth study was conducted in developing country, Jeddah, Saudi Arabia (Elserafy et al., 2009). All of the four selected studies were conducted in NICU. Among them, three further specified the setting was tertiary level NICU (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 2005). All the four selected studies were RCTs. Among the four studies, the study conducted by Stevens et al. (1999) was funded by the research grant from the National Institutes of Health and a National institute of Health Pediatric Clinical Research Centre. The remaining four studies did not state their source of funding.

**Quality assessment**

All of the four studies were assessed by using the critical appraisal checklist from Scottish Intercollegiate Guidelines Network (SIGN). The methodology checklist 2 for controlled trials was used (Appendix 3). The internal validity for the five studies were assessed in accordance to the ten components shown in appendix 4 and the overall assessment of the study was presented in appendix 5.
Study characteristics

Randomization strategies

All of the four studies addressed a clear and well defined focused question (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). They were focused on the combined use of oral sucrose with NNS and its effects on preterm infant’s pain level. The four studies used randomization and the concealment were mentioned clearly. In Stevens et al’s study (2005), a computer-generated random numbers table was used. In Gibbins et al’s study (2002), the researchers were very specific in describing their randomization procedures. In this study, a centralized randomization table was used. In the study by Stevens et al. (2005) and Gibbins et al. (2002), the randomization sequence was adequately concealed, in which the research pharmacists were provided instructions in allocation concealment and the research nurses were unaware of which group the infants were being allocated to when they entered the study, providing assurance of allocation concealment. In Elserafy et al. (2009) study, the randomization method was done well by using coded envelops for the six treatment regimens with a folded paper inside. Nurses were unaware of which group the infants were being allocated to as the solutions used were coded by pharmacist and none of the nurses knew the identity of the solutions. In the study conducted by Stevens et al. (1999), its randomization procedure was clearly defined.
Each infant served as its own control as they received all the interventions in random order. Besides, the allocation concealment was adequate in which there was no detectable difference between solution containers, ensuring the allocation sequence was concealed.

**Blinding**

Blinding technique was essential in minimizing the risk of expectation bias in the study, which may affect the study outcomes (Polit & Beck, 2010). However, in these four studies, blinding was not possible for the groups who received a pacifier as it was visible to the research assistants or nurses. This reason for failure to mask was acceptable. Nonetheless, the four studies tried to blind the study solutions used, that is, the sterile water and sucrose. The solutions were either coded or labeled as “study drug” so that none of the research assistants or nurses knew the identity of the solutions.

**Drop-out-rate**

The drop-out-rate was zero in three of the studies (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999) while 2.94% of infants dropped out prior to any data collection in Stevens et al’s study (2005). The drop-out-rate was low but the reason for infants dropped-out was not mentioned.

**Sample size**
Among the four studies, the sample size ranged from 36 to 190 (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005).

**Assessment methods**

For the data collection procedures, three studies except the study conducted by Elserafy et al. (2009), Stevens et al. (1999) did well in minimizing variation in the heel lance procedure by standardizing it into different phases. The study conducted by Stevens et al.’s. (1999) further specified that the heel lance procedure was performed by the same research nurse while the rest of the studies did not state it. The pain assessment tool, Premature Infant Pain Profile (PIPP) was use in the four studies. PIPP has been shown to be a reliable and valid instrument in assessing pain in preterm infants (Elserafy et al., 2009; Gibbins et al., 2002; Gibbins et al., 2003; Stevens et al., 1999; Stevens et al, 2005) It was suitable to reflect a comprehensive conceptualization of pain by using this multidimensional pain assessment tool rather than outcomes such as duration of time crying, which do not necessary to confirm or deny that the infant was in pain (Pasero, 2002). Efforts were made to ensure high accuracy in recording ,information by using ECG monitor and pulse oximeter, with the model number clearly delineated in all the four studies. In addition, the PIPP scores were completed by an experienced and trained coder, who was blinded to the treatment group assignment (Elserafy et al., 2009; Gibbins et al., 2002; Gibbins et al., 2003;
Stevens et al., 1999; Stevens et al, 2005). Moreover, the researchers have the skills necessary for proper interpretation of the outcome measures.

Among the four studies, three of them were conducted from a single site (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al, 2005). In Stevens et al’s study (1999), the research was conducted in four different hospitals in Canada and the United States.

Based on the overall quality and the evidence level of SIGN, three of the studies were ranked as high quality (Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). All of the three studies were carefully planned prospective RCTs with a control group and more than one treatment intervention. These studies performed well in randomization, concealment, blinding and the only difference between the groups was the treatment of oral sucrose plus NNS. All studies measured the pain level in a standard, valid and reliable way by using PIPP (Elserafy et al., 2009; Gibbins et al., 2002; Gibbins et al., 2003; Stevens et al., 1999; Stevens et al, 2005). Besides, three studies provided detailed information in the standardization of heel lance procedure except the one conducted by Elserafy et al. in 2009. And the sample size in Elserafy et al’s study (2009) was small in which only 36 preterm infants were recruited. It may result in the lack of statistical representation and statistical conclusion validity may be threatened (Polit & Beck, 2011) Thus, this study was ranked as acceptable.
Data summary

Purpose of the study

All of the four RCTs studies aimed to compare the efficacy of interventions (NNS with sucrose, NNS with water, positioning, sucrose alone, NNS alone and water alone) with standard NICU care for relieving procedural pain in preterm infants (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005).

In Elserafy et al.’s study (2009), it further mentioned to compare the analgesic effects of sucrose versus sterile water alone or with NNS and to determine the synergistic effect with oral sucrose when combined with non-pharmacologic interventions to relieve pain during painful procedures in preterm infants. In the studies by Stevens et al. (2005) and Gibbins et al. (2002), they also aimed to determine the safety of the interventions by determining the nature and incidence of adverse events following the administration of oral sucrose.

Sample characteristics

All of the four studies recruited premature infants with GA between 26 and 43 weeks. Three studies recruited solely preterm infants with GA 26 to 36 weeks (Stevens et al., 1999; Stevens et al., 2005; Elserafy et al., 2009) while one study recruited both preterm and term infants with GA ranging from 27 to 43 weeks. The mean GA was 33 weeks (Gibbins et al., 2002). The sample size ranged from 36 to
Besides, the infants in all of the four studies were hospitalized in NICUs without major congenital abnormalities (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). The four studies reported that there was no significant difference between treatment groups in relation to gestational age, birth weight, Apgar score or severity of illness.

**Types of intervention**

There were a total of six different types of interventions presented in the four studies. It included the combination of oral sucrose plus NNS (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005), sterile water plus NNS (Elserafy et al., 2009; Stevens et al., 1999; Stevens et al, 2005), sterile water alone (Elserafy et al., 2009), sucrose alone (Elserafy et al., 2009; Gibbins et al., 2002), NNS alone (Elserafy et al., 2009) and prone positioning (Stevens et al., 1999). Two of the studies’ control group used supine or side-lying position as their intervention (Stevens et al., 1999; Stevens et al, 2005). One study used swaddling (Stevens et al, 2005), and one study used sterile water plus NNS (Gibbins et al., 2002) while the remaining one had no treatment for the control group (Elserafy et al., 2009).

**Method of administration**

From the four studies, the solutions sucrose or sterile water, were administered
by two different approaches. The solution was either instilled onto infants’ anterior surface of the tongue with a 1ml syringe (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al, 2005) or placing a pacifier dipped with the solutions into the infants’ mouth (Stevens et al., 1999).

For the administration of NNS, all the four studies described it as “pacifier held in place in the infants’ mouth”. Elserafy et al. study (2009) specified that the pacifier should be stuffed with gauze square for resistance.

