

The Use of Sucrose as an Analgesic in Infants

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Abstract

The use of sucrose in infants undergoing painful procedures is not a new phenomenon. Nursing professionals have performed much valuable research to support the use sucrose in clinical settings that treat children less than 12 months of age. This paper is a review of literature giving evidence and guidelines for sucrose usage. A combination of twelve studies and study reviews published in the past decade were helpful in establishing recommendations for evidenced based practice regarding the use of sucrose to reduce the pain of infants undergoing procedures. This review by Ferris State University (FSU) students in Nursing 350 summarizes the evidence provided by these studies, assesses their value, and makes recommendations concerning their utilization.

The Use of Sucrose as an Analgesic in Infants

There has been a history of using sweet tasting solutions for their analgesic properties in infants documented as far back as 632 AD (Harrison, 2008, p.39). Sweet suckers laced with opium or cocaine and alcohol were often given to newborns to calm the infant or to treat colic. In 1938, it was recommended that a sugar water sponge could often replace anesthesia for infants undergoing surgery (Harrison, 2008, p.40). Despite this history, it was not until 1991, that a randomized control trial published by Blass and Hoffmeyer demonstrated the effectiveness of sucrose in relieving pain related to procedures (Harrison, 2008, p.40). Today a large body of evidence supports the use of sucrose for relief of mild to moderate procedural pain in infants. The sweet taste of sucrose on the tongue is thought to trigger an opioid release in the infant (Dalglish, 1999, p. 20). Low volumes are possible because it is the taste not the absorption that triggers this release. This treatment is recommended by the American Academy of Pediatrics, the Canadian Paediatric Society, and other professional organizations concerned with the care of infants (Harrison, 2008, p.40). Unfortunately, “infrequent utilization of oral sucrose in the clinical setting has been reported (Fernando et al., 2001; Gray et al., 2006; Harrison et al., 2006; Rohrmeister et al., 2003)” (Harrison, 2008, p.40). This review by Ferris State University Nursing 350 students will respond to this problem from the viewpoint of their individual clinical settings.

In 1979, the International Association for the Study of Pain (IASP) defined pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (Gibbins, Stevens, Hodnett, Pinelli, Ohlsson, & Darlington, 2002, p 375). They emphasize “that the inability to communicate in no way negates the possibility that an individual is experiencing pain and is in need of appropriate pain relieving

treatment” (Gibbins, et al., 2002, p.375). Our non-verbal patients depend on nurses to be able to accurately assess and treat their pain. Infants were once thought to be too neurologically immature to feel “real” pain and it was once thought that their pain was a transient and inconsequential event (Dalglish, 1999, p. 18). It is now recognized that if we do not intervene in the painful experiences of our smallest non-verbal patients, there are both short and long-term consequences. The “long term effects of unmanaged pain in human infants have been shown to include permanent impairment of elements of cognitive development, including learning, memory, and behavior, and increased somatization in childhood....Early painful experiences affect children’s future response to analgesia” (Hatfield, Gusic, Dyer, & Polomano, 2008, p. e328). “Pain is known to cause a significant stress response in both term and pre-term babies.... It is unethical to ignore pain relief measures for any baby” (Dalglish, 1999, p. 18). It is our ethical responsibility, as nurses caring for infants, to be competent in our pain assessments with the use of appropriate assessment tools and be aware of current literature involving the treatment of that pain. The aim of this study is to examine what the literature says about sucrose for pain in infants. We will examine the evidence produced by research, determine its value and recommend utilization of the evidence.

