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Sucrose Use in Children: A Systematic Review

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Walden University

College of Health Sciences

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Dorothy Luongo

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2017

Abstract

Sucrose Use in Children: A Systematic Review

by

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FNP, Walden University, 2013

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

Walden University

October 2017

Abstract

Sucrose is a method of pain relief that can be used for children during minor painful procedures. Pain left unrelieved has been found to lead to long-term consequences such as distress, anxiety, needle fear, parental non-adherence with vaccination administration, and avoidance of medical care. Therefore, it is important to ensure pain management methods are provided to infant and toddlers. The purpose of this project was to present a systematic review on the use of sucrose in child in primary care. The comfort theory by Kolcaba served as the theoretical framework in exploring the use of sucrose in children in primary care. A comprehensive search was completed and 37 articles pertaining to the use of sucrose were identified. The articles were appraised using Fineout-Overholt, Melnyk, Stillwell, and Williamson's critical appraisal guide and then categorized using Melnyk and Fineout-Overholt's level of evidence system. This systematic review revealed that 85 percent of the articles identified found sucrose to be an effective method of pain relief for children during minor painful procedures. This systematic review gives a final recommendation that sucrose should be used for pain relief during minor painful procedures for children up to 18 months of age. Future studies should be focused on translating this evidence into practice guidelines to narrow the knowledge to practice gap. The creation of practice guidelines would bring about a positive social change for infants and toddlers by providing pain relief methods such as sucrose in daily practice reducing anxiety and needle fear for children and their parents, increasing vaccine and medical care adherence.

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Dedication

This paper is dedicated to my husband, my daughter and my mother:

- Chloe, my daughter, throughout my journey has been my biggest cheerleader and #1 fan. Her unconditional love and support has helped me to persevere through many years of schooling to accomplish my final goal.
- Dominic, my husband has sacrificed throughout the years to help me accomplish my dream. His support throughout the years has been unwavering.
- Bernice, my mother, has been there throughout my entire nursing journey and has continually helped to push me forward to complete this terminal degree. I wouldn't be where I am without her support.

You have all been my greatest source of motivation and inspiration and without all of your love and support I would have never made it as far as I have!

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I would like to thank my committee members, Dr. Amelia Nichols and Dr. Susan Hayden, not only for your support but also for all of your help with my many grammar mistakes. I am grateful for your assistance in bringing this journey to completion.

To my husband, Dominic, and my daughter, Chloe, your sacrifices throughout the years have not gone unnoticed. Thank you for your patience, love, strength, and for tolerating all of the time I have been away or not available. Chloe, thank you for being my cheerleader and number 1 fan! Your pride in me has helped to light the way in the dark. Let my journey be an example of how to persevere through life and accomplish your goals, but also what to avoid so you don't have to learn the hard way as I have.

A very special thanks to my parents, Bernice and Denis Glaude, to whom I owe everything I am today. Your faith and confidence in my abilities, even when I doubted

myself, has helped me to stand where I am today. Thank you so much for everything, your support through the ups and downs is priceless.

To my sister, Katrina, thank you for all of your support and for being available for all of the times I've needed to vent. I hope now that we have both completed our final degrees that we have more time for sister trips and tackling our ever growing bucket lists!

While there are many more to thank and acknowledge that would result in this list going on forever. Thank you to all of the friends, family, and co-workers who have cheered me on throughout this journey, you know who you are! Your support, advice, kind words, or just friendship, no matter how big or small your contribution has been, it has helped me bring this journey to completion.

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Section 1: Nature of the Project

Introduction

Pain is considered a universal vital sign, and it should be assessed during all patient encounters. Pain in adults and older children is documented and addressed in every patient encounter. Yet, for the youngest patients who are unable to verbalize their pain scores, pain is often not assessed or addressed. Unrelieved pain has been found to lead to long-term consequences. According to Harrison, Elia, Manias, and Royale (2014), unrelieved pain can “result in distress and anxiety for infants and children and their parents as well as risks of longer term fears of needle pain, parental non-adherence with vaccination administration, and avoidance of medical care” (p. 20).

The use of sucrose for pain in infants and neonates has been studied since the first randomized controlled trial using sucrose was published in 1991 (McCall, DeCristofaro, & Elliott, 2013). The first study for the use of sucrose in infants was by Blass and Hoffmeyer (1991) who found a 31% reduction in crying when using a pacifier during circumcisions and a 69% reduction in crying when sucrose and a pacifier was used together. Sucrose is a simple method of pain relief that is easy to administer, inexpensive, and has proven effectiveness (Wilson, Bremmer, Mathews, & Pearson, 2013). The aim of this study was to conduct a systematic review of the literature on the use of sucrose for children in primary care to advocate for positive social change in pain management techniques for children during painful procedures.