In terms of sequence, all the four studies administered the solution first, followed immediately by the insertion of pacifier.

**Dosage of solutions used**

In the two selected studies (Elserafy et al., 2009; Gibbins et al., 2002), a single dose of 0.5ml solution was administered to the infants. In one study conducted by Stevens et al. (2005), only 0.1ml solution was used. It was also single dose only. In another study, the solutions were administered by dipping the pacifier into the solutions (Stevens et al., 1999). The author mentioned that the approximately 0.1ml solution was covered on the pacifier.

**Timing of intervention**

In the three selected studies, the interventions were administered 2 minutes prior to the heel lance procedure (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al,
2005). One study conducted by Stevens et al. (1999), the intervention was given 5
minutes and 2 minutes prior to the procedure.

**Concentration of oral sucrose**

The concentration of oral sucrose used in all of the four trials was the same
(Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005).
All of the four studies used 24% oral sucrose. It was found to provide sufficient
analgesia in relieving minor procedural pain in neonates (Cooper & Petty, 2012;
Mokhnach et. al., 2010; Pasek & Huber, 2012).

**Personnel for conducting interventions**

In these four RCTs, the authors arranged research nurses (Stevens et al., 1999;
Stevens et al., 2005), research assistants (Gibbins et al., 2002) and nurses (Elserafy et
al., 2009) to conduct the interventions.

**Outcome measures**

All of the four studies used PIPP to measure to pain level experienced by the
premature infant from the heel lance procedure (Elserafy et al., 2009; Gibbins et al.,
2002; Stevens et al., 1999; Stevens et al, 2005). Three studies obtained the PIPP at
baseline and the PIPP during heel lancing and the PIPP following heel lancing
(Elserafy et al., 2009 Stevens et al., 1999; Stevens et al, 2005). The PIPP following
the heel lancing were scored with the time interval ranging from one minute to ten
minutes. One study measured the pain score 30 seconds following the heel lancing, and subsequent PIPP were obtained every 30 seconds until the procedure was completed (Gibbins et al., 2002).

The method of scoring the PIPP was consistent among the four studies (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). In all of the four studies, baseline heart rate and oxygen saturation of the infant was recorded. The gestational age of the infant was scored on a 4-point scale. After that, the infant was observed for 15 seconds for scoring of the behavioral state regarding active, awake, quite or sleep. For the physiologic state, the infant was observed for 30 seconds and the following indicators was scored: the maximum increase in heart rate, the minimum decrease in oxygen saturation, and the duration of time that the infant had brow bulge, eye squeeze and naso-labial furrow. In all of the four studies, the heart rate and oxygen saturation were measured by pulse oximetry.

**Effectiveness of intervention**

All of the four studies showed the lowest PIPP score in the sucrose plus NNS group when compared with the control group and the rest of treatment groups (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). In the studies by Stevens et al. (2005) and Stevens et al. (1999), there was a significant reduction in PIPP scores between the sucrose plus NNS group and
standard care group with \( p=0.01 \) and \( p<0.0001 \) respectively. In Gibbins et al.’s study (2002), the PIPP scores were significantly lower in the sucrose plus NNS group when compared to sucrose alone group \( (p<0.02) \) and sterile water plus NNS group \( (p<0.01) \). In the study by Elserafy et al. (2009), the sucrose plus NNS group resulted in the lowest PIPP scores of all groups for all measurement time intervals. It was statistically significant with \( p<0.05 \).

**Adverse events**

In Gibbins et al.’s study (2002), five infants had mild desaturation during the study period while one infant choked on the pacifier. In Stevens et al.’s study (2005), the incidence of adverse events was very low but no exact number were presented. Both studies did not specify the GA of these infants. All adverse events in the above studies were resolved spontaneously. In the studies by Elserafy et al. (2009) and Stevens et al. (1999), no adverse events were mentioned.

**Data synthesis**

After summarizing the findings from the selected studies, the evidence was synthesized as followed.

**Target group**

With reference to the four studies selected, the target population was preterm infants with GA at least 26 weeks who were hospitalized in NICU, and had no
congenital abnormality (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005). Infants who were intubated or put on intermittent positive pressure ventilation were excluded.

**Method of administration**

The sucrose was administered orally. Majority of the studies administered the sucrose orally by directly instilling onto the anterior surface of the tongue using 1 ml syringe rather than using a pacifier dipped with oral sucrose (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al, 2005). This was consistent with the mechanism for the analgesic effects of sucrose involved in the activation of the endogenous opioids through gustatory pathways or taste (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). Opioid receptors that detect sweetness were present on the anterior tip of the tongue, where sucrose was administered. Thus, the practice of direct application of sucrose to the tongue was supported by evidence. Meanwhile, according to the study by Gibbins et al. (2002), sucrose delivered into the stomach via a nasogastric tube did not reduce the pain response as sucrose does not rely on systemic absorption. All of the four studies supported that after the administration of oral sucrose, it had to be followed by NNS via a pacifier. It was suggested that sucking on a pacifier potentiates the analgesic effect of sucrose (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005).
Thus, pacifier used along with sucrose was considered to have a synergistic effect in relieving pain.

**Timing of intervention**

The four selected studies commonly administered the intervention two minutes prior to the procedure (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). The onset of action of oral sucrose was ten seconds with peak response time at two minutes, while the actions persist approximately five to ten minutes. According to the study by Stevens et al. (1999), the peak response time for sucrose was coincided with the time needed for the activation of endogenous opioid system. Thus, it was appropriate to administer oral sucrose two minutes prior to the procedure.

**Dosage of oral sucrose**

All of the four studies recommended a single-dose of sucrose ranging from 0.1ml to 0.5ml as an effective dose for pain relief (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). The four selected studies vary in the dosage of oral sucrose but they did not differ in the result of pain reduction. As mentioned above, the only product available in the proposed local NICU is the commercial 24% sucrose preparation TootSweet, which comes in a 2 ml unit-dose vial. It can be dispensed in single drops with 1 drop equaling to 0.05ml. In this way, the sucrose can
be administered up to 10 drops within the heel lance procedure. The dispensed drops can be visualized clearly when slightly press on the vial so that the sucrose can be administered to the anterior tongue precisely.

**Concentration of oral sucrose**

Given that all of the studies showed a significant reduction in pain response, it was recommended that 24% oral sucrose is the best concentration of oral sucrose as this concentration was sufficient to provide analgesia (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005).

**Evaluation method of pain**

Among the four studies, PIPP was adopted to be the tool for evaluating pain (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). PIPP has been shown to be a reliable and valid instrument in assessing pain in preterm infants. It is a multidimensional pain scale, which requires healthcare providers to observe the behavioral state and to monitor the physiological changes of infant, including changes in heart rate, oxygen saturation and facial expression.

All of the four studies vary in the time interval in obtaining the PIPP score. Majority of studies obtained the baseline PIPP score and the PIPP score during heel lancing (Elserafy et al., 2009; Stevens et al., 1999; Stevens et al, 2005). The common time interval for scoring PIPP after the heel lance procedures was 5 minutes.
Efficacy of oral sucrose with NNS

Among the four studies, it was reported that the sucrose plus NNS group shown the lowest PIPP score (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005). Given that the combination of oral sucrose with NNS had shown a significant reduction in pain response for heel lance procedure, it was suggested that sucrose with NNS was effective in reducing heel lance pain in preterm infants when compared with standard care, positioning, or sterile water with NNS.