Descriptive Summary of Research

Studies of Term Neonates and Older Infants

There are quite a few studies on the effects of sucrose in the neonate but only a few studies that involve older infants. In the randomized controlled trial of sucrose and or pacifier as analgesia for infants receiving venipuncture in a pediatric emergency department, the researchers, Curtis, Hsing, Ali, Vandermeer, & Klassen (2007), anticipated that the use of sucrose with or without pacifiers is useful for infants undergoing assessment in pediatric

emergency departments. This study was performed on infants 0-6 months of age. Sampling size was 84 patients chosen randomly to receive one of the four options, sucrose, sucrose and pacifier, control, and control and pacifier. The size and randomness was appropriate to get enough data to represent the aggregate (Curtis, Hsing, Ali, Vandermeer, & Klassen, 2007). The infants were evaluated using the FLACC pain scale score, heart rate and crying time. The FLACC scale consists of assessing facial expression, leg position, activity pattern, presence of crying, nature of cry, and ability to be consoled (Atkinson, Chesters, & Heinz, 2009). "Sucrose did not significantly reduce the FLACC score, crying time or heart rate. However, sub-group analysis revealed that sucrose had a much greater effect in the younger groups. Pacifier use reduced FLACC score (not statistically significant), crying times (statistically significant) but not heart rate" (Curtis, 2007, para 3).

In this study a variety of measures were used, adding to the validity of this trial. Pain scale, crying time and heart rate were given a baseline and measured from this baseline after venipuncture. By starting with an individual baseline and measuring the change, differences in tolerance and vital signs can be accounted. Consent was gathered from the parents and the trial was explained. Ethical considerations such as children too ill or who did not meet the criteria were not included in this study (Curtis, Hsing, Ali, Vandermeer, & Klassen, 2007).

Curtis, Hsing Ali, Vandermeer, & Klassen, 2007, concluded their study demonstrates "The use of pacifier with sucrose as procedural analgesia for venipuncture in the pediatric emergency room is effective in reduction of pain in infants 0-3 months old, as shown by decreased in cry times" (Curtis et al., 2007). The study also goes on to say the use of sucrose is "inexpensive, easy to use, quick onset, short duration of action, and no serious side effects" (Curtis et al, 2007).

One thing that should be recognized in studying pain in children is that a large observational study "found little evidence for using abnormal physiology- such as tachycardia, tachypnea, and hypertension- to screen for severe pain" (Atkinson, Chesters, & Heinz, 2009, p. 1074). This tells us that we cannot rely solely on physiological symptoms, but we need to look for other signs. Atkinson, Chesters, and Heinz (2009) tell us "behaviour is the main way that infants and preverbal children communicate their pain" (p. 1074). Researchers have studied children's behaviors with pain and have developed pain assessment tools for children such as the CHEOPS scale and the FLACC scale.

According to a study published in the British Medical Journal, as reported by Smith in Global Medical News, glucose and sucrose solutions are effective analgesics in infants as old as twelve months during immunizations (2010). To reach this conclusion, researchers identified fourteen randomized controlled trials to study the analgesic effects of sucrose or glucose solutions on children. These solutions were administered orally prior to 1,600 immunization injections from 1-12 months of age (Smith, 2010). The concentrations varied widely among the trials. In ten of the trials, sucrose concentrations ranged from 12% to 75%. In three of the trials, a 30% concentration of glucose was used. In one trial, a combination of two sucrose solutions (25% and 50%) and a 40% glucose solutions was used (Smith, 2010). In all of the cases, sucrose was administered 2 minutes prior to immunization. Each child received 2 milliliters of the sugar solution. Controls consisted of an equal amount of water or no treatment (Smith, 2010).

To measure the effects that sucrose had on infants receiving immunization injections, most studies used crying incidence, intensity, or duration as a measure of pain; some used composite pain scores developed for infants. One study measured salivary cortisol before and after immunization and control groups (Smith, 2010). The result is that the more concentrated

solutions tended to produce better results in the reduction of “crying incidence, crying duration, and composite pain scores during and following immunization” (Smith, 2010, para.9).