Problem Statement

Immunizations and minor office procedures, such as heel sticks, finger sticks, blood draws, injections, and suture placement/removal, are the most common type of procedures conducted in the primary care setting. These procedures and immunizations can be distressing to the patient and parents. Children up to the age of 2 may undergo as many as 24 immunizations by injection, depending on immunization schedule and available formulations (Rishovd, 2014). Harrison, Elia, Royle, and Manias (2014) noted that these procedures result in “anxiety for the infants and children and their parents as well as risks of longer term fears of needle pain, parental non-adherence with vaccination and administration and avoidance of medical care” (p. 20). In addition, early exposure to painful procedures and immunizations sets the stage for future fearful, anxiety-filled responses (Yilmaz, Caylan, Oguz, & Karacan, 2014).

Using sucrose for pain management in newborns and infants has been studied in many different areas of practice around the world. Harrison, Beggs, and Stevens (2012) stated that there have been over 150 studies done on this subject either using sucrose or other sweet-tasting substances for analgesia. Many of these studies have led to guideline changes in newborn nurseries to include the use of sucrose for neonates before any painful procedure (Lago, Garetti, Pirello, Merazzi, Bellieni, Savant Levet, ... Ancora, 2009). Yet, despite all of the available evidence beyond the neonate period, there are no guidelines to support the use of sucrose for children.

Purpose Statement

The purpose of this project was to conduct a systematic review of the literature supporting the use of sucrose for the management of pain in children. A systematic review was conducted following the steps outlined by Khan, Kunz, Kleijnen, and Antes (2005). These five steps consisted of framing the question to be reviewed, identifying the relevant studies, appraising the quality of the studies, summarizing the evidence, and synthesizing the results into easy to read format. The practice-focused question was the following: What is the current evidence supporting the use of sucrose for pain management in children in primary care?

Nature of the Doctoral Project

In this doctoral project, I explored the evidence on the use of sucrose in children. A systematic review is considered an “essential tool for summarizing evidence accurately and reliably providing a comprehensive high-level summary of primary research to a specific question” (Wardle & Steel, 2015, p. 103). Systematic reviews “increase statistical power and ability to discover potentially meaningful findings and to help identify gaps and methodology flaws in the existing literature” (Bin-Riaz, Shahzeb Khan, Riaz, & Goldberg, 2016, p. 339.e11). A systematic review was conducted by accessing databases including CINAHL, MEDLINE, OVID, and ProQuest. Search methodology, terms, and results will be discussed later in Section 3. This systematic review provides a summary of the available evidence to help support further decision making to help narrow the knowledge-practice gap.

Significance

Sucrose is easy to obtain, inexpensive, has few side effects, and is easy to administer, making it a good solution for use in pediatrics (Wilson et al., 2013). Despite all of the presenting evidence on the benefits of relieving pain in children, little has been translated to practice (Harrison et al., 2012). In this project, I assessed the current body of evidence to determine if there is enough evidence available to support the use of sucrose and bring about a social change for these children. It has been determined that the evidence supports the topic, so the next step was the translation of the evidence into practice. The identified stakeholders for this project are medical and nursing providers who work with children, parents, and children. The identified stakeholders would be impacted once the supporting evidence is translated into daily practice through guideline development.

Summary

The purpose of Section 1 was to provide the background information on this project. I presented the project question, purpose of the study, nature of the study, and why it is important to practice pain management techniques for the youngest patients. The use of sucrose has been well studied and takes minimal time and training; yet, it is underused despite the supporting evidence. Section 2 of this project provides the supporting framework and background information for this project.

Section 2: Background and Context

Introduction

Sucrose is an underused tool that has been shown effective for pain management in children, but is not used in practice despite supporting evidence. In this section, the focus will be on the theoretical framework that guided this project, the relevance this project has to nursing practice, the background information including the logistics of the project, and the role of this author as the DNP student in relation to this project.

Concepts, Models, and Theories

Theoretical Framework

Pain management is an integral part of nursing. Preventing or treating pain in any patient from the young to the old should be a priority. For the purpose of this project, the comfort theory by Kolcaba served as the theoretical framework towards the use of sucrose in children (Kolcaba & DiMarco, 2005). Kolcaba's comfort theory is a perfect fit for this practice-focused question (Kolcaba & DiMarco, 2005). Using the practice-focused question, I attempted to determine if there is enough evidence to support a method that can provide a form of physical comfort. There are many procedures that inflict pain and discomfort for these children. If there is an inexpensive and easy way to provide comfort, then medical and nursing providers should do so.