Safety of oral sucrose

All of the studies agreed that sucrose is safe to use as none of the adverse effects were considered as clinically important (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005). It was suggested that reasonable precautions such as visualizing dispensing drops and careful administration to the anterior tongue can limit these effects.

Personnel for implementing the intervention

Nurses were the one to implement the intervention as only nurses were permitted and responsible for performing heel lance in the proposed local NICU.

Implications to nursing practice

This integrative review supported that the combined use of oral sucrose with NNS is efficacious for heel lance pain relief in hospitalized preterm infants with GA.
at least 26 weeks. This innovation achieved the lowest pain score with statistically
significance. Moderate effect was noted when utilizing both oral sucrose and NNS.
Therefore, the four studies suggested that 0.1ml to 0.5ml of oral sucrose can be
administered onto the anterior tongue of the infant prior to heel lance procedure,
followed immediately by the insertion of a pacifier.
Chapter 3

IMPLEMENTATION POTENTIAL

From the literature review in Chapter 2, it is suggested that the combined use of oral sucrose with NNS is a safe and effective way in relieving heel lance pain in premature infants in NICU. According to Polit & Beck (2011), a formal assessment to assess the appropriateness of innovation within a particular clinical setting before embarking on implementing it is warranted. In determining the implementation potential of this pain-relief innovation in the NICU where I work, several issues will be considered. In this chapter, the transferability of the findings, the feasibility of the implementation and the cost-to-benefit ratio of the innovation is examined.

Transferability

The proposed setting is a tertiary level NICU of an acute hospital in Hong Kong. The hospital is managed by the Hospital Authority (HA). According to the classification of levels of care defined by American Academy of Pediatrics in 2004, tertiary NICU is the most advanced level. It is differentiated by the ability to provide comprehensive care to extremely low birth weight infants with less than 28 weeks’ gestation and weighing less than 1000 gram at birth, or having medical or surgical conditions. Tertiary level NICU, are also expected to provide sustained mechanical ventilation, high-frequency ventilation and inhaled nitric oxide. Full range of pediatric
specialists should also be readily available. In the literature review, all of the four selected studies were carried out in tertiary level NICU, implying the equipment and technology are similar with the target setting (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). Thus, the innovation that was suggested by the studies is similar for the proposed setting.

The target population in all of the four selected studies and the proposed setting are similar in which preterm infants are born before 37 weeks of gestational age. Similar to the studies that was retrieved, the proposed setting also admits preterm infants. In accordance to the data synthesis in chapter 2, infants who have congenital abnormalities and are endotracheally intubated will also be excluded from using the innovation. Hence, the target population in the proposed setting is similar to the one in the selected studies.

**Philosophy of care**

The philosophy of care of the proposed innovation is consistent with the target setting and the organization. Pain is harmful to preterm infants, in which they may suffer from adverse consequences (Walden & Carrier, 2009). Therefore, optimizing comfort and providing a safe and pain-free environment for the preterm infants are the philosophies of care of the proposed innovation. This matches the mission of the hospital where I work, which is to ‘deliver quality and effective healthcare services
through a professional and caring team’ (Hospital Authority, 2011). It also coincides with the missions of the Department of Paediatrics & Adolescent Medicine which is to ‘advocate and enhance children’s health and well-being’ and to ‘provide quality health care for the children and their families’ (Hospital Authority, 2009). Thus, the hospital, the paediatrics department and the innovation have the same prospect to provide quality care and promote the well-being of the patients.

**Number of clients benefit from the innovation**

In the proposed NICU, there are no official data regarding the admission rate for infants diagnosed with ‘prematurity’. However, it is roughly estimated that around 250 premature infants are admitted annually. Almost all the preterm infants are being exposed to heel lance blood sampling upon admission. Thus, it is expected that the innovation can benefit a sufficiently large number of clients.

The proposed schedule for implementing and evaluating the innovation will be about forty weeks. The first two weeks are designated to prepare and develop the promotion plan for the innovation. Eight weeks will be spent on getting approval for the new guideline from the staffs from administrative level. Another two weeks are needed for introducing the guideline and providing training to the all the nursing staffs in the NICU. After that, the eight weeks are for conducting pilot testing and pilot evaluation. The guideline may need to be refined if necessary. The actual
implementation will last for fifty-two weeks. For the evaluation, eight weeks will be required for collecting data and monitoring the compliance of the new guideline by means of auditing.

**Feasibility**

After assessing the transferability of the innovation, feasibility of implementation is another concern to be addressed. According to Polit & Beck (2011), issues on the availability of staff and resources and the organizational climate have to be examined.

**Freedom to carry out intervention**

The proposed NICU is supportive for sucrose administration for the purpose of pain relief and no physician prescription is needed in advance. Nurses have the autonomy to administer oral sucrose and NNS in the proposed NICU. They will assess the needs of the infant who will undergo heel lance procedure and have the autonomy to carry out the innovation. If the innovation is considered undesirable, nurses have the freedom to terminate it.

**Interference with current staff functions**

The implementation of the innovation will be arranged as according to current staff functions. The time spent on obtaining the sucrose solution and pacifier, planning for administration before the heel lance procedure and documenting the process may be conceived as the constraints for implementation. In fact, the practice of combined
use of oral sucrose with NNS to combat heel lance pain has long been adopted by nurses in the proposed NICU. However, pain practices in the NICU are inconsistent which is associated with variations in the treatment preferences of individual nurses. This guideline is intended to standardize the nursing practice. Also, the implementation of this guideline will not induce heavy workload to the nursing staff because this intervention has long been adopted by nurses. Besides, nurses are not required to devote extra time after office hours to attend training courses. There are no extra skills needed to carry out for the implementation and evaluation of the innovation. It will not cause the problem of manpower shortage. Thus, interference with current staff function brought by the implementation of the innovation is minimal.

**Barriers on implementing the innovation**

Still, change is not easy. Resistance may arise when introducing new guideline into routine daily practice. Resistance is recognized as a neutral and expected response as the homeostasis or balance of the nurses may be disrupted by such a change (Marquis & Huston, 2009). In the proposed NICU, restraining forces such as conformity to norms, lack of motivation to change may hinder the successful implementation of new guideline. Nurses may be reluctant to accept the guideline in
short run as their individual pain practices are rooted in their mind. It may take times for them to change their practice.

**Consensus among the staff**

Nonetheless, there is a consensus among all staffs that the innovation is beneficial to the infants. It is well recognized that delivering quality pain care in the NICU is not a simple task due to subtle pain expression by the preterm infants. Given the unique challenges of assessing pain in preterm infants and the deleterious effects of pain for them, nurses in the proposed NICU are strived to promote a ‘pain free’ environment for infants. In the proposed setting, the nurse specialist advocates for minimizing pain in infants and takes part in pain care discussions with physicians if necessary. Nurses also seek advice from the nurse specialist if the infants undergo painful activities such as laser therapy for retinopathy of prematurity. Thus, if the value of the guideline can be identified by the nurses, the new practice can become the norms in the long run.

**Organization climate**

For the organizational aspects, the organizational climate is favorable to evidence-based practice. Hospital Authority (HA) has developed e-Knowledge Gateway (eKG) for the provision of easy access to comprehensive and quality information resources and databases to staffs. Platform is also established for staffs
from different specialties and fields to share their research studies in the Hospital Authority Convention which held annually. Such platform helps to promote the sharing of knowledge and experience on clinical advances and approaches to modern healthcare services. Also, in our department, nursing journal club has been established for few years. Staffs are encouraged to raise any clinical concerns, to search for the updated literatures and evidence-bases practice with the colleagues. Moreover, the proposed NICU has considerable experience in applying research evidence into clinical practice in the proposed NICU. For example, the use sterile water or boiled water is encouraged and substituted the use of 70% alcohol pad for cord cleansing as there is no difference shown in the cleansing effect. Thus, it is suggested that the organizational climate is conducive to research utilization.