A review of randomized controlled trials (RCTs) comparing the “efficacy of sweet solutions to water or no treatment in infants aged 1-12 months during immunization” (Harrison, Stevens, Bueno, Yamada, Adams-Weber, & Beyene, 2010, p. 406) was published in February of this year. The authors identified 14 RCTs for use in determining the efficacy of glucose and sucrose during immunizations. They found that using sucrose or glucose, while more moderately effective in infants older than newborn, was still effective in reducing the “incidence and duration of crying,” and concluded that, “healthcare professionals should consider using sucrose or glucose before and during immunization” (Harrison et al., 2010, p. 406). The authors found a small amount of evidence to suggest that older infants had more effective pain relief with higher concentrations of sweet solutions given in divided dosages during more prolonged painful procedures (Harrison et al., 2010, pp. 411-412). They referred to the Blass study in which “sweet taste mediated analgesic effects peaked at 2 minutes and lasted for between 3 and 5 minutes, an interval considered to coincide with endogenous opioid release” (Harrison et al., 2010, p. 411). This study is deemed reliable in format, inclusion of peer reviewed studies, and published in a widely reviewed journal. It is effective as a secondary analysis study, which Nieswiadomy calls, “an efficient and economical” study method (Nieswiadomy, 2008, p. 163).

Hatfield, Gusic, Dyer, and Polomano studied the pain responses of 83 two and four-month old infants in a RCT during their routine immunizations (2008). The 38 infants that received a 24% oral sucrose solution with pacifier showed a reduction in pain scores compared to the 45 children in the placebo (water and pacifier) group based on the Wisconsin Children’s Hospital Pain Scale (UWCH). The sucrose treated group returned to normal 9 minutes after the

last injection, whereas, the placebo group still reported a mean pain score of 2.91 at 9 minutes based on the UWCH pain scale showing a 78.5% difference. A recognized strength of this study was that all infants received the same dose of sucrose (Hatfield et al., 2008, p. e331).

Taddio, Pollock, Gilbert-Macleod, Ohlsson, and Koren conducted a study to determine if combining a sucrose pacifier with other analgesics would decrease the pain response in infants during circumcision. The study involved 86 infants and two different methods of circumcision. The study concluded that "infants circumcised with the Mogen clamp and combined analgesia have substantially less pain than those circumcised with the Gomco clamp and lidocaine/prilocaine cream" (Taddio et al., 2000, para 1).

The Cochrane Review concluded that the evidence supported "the efficacy and safety of sucrose for reducing pain from single and repeated heel lances" (Stevens, Yamada, & Ohlsson, 2010, p. 57). They called for more research regarding the use of sucrose for other painful procedures due to conflicting evidence. They state that "sucrose reduces procedural pain with minimal to no side effects," and recommend that "0.012 to 0.12 g of sucrose should be administered approximately two minutes prior to single heel lances and considered for use with venipunctures for pain relief in neonates" (Stevens, Yamada, & Ohlsson, 2010, p. 57). They also conclude that "other methods of pain relief, including non-nutritive sucking, should be considered in combination with sucrose to significantly reduce or eliminate pain in this population. "Effective knowledge translation strategies are required to effectively translate research evidence on sucrose into practice" (Stevens, Yamada, & Ohlsson, 2010, p. 57).

Studies of Preterm Infants

A small study (36 infants) published in late August of last year looked at the use of sucrose in preterm infants (mean 31 weeks gestational age, range 27 to 36 weeks). They

concluded that their own research combined with previous research shows that “the synergistic effect of the combination of sucrose and nonnutritive sucking is a statistically and clinically effective and safe intervention for relieving pain during simple procedures as venipuncture or heel stick in pre term and term infants” (Elserafy, Alsaedi, Louwrens, Sadiq, & Mersale, 2009, p. 187). They also iterate the call for research on combination interventions and “clinical outcomes in very low birth weight neonates in the NICU” (Elserafy, et al., 2009, p. 187).

Gibbins et al. researched 190 preterm and term neonates admitted to Neonatal Intensive Care Units on the differences in pain responses regarding the use of sucrose with heel lances. The neonates were divided into 3 groups, sucrose with non-nutritive sucking (pacifier), sucrose alone, and water with pacifier. A significant decrease in pain response was noted in the sucrose with pacifier group with no noted difference with gestational age or severity of illness seen (Gibbins et al., 2002, p. 380-81).