Comfort is defined as the “the immediate state of being strengthened through having the human needs for relief, ease, and transcendence addressed in four contexts of experience (physical, psycho-spiritual, socio-cultural, and environmental)” (Kolcaba &

DiMarco, 2005, p. 189). In Kolcaba's theory, there are three types of comfort: relief that is the "state of having a specific comfort need met," ease that is the "state of calm or contentment," and transcendence that is "the state in which one can rise above problems or pain" (Kolcaba & DiMarco, 2005, p. 189). Kolcaba also defined the contexts in which comfort may occur. There are four total contexts: physical "pertains to bodily sensations and homeostatic mechanisms," psycho-spiritual "pertaining to internal awareness of self," environmental "pertaining to the external background of human experience," and sociocultural pertains "to interpersonal, family, and societal relationships" (Kolcaba & DiMarco, 2005, p. 189).

Sucrose use provides comfort in the physical context and fits into all three forms of comfort. By using sucrose, medical providers are providing a form of pain management, meeting the need for comfort by the patient. Sucrose also provides a state of calm and aides the patient to rise above the pain. Kolcaba pioneered the comfort theory, which has been used in multiple areas of nursing, including pediatrics, since 1994 (Kolcaba & DiMarco, 2005).

In nursing education, the first concepts often learned are the 6 C's, which are considered the core values of nursing: care, compassion, competence, communication, courage, and commitment (Wood, 2016). Within the act of caring is the art of providing comfort for patients (Wood, 2016). Part of the art of providing comfort for patients is providing pain management to all patients, including pediatrics.

Relevance to Nursing Practice

Nurses provide pain medication for all patients. For many years, newborn nurseries around the world have been providing standard orders that include the use of sucrose for neonates before any painful procedure (Lago et al., 2009). While there has been evidence to expand this practice to older children past the neonate period, there has been little done to identify the available evidence and translate that evidence into practice.

The American Nurses Association (ANA, 2015) Code of Ethics requires nurses to practice with compassion and respect to the needs of all individuals. This is the nurse's primary responsibility. Nurses have a duty to provide the best and most up-to-date care for their patients and to advocate for methods that will facilitate their comfort. According to Zalon, Constantino, and Andrews (2008), "patients have a right to effective management of pain," and nurses are ethically obligated to manage that pain (p. 94).

Medical providers often cause pain through various methods including needle sticks from immunizations or heel or finger sticks for various lab tests. Yet, medical providers also have the ability to reduce the pain caused through proven methods of pain management. By providing patients with medications or other alternative pain relief methods including sucrose before painful procedures or immunizations, nurses are able to make a difference in their patients' lives. Therefore, the use of sucrose before any pain provoking procedure is relevant to nursing practice.

Local Background and Context

My practicum site was a pediatric primary care practice in my local area. The practice has three medical doctors and four nurses. Overall, the practice has a panel size of approximately 6,000 patients. I identified the practice-focused question during patient visit observations. My nursing background encompassed experience in pediatrics and maternity care, including neonates. In the maternity unit, sucrose was used with neonates for all procedures including immunizations, heel sticks, IV placement, circumcision, or any other hospital procedure that may cause pain. When asked about the use of sucrose, the providers noted that there was not enough evidence available to support the use of sucrose in primary care past the newborn period. This sparked the need for further investigation on my part and the formulation of the practice question.

Definitions

Comfort theory: “The immediate state of being strengthened through having the human needs for relief, ease, and transcendence addressed in four contexts of experience (physical, psycho-spiritual, socio-cultural, and environmental)” (Kolcaba & DiMarco, 2005, p. 189).

Injection: “The act of forcing a liquid into the body by means of need and syringe” (Cincinnati Children’s Hospital, 2013, p. 6).

Pain: “An unpleasant sensory and emotional experience associated with actual or potential tissue damage” (Zalon et al., 2008, p. 94).

Sucrose: “An oral solution consisting of a percentage of sucrose which provides quick, non-invasive, non-pharmacologic means to manage pain associated with minor procedures” (Cincinnati Children’s Hospital, 2013, p. 6).

Systematic literature review: Follows steps to review and analyze the current literature to provide a comprehensive summary to answer a practice-focused question (Wardle & Steel, 2015, p. 103).

Role of the DNP Student

Doctoral-prepared nurses, registered nurses, and advance practice nurses are in a position to translate evidence into practice (Walker & Polancich, 2015). Skills learned by the doctoral-prepared nurse include the processes of the improvement of initiatives, quality care, and evidence-based practice (EBP) translation (Walker, & Polancich, 2015). Doctoral-prepared nurses are prepared to “lead change within a health care system through the translation of evidence” (Walker, & Polancich, 2015, p. 263). I have used the skills learned to date to conduct a comprehensive systematic review of the literature on the practice-focused question.

Within this project, my role was to be the researcher and evaluator, identifying the evidence, appraising it for inclusion and quality, and then synthesizing it into easy to read format in anticipation that the identified supporting evidence will later be translated into practice through guideline development. This information is pertinent to my everyday practice working with this age group, administering immunizations and conducting minor painful procedures. I am motivated to find solutions to providing my patients with the

best available techniques to reduce discomfort that I inflict on this group. Working in pediatrics may cause a bias for this study. To reduce this bias, I have followed a systematic approach for literature inclusion, which is discussed later in Section 3.