Friction from the organization level for implementing the innovation is low. The innovation is proposed to be carried out in the NICU and implemented by the nurses there. Equipment needed for the innovation have already available in the proposed NICU. Thus, budget planning or resources allocation among departments will not be affected.

**Equipment and facilities needed**

Concerning the availability of resources, the innovation requires both manpower and equipment. For the equipment, pacifier and oral sucrose solution are needed. Both
of them are already available in the proposed NICU. The pacifiers are reusable after sterilization in the Central Sterile Supply Department (CSSD). It can ensure the stability for the supply of pacifiers. For the sucrose solution, it is ordered by the ward manager from medical product company. The inventory is kept in the top-up cupboard in the NICU and nurses can take one when necessary. For the manpower, nurses in the NICU are familiar with the technique in administering oral sucrose and pacifier. Thus, it is suggested that no extra skills has to be learnt and no extra equipment are needed for the implementation of innovation. Debriefing of the innovation can be arranged in the multi-purpose room in the NICU.

**Evaluation tools**

Appropriate measuring tool for a clinical evaluation of the effectiveness of the innovation is available. The Premature Infant Pain Profile (PIPP) has long been adopted in the proposed NICU for assessing pain level in premature infants. PIPP has been shown to be a reliable and valid instrument in assessing pain in preterm infants. It is a multidimensional pain scale, which consists of seven indicators, including three behavioral, two physiological and two contextual indicators (Stevens et al., 1999; Walden & Carrier, 2009). Nurses in the proposed NICU are familiar with the usage of PIPP. Apart from measuring the effectiveness of the innovation, nurses’ satisfaction
level about the guideline is also essential. The ward manager can collect the feedback
and opinion from frontline nurses daily during the handover section.

To conclude, the innovation is suggested to be feasible for implementation. Nurses have the autonomy to carry out or terminate the innovation. Resistance to change is minimal and may not be perceived as a restraining factor, a strong pool of potential benefits is also present. It includes the minimal interference of staff functions, consensus reached among the administrators and staffs, culture of promoting evidence-based practice and the availability of resources and evaluation tools.

Cost-benefit ratio

Risks of innovation to the clients

Performing assessment on the costs and benefits of the innovation is essential. There are potential risks that the infants would be exposed to during the implementation of the innovation. As mentioned in the Chapter 2, the administration of oral sucrose solution may cause choking and mild desaturation for preterm infants. However, in accordance to the reviewed studies, the incidence rate of these adverse effects is very low and the adverse effects are resolved spontaneously. Besides, it is recommended by the literature that these adverse effects can be minimized by
reasonable precautions such as visualizing dispensing drops and careful
administration to the anterior tongue (Mokhnach et. al., 2010; Thompson, 2005).

**Potential benefits**

Conversely, there are also potential benefits that could result from the
implementation of the innovation. Apart from promoting the comfort for the preterm
infants, the quality of pain care in the proposed NICU can be improved. The proposed
clinical guideline do not only provides step-by-step interventions for nurses to follow,
but also promote evidence-based and high-quality care. Thus, the nursing standard
can be kept in line with current evidence. According to Huston (2008), identifying and
adopting innovative quality improvement approaches is essential. It is a
demonstration of accountability to our patients. The nursing standard can also be
pushed to maximal by ensuring proactive quality improvement. Besides, expansion of
nursing role for professional practice is recognized as the potential benefit from
implementing the innovation. It demonstrates the competence of nurses to take
responsibility of an area of care and to have considerable autonomy (Faithfull & Hunt,
2005). It may also imply the advancement in the nursing professional status in the
future. On the other hand, parents’ satisfaction level with pain management can be
improved. Pain management is a priority concern for parents as they may feel stressed
when seeing their infants in pain and being unable to protect them from it (Gardner,
Carter, Enzman-Hines & Hernandez, 2011). The innovation facilitates the delivery of quality pain care for the fragile preterm infants. Thus, it is suggested that by satisfying the concerns of clients, the reputation and image of the hospital can be enhanced.

**Risks of maintaining current practice**

The risk of maintaining current practices comes from practice variation. According to Coleman and Pon (2013), practice variation is associated with higher cost of medical care, but higher cost has no particular association with higher quality care or better patient outcomes. It is suggested that minimizing practice variation will probably lower the cost without compromising the quality of care (Coleman & Pon, 2013).

**Material cost for the innovation**

Material costs for this innovation are mainly spent on purchasing oral sucrose solution from medical product company. There are 100 vials sucrose solution per box which costs $800 (Personal communication, 2013). It is estimated ten boxes are needed every three months. Thus, the monthly material cost will be around $2667. For the pacifier, it is reusable and sterilized in the CSSD. The CSSD supplies the pacifier to the proposed NICU everyday in the afternoon and thus it is not necessary to purchase pacifier.

**Non-material cost for the innovation**
The non-material costs are the time that spent on refining the guideline, meeting
with the staffs from administration level and physicians to gain their support and
approval. Time is also needed to introduce the new guideline to all nursing staffs in
the proposed NICU.
Chapter 4

EVIDENCE-BASED PRACTICE GUIDELINE

After assessing the implementation potential, the next step is to develop a guideline reflecting accumulated research evidence (Polit & Beck, 2011). The grading system from Scottish Intercollegiate Guidelines Network (2008) in appendix 6 is adopted to state the levels of evidences and grades of recommendations. The level of evidence for each reviewed studies are graded after the quality assessment in Chapter 2. Three of the reviewed studies are graded as 1++ (Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005) while the remaining one is graded as 1+ (Elserafy et al., 2009).

Title

The title is named as ‘Evidence-based guideline for the combined use of oral sucrose and non-nutritive sucking in relieving heel lance pain in premature infants in NICU’.

Aim

The aim of the guideline is to assist the healthcare team in the neonatal intensive care unit setting up a standardized pain-relief intervention for preterm infants undergoing heel lance procedure.
Objectives

The objectives of the guideline are:

1. To promote evidence-based pain-relieving intervention with the combined use of oral sucrose and non-nutritive sucking;

2. To standardize nursing practice for management of heel lance pain;

3. To relieve pain and distress for premature infants undergoing heel lance procedure;

4. To assist neonatal nurses in decision-making for administrating oral sucrose.

Target Group

The target group of this guideline is the preterm infants in the NICU with gestational age between 26 and 36 5/7 weeks, who do not have congenital abnormalities, are not endotracheally intubated and is going to be subjected to heel lance procedure.

Recommendations

1.0 Combined use of oral sucrose solution and non-nutritive sucking (NNS) is suggested to be initiated to preterm infants subjected to heel lance procedure.

(Grade of recommendation: A)

Evidence:

All of the reviewed studies showed the lowest PIPP score in the sucrose
plus pacifier group when compared with the control group and the rest of treatment groups (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005) (1+, 1++, 1++, 1++). The results is shown to be statistically significant, indicating the combined use of oral sucrose with NNS is effective in relieving heel lance pain in preterm infants.

2.0 Assessment of infants’ vital signs and baseline pain level is suggested before the start of heel lance procedure. (Grade of recommendation: A)

Evidence:

All of the reviewed studies suggested obtaining the baseline PIPP prior to heel lance procedure (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005) (1+, 1++, 1++, 1++). In a high quality study done by Stevens in 1999 (1++), the health status of the infants is assessed to check whether there is physiologic derangement. It is recommended that the vital signs of the infants have to be assessed before the initiation of innovation.