A study of 103 infants born at less than 31 weeks gestation by, Johnston et al., 2002, to determine “if procedural pain were adequately managed in the first week of life in preterm neonate, then there might be positive long-term development effects”(p. 524), concluded an opposite effect than hypothesized. While pain was relieved, there was poorer neurobehavioral development and physiologic outcomes on the less than 31 week preterm infants, when assessed at 36 and 40 weeks gestational age, with the more doses of sucrose they received. Johnston et al. admits to poor compliance at one study site, small study size, and length of study as possible reasons for the unexpected result. At this time, they do not recommend routine sucrose analgesia for infants less than 32 weeks gestation. A similar study in 2005, by Stevens et al, “did not show any such association between sucrose use and adverse outcomes” (Harrison, 2008, p. 42). The

Stevens study was of longer duration, thus thought to be more accurate by Harrison (2008, p. 42).

Critical Appraisal of Evidence

Cochrane reviews “are based on the best available information about health care interventions. These reviews provide evidence for and against the effectiveness and appropriateness of treatments which include medications, surgery, and educational programs” (Nieswiadomy, 2008, p. 365). This year Cochrane published a review of 44 studies on the use of sucrose for analgesia in newborns undergoing painful procedures. Their search included studies published through August 24, 2009. They excluded studies including children over 28 days old.

Stevens (2010), as published in a Cochrane review, suggests more research on optimal dose and the interaction of sucrose with other pain interventions. They also suggest further research on the use of sucrose with other painful procedures and the use in older infants and neonates that are extremely low birth weight or unstable.

Evidence is provided in the study by Curtis (2007) that the use of sucrose is effective in the younger infants, but has little effect on older infants. One limitation to this study was the age group of 3-6 months was under represented compared to those 0-3 months of age. "Further study to clarify effects of age and sucrose concentrations, as well as effectiveness for other painful procedures is required" (Curtis, 2007).

The study by Hatfield et al.(2008) is one of a few studies demonstrating the effectiveness of sucrose for management of mild pain in older infants of 2 and 4 months. An advantage of this study was the uniform dosing of the infants. All infants were given the same dose of sucrose. This was identified as an important addition to the literature since it had not been shown in previous studies in older infants. The advantages to using sucrose include that it is “inexpensive,

short acting, nonsedating, easily administered, noninvasive and commercially available” (Hatfield et al, 2008, p. e332). It is hoped, that by reducing the pain during the many immunizations received by infants early in their lives, parents will be more compliant with following immunization schedules. One of the weaknesses of the study was the way the immunizations were given over a period of seven minutes with sucrose given 2 minutes prior. It is not practical to think a busy immunization clinic has this kind of time to administer injections (Hatfield et al., 2008, p. e332).

The studies of Elserafy, et al., 2009, Johnston et al., 2002, Stevens et al, 2005 (as cited by Harrison, 2008, p. 42), and Gibbins et al., 2002, all demonstrated effective pain reduction during minor procedures such as heel lances in infants in the Neonatal Intensive Care Unit (NICU). In most of these studies, it is inconclusive if the use of sucrose has long-term effects. Only one study, Johnston et al. (2002), demonstrated a negative developmental effect on preterm infants. Contrary to this study, a similar but larger study by, Stevens et al. (2005), did not show the negative developmental effect and recommended additional studies. Other studies also recommended additional studies on long-term outcomes.

The evidence supports the use of sucrose in infants as a mild analgesic. Sucrose has been demonstrated as a simple, inexpensive and effective pain reliever for mild pain in infants without side effects. Further study needs to be done on the effectiveness in older infants, standardizing doses, and the long-term effects on the preterm neonate.

Integration of Evidence

Denise Margaret Harrison identifies eight sucrose myths from questions frequently asked during pain management and sucrose use in infant lectures (2008, p.40). “These questions have been titled the eight .sucrose myths, and are summarized as follows:

1. Not “baby friendly”
2. Grows bacteria
3. Risk of dental caries
4. Increased risk of poor neurological outcomes in infants less than 32 weeks
5. Increases risk of necrotizing enterocolitis
6. Results in hyperglycaemia
7. Not effective in older babies
8. Repeated doses lead to development of tolerance to sucrose” (Harrison, 2008. p.40).