3.0 Nurses are recommended to initiate the intervention two minutes prior to the heel lance procedure. (Grade of recommendation: A)

Evidence:

All of the reviewed studies recommended the intervention to be administered two minutes prior to heel lance (Elserafy et al., 2009; Gibbins et al.,
The rationale is that the onset of action of oral sucrose is 10 seconds and the peak response time is 2 minutes. This interval coincides with the release of endorphin opioid activated by the sweet taste.

4.0 Dosage of 0.1ml to 0.5ml of 24% oral sucrose solution is suggested to be used. (Grade of recommendation: A)

Evidence:

All of the reviewed recommended the use of 24% sucrose ranged from 0.1ml to 0.5ml (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005) (1+, 1++, 1++, 1++). If necessary, administer the solution until the maximum recommended dosage is achieved. It is suggested that this concentration is sufficient and effective to provide pain-relieving effect.

5.0 Oral sucrose solution is suggested to be directly applied to the anterior surface of the tongue. (Grade of recommendation: A)

Evidence:

All of the reviewed studies suggested the sucrose solution has to be administered orally by directly instilling onto the tongue. (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005) (1+, 1++, 1++, 1++). The mechanism for the analgesic effects of sucrose involved the activation of the
endogenous opioids through gustatory pathways or taste (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005) (1+, 1++, 1++, 1++). The opioid receptors that detect sweetness are present on the anterior tip of the tongue, where sucrose is administered. Sucrose delivered into the stomach via a nasogastric tube did not reduce the pain response as sucrose does not rely on systemic absorption (Gibbins et al., 2002; Stevens et al., 1999) (1++, 1++).

6.0 Provision of a pacifier followed by administration of oral sucrose solution is recommended. (Grade of recommendation: A)

Evidence:

All of the reviewed studies recommended the provision of pacifier soon after the administration of oral sucrose (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al., 2005) (1+, 1++, 1++, 1++). It is suggested that sucking on pacifier can potentiate the effect of sucrose and provide comfort to the infants. The calming effect is lost once the pacifier is removed.

7.0 Evaluation of infant’s pain level is suggested after the heel lance procedure.

(Grade of recommendation: A)

Evidence:

All the reviewed studies measured the PIPP scores to evaluate the pain level experienced by the infants (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al.,
1999; Stevens et al, 2005) (1+, 1++, 1++, 1++). It is suggested that nurses evaluate the infants’ pain level using the PIPP during and 5 minutes after the heel lance procedure.
Chapter 5

IMPLEMENTATION PLAN

In Chapter 3, it is revealed that the innovation is transferable and feasible to be implemented. Yet, implementing a planned change is not an easy task. Before introducing evidence and clinical guidelines into daily practice, a comprehensive communication with different level of parties is required.

Communication plan

Identification of stakeholders

Identifying stakeholders is a critical step in initiating change as it facilitates organizations to develop a communication plan to meet the needs of each party (Marquis & Huston, 2009). The key stakeholders from the administrative level include the Chief of Service (COS), the Department Operational Manager (DOM) and the Ward Manager (WM). They participate in organizational strategic planning and fiscal planning. The COS has the authority to make to decision on approving new guidelines and the DOM and WM are responsible for arranging nursing manpower to facilitate the implementation of innovation. The Nurse Specialist (NS) in the NICU is also a key stakeholder who advocates for pain-free practice and will probably support the proposed change. All the sixty frontline nurses are the stakeholders of user level as they are the users of the proposed guideline. Their support and comments are essential.
for successful implementation of the new guideline.

**Communication process**

In addition to identifying stakeholders, it is necessary to prioritize them and determine their influence (Marquis & Huston, 2009). The NS in the NICU will be the first one to communicate with as she has a key supportive influence on the implementation of the guideline. The proposal will be sent to the NS and then a formal meeting will be arranged to introduce the innovation. Evidence from studies will be presented to the NS to explain the reasons for the change and the related benefits to the premature infants, parents and nursing staffs. After that, a formal meeting will be held with the administrators including the COS, the DOM and the WM. The issue will be raised together with the NS in the meeting. Evidence from literatures will be disseminated, including the significance of change, transferability, feasibility and cost-benefit ratio of the innovation. An open discussion can facilitate direct communication so as to understand administrators’ interest and concerns. After reaching the consensus with the administrators, the frontline staffs will be approached and resistance response is expected from them. Thus, the planned change and desired outcomes have to be clearly outlined and communicated to them. Strategies for initiating change will be discussed in the following parts.

**Forming a steering committee**
Forming a well-structured committee is essential as committee communicates upward and downward to encourage participation of all involved staffs and to assist the unit in receiving feedback (Marquis & Huston, 2009). The guideline proposer will invite the NS, two advanced practice nurses (APNs), and three registered nurses (RNs) to form together to promote the innovation to the colleagues. The two APNs and three RNs will be invited as they are from the pain management coordinating committee of the hospital. They are the expertise in the field of pain control. The NS will be invited to be the chairperson to lead the committee. The committee members will receive a briefing session from the proposer to familiar with the new guideline and help to provide training to the other NICU staffs.

**Strategies of change**

To create the motivating climate of change, it is essential for the NICU nurses to feel empowered to implement change. Empowerment occurs when leaders communicate their vision and staffs are involved in implementing change so that they believe that they have some input and control in what is about to happen (Marquis & Huston, 2009). To initiate the open discussion among frontline staffs, the proposed guideline with the evidence support from the literature will be sent to them by email. An introductory talk will be held during the briefing session each morning shift to raise their awareness of a need to change. The vision and the details of the guideline
will be introduced. To facilitate staff cooperation and compliance, the committee will further initiate open discussion during informal meeting which is held once per week. The aim and objectives and the benefits of this innovation will be clearly presented with evidence support from the literature. The committee members will then provide statistics to show that a change is necessary to achieve optimal patient’s outcome. Staffs will be encouraged to speak openly so that their worries and concerns can be identified. Committee members will reassure them and share successful experiences from foreign countries. By providing sufficient knowledge on the innovation, sharing of successful cases, and accepting the concerns expressed during the open discussions, it is believed that the staffs will become more engaged to the innovation.

After the staffs are motivated, they will receive a one-hour formal training arranged by the committee members. The training will be held in the afternoon everyday. Attendance will be recorded and it is estimated to take about two weeks to complete the training for all staffs. The workflow of the guideline will be demonstrated and the technique of administering sucrose solution will be shown by playing the educational video clip, which is produced by the committees. Return demonstration will be required by using the simulation baby model which is readily available in the ward. They will be encouraged to raise any questions and their performance will be assessed by the committee members. Besides, since the nurses in
the NICU are already well-trained for the use of PIPP, this issue will not be covered in
the training. Apart from the training, posters will be hoisted in staff pantry to promote
the innovation.

To sustain the change process, the NS or APNs will conduct performance audits
every half a year to ensure the quality and safety of practice. They will observe
whether the nursing staffs follow the guideline or not. Reminders for the new practice
will be posted in every blood-taking trolley. The educational video clip will also be
posted on the department webpage for orientating new nursing staff. Besides,
revisions of guideline will be made if more new evidence is available from literatures.

**Pilot plan**

Pilot test is a trial run of the innovation before widespread adoption. It allows the
opportunity to test the workflow of the implementation and collect the opinions from
guideline users. Thus, it helps to identify any unexpected barrier and determine
whether revisions are needed before implementation.

**Objectives**

1. To determine the feasibility of the proposed guideline;

2. To assess the compliance level of the RNs;

3. To assess the RNs’ satisfaction level about the proposed change;

4. To identify any potential difficulties in implementation.
Design

The pilot plan will be conducted in the target NICU. It will last for eight weeks, including six weeks for recruiting subjects and carrying out intervention. Convenience sampling method will be used for recruitment of subjects. During that period, the frontline nurses will perform heel lance in accordance to the proposed guideline. Data analysis and evaluation will be carried out in the last two weeks to see whether amendment of guideline is needed.

Subjects

The target participants of the pilot test will be the same as the one stated in the inclusion and exclusion criteria of the proposed guideline. All the preterm infants with gestation age of at least 26 weeks, who are hospitalized in NICU, and have no congenital abnormality will be included. Infants who are intubated or put on intermittent positive pressure ventilation will be excluded. According to the statistics from the target NICU, there are approximately 20 preterm infants admit each month. Preterm infants who admitted to the NICU and fulfilled the inclusion criteria within that six weeks will be recruited. It is expected to recruit 40 subjects. Clear explanation will be given to the parents and written consent is required.

Evaluation of the pilot study

The pain response will be assessed by using Premature Infant Pain Profile (PIPP)
Appendix 7. Baseline PIPP score and a subsequent PIPP scores during the heel stick and 5 minutes following the heel stick will be obtained. For scoring of the PIPP, the responsible nurse will prepare the PIPP form which has long been using in the proposed NICU. The gestational age of the infant will be recorded. The baseline heart rate and oxygen saturation will also be recorded, and these data can be read from the cardiac monitor which has been monitoring the heart rate, oxygen saturation, respiratory rate, ECG rhythm since admission. Thus, no additional monitoring device is required. After that, the nurse will observe the behavioral state of the infant for 15 seconds and score in accordance to whether the infant has eye opening and facial movements. Furthermore, the nurse will observe the infants for 30 seconds and read the parameters from the monitor and look at the infant’s face. Nurse then score the physiologic changes including the maximum increase in heart rate and minimum decrease in oxygen saturation, and the facial changes in relation to brow bulge, eye squeeze and naso-labial furrow. Final score can be obtained by adding up the score from each column.

In each shift, there will be one APN or RN from the committee to act as observer. They will look at the performance of the nurses during each of the heel lance procedure, observing if there are any discrepancies between the nurses’ practice and the guideline’s recommendation. Their performance will be recorded on the guideline
checklist (Appendix 8). Comments will be given after the entire procedure.

Questionnaires will also be given to the frontline nurses to evaluate their satisfaction level towards the new guideline (Appendix 9).

**Review of guideline**

After conducting the pilot test, a review board will be formed by the WM, NS and the committee members. The committee members will gather and analyze the questionnaires and checklist. The issues about smoothness of workflow, effectiveness of pain control and compliance of nurses will also be discussed. The guideline will be modified and reviewed by the review board before full implementation.
Chapter 6

EVALUATION PLAN

The last step in developing evidence-based practice guideline involves evaluation. It is concerned with the effectiveness of the guideline. It helps to determine whether the desired outcome stated in the planning stage is achieved and provides information on whether to adopt the innovation (Polit & Beck, 2010). This evaluation plan outlines how the proposed guideline is evaluated in accordance to patient outcomes, healthcare provider outcome and system outcomes. Details about nature and number of clients involved, timing and frequency for measurements, data analysis and criteria for its effectiveness is also covered.

Outcomes and measurements

The primary outcome is to reduce the heel lance pain in infants. It is necessary to determine whether the innovation is effective in relieving pain in premature infants. Assessment of pain in neonates is often challenging as they cannot verbalize their subjective feelings. To facilitate health care professionals to recognize the presence and severity of pain in premature infants, standardized pain assessment tool is suggested to be used. As mentioned in the literature review, PIPP has been validated and reliable to use in infants’ gestational age ranging from less than 28 weeks to greater than 36 weeks (Pasero, 2002). The range of PIPP is between 0 and 21. Scores
with less than 7 are considered as minimal pain while scores greater than 12 means moderate to severe pain (Pasero, 2002).

Regarding the healthcare provider outcomes, it is essential to measure to NICU nurses’ satisfaction level to the new guideline. For measuring staff satisfaction level towards the new guideline, staffs are required to complete a self-report questionnaire (Appendix 9). It includes areas about (1) the clarity of the guideline, (2) competence of using the guideline, (3) any extra workload brought by the new intervention, (4) the effectiveness of pain relief on heel lance procedure, and (5) satisfaction towards the guideline. For each statement, they are required to express their viewpoint by using a 5-point Likert scale with 0 represent strongly disagree while 5 represents strongly agree. The total score range between 6 and 30. The result of the survey helps to evaluate the acceptance of the nurses.

**Nature and number of clients to be involved**

The inclusion and exclusion criteria would be the same as the protocol stated before. All preterm infants with gestation age of at least 26 weeks with no congenital abnormality and was hospitalized in NICU will be included. Infants who were intubated or put on intermittent positive pressure ventilation will be excluded. The optimal sample size will be calculated by using Java Applets for Power and Sample Size. From the previous reviewed studies, it is revealed that the PIPP score reduced 2
with the use of innovation (Stevens et al., 1999; Stevens et al., 2005). From the selected studies, the effect size is ranged from 0.51 to 0.54 (Gibbins et al., 2002; Stevens et al., 1999). Effect size of 0.54 from Stevens et al.’s study is adopted as the level of evidence is 1++. Thus, estimating the standard deviation is 3, effect size is 0.51, power is 0.8 and alpha is 0.05, the estimated sample size is 59. However, it is necessary to predict the potential loss of samples. Assuming the drop-out rate is 20%, around 75 samples is required.

**Timing and frequency of taking measurements**

Primary outcome would be measured right before lancing and 30 seconds after lancing. The staff satisfaction level would be measured during the mid-term of the implementation phase, i.e. week 16 and the end of implementation phase, i.e. week 32. The total number of adverse event will be counted at the end of the implementation.

**Data analysis**

After the implementation phase, the data collected will be entered into the computer system. The Statistical Package for the Social Sciences (SPSS) will be adopted. The three RNs of the committee will be responsible for inputting the data. The objective of the evaluation of the primary outcome is to compare the mean PIPP score of baseline, during lancing and post-lancing to determine the effect of the intervention. The significance level will be set at 0.05.
For the satisfaction level of the nurses, as it is measured using the 5-point Likert scale. The results will be reported with means and percentage.

**Basis for adopting the innovation**

It is essential to determine the effectiveness of the innovation before adopting in clinical setting. To determine whether it is effective, the validated pain assessment tool PIPP and questionnaires have been used. Data and statistics from previous reviewed literature are the reference for setting the criteria of effectiveness.

For the primary outcome, the mean PIPP score ranged between 7.8 and 8.1 among the four selected studies (Elserafy et al., 2009; Gibbins et al., 2002; Stevens et al., 1999; Stevens et al, 2005). The intervention will be considered as effective if the mean PIPP score calculated is 8.1.

The staff satisfaction level is another criterion for indicating whether to adopt the innovation. The total score range between 6 and 30 and score with 20 or above is considered as satisfaction. It is expected over 80% of nurses to report their satisfaction towards the new guideline. If the nurses do not support the new guideline, it will be difficult to maintain the compliance of nurses to follow the guideline.
Premature infants undergo multiple, painful, invasive procedures daily. Unlike adults or children, infants cannot tell us when they are in pain. It is uncommon to tell heel lance pain is not always managed optimally in relation to subtle pain response of preterm infants, and healthcare professionals may neglect the procedural pain management due to the belief that heel lancing is a minor procedure. It is clearly documented that infants may suffer adverse consequences in response to repeated painful procedures. It is therefore our responsibility as the caregivers to optimize comfort using evidence-based principles. A literature review indicated the combined use of oral sucrose and non-nutritive sucking can provide the most efficacious pain relief in heel lance procedure. After assessing the implementation potential of the innovation, it can be concluded that the proposed local NICU setting is fundamentally congruent with the innovation in terms of the philosophy of care, types of client served, organizational climate and availability of staff and resources. Thus, the evidence are assembled and translated into an evidence-based practice guideline. This guideline combines a synthesis and appraisal of research evidence with specific recommendations made.