Harrison refutes these myths in her article *Oral sucrose for pain management in infants: Myths and misconceptions* (2008). Three of the myths are directly related to the newborn care of well infants at Munson Medical Center and are the barriers for utilization of sucrose for mild to moderate painful procedures in newborns. The myth that sucrose is not baby friendly combined with the myth that it results in hyperglycemia are the primary reasons sucrose is not used during heel lances and injections of well newborns at Munson Medical Center. The Baby Friendly Health Initiative (BFHI), started in 1991, is an effort by the United Nations Children’s Fund (UNICEF) and the World Health Organization (WHO) to encourage breastfeeding globally (Harrison, 2008, p. 39). The policies of BFHI are meant to encourage only breast milk without supplements during the early months of life. In addition, sucrose is thought, at Munson, to raise infant blood sugars decreasing the natural tendency to want to breast feed. In a personal communication to the author, Ms. Harrison, dated November 24, 2006, the manager of the Australian BFHI “stated that oral sucrose for the purpose of procedural pain management did not contravene the BFHI principles, and furthermore was endorsed by the BFHI as an evidence-based pain management strategy (Kylie Campbell, Manager Baby friendly Health Initiative,

2006)” (Harrison, 2008, p. 40). Ms Harrison disputes the hyperglycemia myth by citing the results of both Johnston and Stevens as having no differences in blood glucose levels between the sucrose and water groups in their preterm neonate studies. In addition, she recognizes the minimal amount of sucrose that is used on the tongue rather than the volume needed to be absorbed in the gut to raise blood sugar (Harrison, 2008. P. 43). The third myth identified, as a barrier at Munson is that sucrose grows bacteria has been eliminated with the availability of unit dosing of sucrose.

It is difficult to inflict even mild pain on a newborn when knowing that a simple sucrose pacifier can relieve that pain. It is even more difficult to reassure parents that these mild invasive procedures accompanied by pain are part of the “norm” when the pain can be managed simply with little expense. The evidence suggests there are significant benefits to the use of sucrose in pain management of mild painful procedures in the newborn and young infant. Further studies are needed on the long-term effects on the pre-term neonate.

Conclusion - Recommendations for Use

We recommend the use of sucrose as a mild analgesic for infants, and make the following suggestions, based on the evidence of these studies:

1. Rather than relying upon physiological indicators to determine pain in children under 12 months of age, the use of FLACC or CHEOPS scales are more accurate in assessing pain at this age.
2. Painful procedures performed on children less than 12 months of age include immunizations, heel sticks, intravenous catheter insertion, and circumcision.
3. Sucrose and, when possible, pacifier sucking should be utilized 2 minutes prior to painful procedures, and repeated at 3-5 minute intervals.

Holland Hospital Emergency Department currently stocks sucrose in their unit Pyxis for use in painful procedures on infants. The use is sporadic and unit education should be considered to increase the use of this intervention. Group member, Barbara Van Der Male, will summarize this evidence for use in the Holland Hospital ED monthly education folder. The proof is strong that sucrose diminishes pain for this population, but the intervention would also be witnessed by anxious parents, who may find comfort and assurance that staff is concerned for the pain as well as the well-being of their children.

Group member, Patricia Kraemer, will educate the Munson Medical Center nurses and infant care providers on the myths of sucrose and eliminate the perceived barriers of sucrose not complying with the BFHI. This will allow for the initiation of the use of sucrose to comfort newborns during routine immunizations and the sometimes many painful heel sticks in their first 24-48 hours of life. (Sucrose is already used during circumcision.) In addition, the Munson parents may also be relieved as well as staff nurses that care is being taken to address the discomfort of their newborn.

The needs of children less than 12 months of age can be better met by adopting the results of these studies in setting that treat this population. We encourage clinicians to give careful consideration to how these studies can best be implemented to reduce the pain of young children receiving treatments.

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