The implementation and evaluation plan for the innovation are developed. The
primary outcome of the evaluation is the pain level of the premature infants. The result contributes to the decision of whether to adopt or modify the innovation. All in all, it is imperative for us to aware of the current evidence and integrate the best evidence available into our nursing practice. It does not only improve the quality of nursing care given to the premature infants, but also facilitate the response to professional practice questions.
References:


Hospital Authority. (2008). *Pain Assessment Record*. Hong Kong: Hospital Authority.


Walden, M., & Carrier, C. (2009). The ten commandments of pain assessment and

### Appendix 1: Search History

<table>
<thead>
<tr>
<th>Keyword</th>
<th>PubMed</th>
<th>CINAHL Plus</th>
<th>British Nursing Index</th>
<th>Cochrane Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature OR preterm OR neonate OR infant (S1)</td>
<td>1029757</td>
<td>31627</td>
<td>8187</td>
<td>38396</td>
</tr>
<tr>
<td>Sucrose (S2)</td>
<td>61966</td>
<td>771</td>
<td>40</td>
<td>1429</td>
</tr>
<tr>
<td>Nonnutritive sucking OR sucking OR pacifier (S3)</td>
<td>6035</td>
<td>111</td>
<td>95</td>
<td>510</td>
</tr>
<tr>
<td>Heel lance OR heel prick OR heel stick (S4)</td>
<td>455</td>
<td>21</td>
<td>36</td>
<td>193</td>
</tr>
<tr>
<td>S1 AND S2 AND S3 AND S4</td>
<td>26</td>
<td>2</td>
<td>1</td>
<td>31</td>
</tr>
</tbody>
</table>

- Articles remained after limited to RCTs 15 1 1 18
- Articles remained after screening title and abstract 10 1 1 12
- Articles remained after removal of duplicated with other databases 8 1 1 7
- Articles remained after screening full paper 4 0 0 0
- Manual search from the references of potential eligible studies 0
- Total 4
### Appendix 2: Table of evidence

<table>
<thead>
<tr>
<th>Bibliographic citation</th>
<th>Setting</th>
<th>Participants</th>
<th>Interventions</th>
<th>Comparison</th>
<th>Pain Evaluation</th>
<th>Results</th>
</tr>
</thead>
</table>
| **Stevens et al. (2005)¹** | A tertiary level NICU in Canada | 66 preterm infants with GA 26-30 weeks; no major congenital abnormalities | IG(1): 0.1ml sterile water with pacifier 2 minutes prior to heel lancing  
IG(2): 0.1ml 24% sucrose with pacifier 2 minutes prior to heel lancing | CG: Positioning and swaddling | PIPP | - Significant differences in PIPP scores between IG(2) & CG (p=0.01)  
- Lowest PIPP in IG(2)  
- Effect size could not be calculated as only mean pain scores provided |
| **Gibbins et al. (2002)²** | A tertiary level NICU in Canada | 190 neonates with GA 27-43 weeks; no major congenital abnormalities, stratified into 3 GA groups: (a) 27-316/7 weeks, (b)32-356/7 weeks, (c)36-43 weeks. Mean GA 33 weeks in all 3 treatment groups | IG(1): 0.5ml 24% sucrose with pacifier 2 minutes prior to, during, and 5 minutes following heel lancing  
IG(2): 0.5ml 24% sucrose alone | CG: 0.5ml sterile water with pacifier | PIPP | - Lowest mean PIPP scores in IG(I) at 30 and 60 secs  
- Significantly lower PIPP scores in IG(1) compared to IG(2) with effect size 0.51, p<0.002 and CG with effect size 0.68, p<0.001 |

IG = intervention group, CG = control group, GA = gestational age, NNS = nonnutritive sucking, PIPP = Premature Infant Pain Profile
<table>
<thead>
<tr>
<th>Bibliographic citation</th>
<th>Setting</th>
<th>Participants</th>
<th>Interventions</th>
<th>Comparison</th>
<th>Pain Evaluation</th>
<th>Results</th>
</tr>
</thead>
</table>
| Stevens et al. (1999)<sup>3</sup> | 4 tertiary level NICUs in Canada and United States | 122 very low birth weight infants with GA 27-31 weeks; mean GA 28 weeks; no major congenital abnormalities | Each infants received all 4 treatments in random order, and served as their own control  
IG(1): Pacifier dipped with 24% sucrose was given at 5 minutes & 2 minutes prior to heel lancing  
IG(2): Pacifier dipped with sterile water was given at 5 minutes & 2 minutes prior to heel lancing  
IG(3): Prone positioning | CG: side-lying/supine position with no pacifier or sucrose or other intervention | PIPP | - Lowest mean PIPP scores in IG(1)  
- Significant lower PIPP scores in IG(1) compared to CG (effect size of 0.54, p<0.0001) & IG(3) (effect size 0.67, p<0.0001)  
- Lower PIPP scores in IG(1) compared to IG(2) although statistical significance not achieved (effect size 0.16, p=0.155) |
| Elserafy et al. (2009)<sup>4</sup> | A tertiary level NICU in Jeddah | 36 preterm infants with GA 27-36 weeks, no major congenital abnormalities | Each treatment given 2 minutes prior to heel lancing:  
IG(1): 0.5ml sterile water with pacifier  
IG(2): 0.5ml sterile water without pacifier  
IG(3): 0.5ml sucrose 24% with pacifier  
IG(4): 0.5ml sucrose 24% without pacifier | CG: Standard of care or no treatment | PIPP | - Lowest pain score in IG(3), p<0.05  
- Effect size could not be calculated as only mean pain scores provided |
IG(5): Pacifier alone

IG = intervention group, CG = control group, GA = gestational age, NNS = nonnutritive sucking, PIPP = Premature Infant Pain Profile

List of articles
Appendix 3: Methodology Checklist 2: Controlled Trials

Methodology Checklist 2: Controlled Trials

Study identification  

Include author, title, year of publication, journal title, pages)

<table>
<thead>
<tr>
<th>Guideline topic:</th>
<th>Key Question No:</th>
<th>Reviewer:</th>
</tr>
</thead>
</table>

Before completing this checklist, consider:

1. Is the paper a randomised controlled trial or a controlled clinical trial? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a controlled clinical trial questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+

2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.

Reason for rejection: 1. Paper not relevant to key question ☐ 2. Other reason ☐ (please specify):

SECTION 1: INTERNAL VALIDITY

<table>
<thead>
<tr>
<th>In a well conducted RCT study...</th>
<th>Does this study do it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The study addresses an appropriate and clearly focused question.</td>
</tr>
<tr>
<td>1.2</td>
<td>The assignment of subjects to treatment groups is randomised.</td>
</tr>
<tr>
<td>1.3</td>
<td>An adequate concealment method is used.</td>
</tr>
<tr>
<td>1.4</td>
<td>Subjects and investigators are kept 'blind’ about treatment allocation.</td>
</tr>
<tr>
<td>1.5</td>
<td>The treatment and control groups are similar at the start of the trial.</td>
</tr>
<tr>
<td>1.6</td>
<td>The only difference between groups is the treatment under investigation.</td>
</tr>
</tbody>
</table>
1.7 All relevant outcomes are measured in a standard, valid and reliable way.  
| Yes □ | No □ | Can't say □ |

1.8 What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?  
| Yes □ | No □ | Can't say □ |

1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).  
| Yes □ | No □ | Can't say □ | Does not apply □ |

1.10 Where the study is carried out at more than one site, results are comparable for all sites.  
| Yes □ | No □ | Can't say □ | Does not apply □ |

**SECTION 2: OVERALL ASSESSMENT OF THE STUDY**

2.1 How well was the study done to minimise bias?  
*Code as follows:*  
- High quality (++) □  
- Acceptable (+) □  
- Unacceptable – reject 0 □

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?  

2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?  

2.4 **Notes.** Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.
Appendix 4: Internal validity assessment

<table>
<thead>
<tr>
<th>Bibliographic citation</th>
<th>Clearly focused questions</th>
<th>Random assignment</th>
<th>Adequate concealment</th>
<th>Double-blinded treatment allocation</th>
<th>Comparable groups</th>
<th>Treatment is the only difference</th>
<th>Reliable outcome measurements</th>
<th>Drop-out rate</th>
<th>Intention to treat analysis</th>
<th>Comparable results for all sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stevens et al. (2005)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>2.94%</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Gibbins et al. (2002)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0%</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Stevens et al. (1999)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0%</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Elserafy et al. (2009)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0%</td>
<td>Yes</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA=Not applicable
### Appendix 5: Overall assessment of the study

<table>
<thead>
<tr>
<th>Bibliographic citation</th>
<th>Bias minimized</th>
<th>Effect due to the study intervention</th>
<th>Results applicable to target groups</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Stevens et al. (2005)  | ++             | Yes                                  | Yes                                 | - Good randomization and concealment method.  
- The intervention was adequately described.  
- Heel lance procedure was standardized to minimize variation. |
| Gibbins et al. (2002)  | ++             | Yes                                  | Yes                                 | - Large sample size.  
- Good randomization and concealment method.  
- Infants in control group received pain management strategies due to ethical reason; the effects among treatments may not be clearly shown.  
- Heel lance procedure was standardized to minimize variation. |
| Stevens et al. (1999)  | ++             | Yes                                  | Yes                                 | - Large sample size.  
- Heel lance procedure was standardized to minimize variation.  
- Randomization procedure was clearly defined.  
- Each infant served as its own control as they were exposed to all experimental conditions. Individual differences were removed from the treatment effect.  
- The intervention was described in details.  
- The study results were comparable at different participating hospitals |
| Elserafy et al. (2009) | +              | Yes                                  | Yes                                 | - Good randomization and concealment method.  
- Small sample size.  
- Details for conducting heel lance procedure were not stated. |

(++) = High quality; (+) = acceptable; (0) = unacceptable

### LEVEL OF EVIDENCE

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+++</td>
<td>High quality meta-analyses, systematic reviews of RCTs or RCTs with a very low risk of bias</td>
</tr>
<tr>
<td>1+</td>
<td>Well conducted meta-analyses, systematic reviews or RCTs with a low risk of bias</td>
</tr>
<tr>
<td>1-</td>
<td>Meta-analyses, systematic reviews or RCTs with a high risk of bias</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of case control or cohort studies</td>
</tr>
<tr>
<td></td>
<td>High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>2+</td>
<td>Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal</td>
</tr>
<tr>
<td>2-</td>
<td>Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies, e.g. case reports, case series</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

### GRADES OF RECOMMENDATION

*Note: The grade of recommendation relates to the strength of the evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation.*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At least one meta-analysis, systematic review or RCT rated as 1+++ and directly applicable to the target population; or</td>
</tr>
<tr>
<td></td>
<td>A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population and demonstrating overall consistency of results</td>
</tr>
<tr>
<td>B</td>
<td>A body of evidence including studies rated as 2++, directly applicable to the target population and demonstrating overall consistency of results; or</td>
</tr>
<tr>
<td></td>
<td>Extrapolated evidence from studies rated as 1++ or 1+</td>
</tr>
<tr>
<td>C</td>
<td>A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or</td>
</tr>
<tr>
<td></td>
<td>Extrapolated evidence from studies rated as 2++</td>
</tr>
<tr>
<td>D</td>
<td>Evidence level 3 or 4; or</td>
</tr>
<tr>
<td></td>
<td>Extrapolated evidence from studies rated as 2+</td>
</tr>
</tbody>
</table>
Appendix 7: Premature infant pain profile (PIPP)
Baseline: Heart rate:________ beats/min; oxygen saturation (SpO₂): _____%
Date: __________; Time: __________

<table>
<thead>
<tr>
<th>Process</th>
<th>From chart</th>
<th>Indicator</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age</td>
<td>0: ≥ 36 weeks</td>
<td>1: 31-35 6/7 weeks</td>
<td>2: 28-31 6/7 weeks</td>
</tr>
<tr>
<td>Behavioral state</td>
<td>0: active/awake (eyes open, facial movements)</td>
<td>1: quiet/awake (eyes open, no facial movements)</td>
<td>2: active/sleep (eyes closed, facial movements)</td>
</tr>
<tr>
<td>Maximum heart rate</td>
<td>0: 0-4 beats/min increase</td>
<td>1: 5-14 beats/min increase</td>
<td>2: 15-24 beats/min increase</td>
</tr>
<tr>
<td>Minimum oxygen saturation (SpO₂)</td>
<td>0: 0-2% decrease</td>
<td>1: 3-4% decrease</td>
<td>2: 5-7% decrease</td>
</tr>
<tr>
<td>Brow bulge</td>
<td>0: None (0-9% of time)</td>
<td>1: Minimum (10-39% of time)</td>
<td>2: Moderate (40-69% of time)</td>
</tr>
<tr>
<td>Eye squeeze</td>
<td>0: None (0-9% of time)</td>
<td>1: Minimum (10-39% of time)</td>
<td>2: Moderate (40-69% of time)</td>
</tr>
<tr>
<td>Naso-labial furrow</td>
<td>0: None (0-9% of time)</td>
<td>1: Minimum (10-39% of time)</td>
<td>2: Moderate (40-69% of time)</td>
</tr>
</tbody>
</table>

Total PIPP score

(Hospital Authority, 2008)
Appendix 8: Checklist for use of oral sucrose solution with non-nutritive sucking to reduce heel lance pain in premature infants in the NICU.

Please tick the appropriate box.

<table>
<thead>
<tr>
<th>Item</th>
<th>Pass</th>
<th>Fail</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assess infant’s vital signs and baseline PIPP score.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Dosage of 0.1ml to 0.5ml of oral sucrose solution is used.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The oral sucrose solution is administered two minutes prior to the heel lance procedure.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. The oral solution is applied to the anterior surface of the tongue of the infant.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Provision of a pacifier followed by administration of oral sucrose solution.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Obtain PIPP score during lancing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Evaluate infant’s vital signs and PIPP score five minutes following lancing, and observe for any adverse events.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 9: Satisfaction survey for healthcare providers on the use of oral sucrose solution with non-nutritive sucking to reduce heel lance pain in premature infants in the NICU.

Please circle the most appropriate answer.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think the guideline is clear and easy to understand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I think there is adequate support from the committee.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I think this innovation does not create extra workload to healthcare providers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I am competent in carrying out the innovation.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. The innovation is effective in relieving heel lance pain.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I support the innovation.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>