Summary

The purpose of Section 2 was to provide the theoretical framework and local background that supports this project. In addition, I identified my role as the student. In Section 3, I will identify the question for this project, as well as provide the literature support and the synthesis of the evidence.

Section 3: Collection and Analysis of Evidence

Introduction

The purpose of this systematic review was to determine if there is enough evidence available to support the use of sucrose in children. In Section 3, I focus on the practice question, systematic review methodology, and sources of evidence.

Systematic Review Methodology

This project was a systematic review of literature pertaining to the current evidence to support the use of sucrose in children. A systematic review follows steps to review and analyze the current literature to provide a comprehensive summary to answer a practice-focused question (Wardle & Steel, 2015). A systematic review consists of five steps that must be followed in order to be classified as such (Ham-Baloyi & Jordan, 2015):

1. Identification of a practice-focused question
2. Literature search
3. Critical appraisal of the literature identified
4. Data extraction and summarization
5. Data synthesis

Practice-Focused Question

A systematic review allows for the gathering and analysis of a large body of evidence that is then broken down into an easy-to-read and understand format. The

information may then be used to translate the research into practice. The first step in a systematic review is to identify a practice-focused question.

The practice-focused question for this systematic review was the following: What is the current evidence supporting the use of sucrose for pain management in children in primary care?

Published Outcomes and Research

Sources of Evidence

A comprehensive literature search was conducted for this project using online databases. The following online databases were used for the search: CINAHL and MEDLINE simultaneous search database, OVID, Cochrane Database of Systematic Reviews, ProQuest, Clinical Key, EBSCO, and PubMed. In addition, the National Guideline Clearinghouse online website was reviewed to determine current guidelines on the use of sucrose in children. The search terms and word combinations used consisted of *sucrose, glucose, sweet-ease, sucrose AND immunizations, sucrose AND pain, sucrose AND infants, sucrose AND children, glucose AND pain, glucose AND immunizations, sweet solutions, and pain management AND procedures AND infants*. The search was exhaustive and comprehensive; all article identified and included were reviewed to determine if other article cited in the references could also be included in this review.

Inclusion and Exclusion Criteria

The numbers of articles found during the literature review were reduced by applying inclusion and exclusion criteria to filter out articles that were not pertinent to the

practice question. The inclusion and exclusion criterion is presented below in Table 1. Articles included in this systematic literature review were peer-reviewed journal publications in the English language, and studies that included infants, toddlers, and children in either a pediatric, emergency, inpatient, or outpatient setting. Articles excluded were studies done on adults, neonates, and any article written in a language other than English. The search was not limited in years, as a majority of the research has been conducted over the past 10 years, with the landmark study occurring 25 years ago in 1991. All duplicates have been removed.

Table 1

Inclusion and Exclusion Criteria

Inclusion	Exclusion
English Language	Adults
Infants	Neonates
Toddlers	Foreign languages
Pediatrics	
Children	
Emergency Room	
Inpatient/Outpatient	

Analysis of the Literature

A literature appraisal is the third step in a systematic review, used to assess the quality of the articles selected. The articles identified through the literature search process were appraised to ensure they were quality articles that were pertinent to this topic. Fineout-Overholt, Melnyk, Stillwell, and Williamson (2010) critical appraisal guide for quantitative studies was used to ensure the articles were appropriate for

inclusion. The critical appraisal guide used seven questions that were reviewed before including the articles in this review (Fineout-Overholt et al., 2010). The seven questions were as follows (Fineout-Overholt et al., 2010, p48):

- Why was the study done and was the purpose clear?
 - Was the purpose clear?
- What is the sample size?
 - Enough participants to support the findings?
- Are the instruments of the major variables valid and reliable?
 - Variable defined
 - Instruments valid and reliable
 - Measure concept same way every time
- How were the data analyzed? Were statistics used?
- Were there any untoward events during the study (people leave and why)?
- How do the results fit with previous research? Was a literature review done?
- What does this research mean for clinical practice?

Data Analysis Process

Each article was looked at individually using the seven questions above. If all seven questions were answered, then they passed the critical appraisal process. If any of the answers to the seven questions above was missing from the article, it was removed from inclusion. The literature that passed the critical appraisal processes was included in

this review; I then conducted a full data analysis as the next step. In Section 4, I will discuss the full data analysis of each article, including a summarization and synthesis.

The articles summarized in the literature review matrix can be found in Appendix A. The literature review matrix was put into a table format (Appendix A) and includes the following categories: reference, design and sample size, population, setting, variables, findings and evidence grade. A full synthesis of the data will be provided in Section 4.

The evidence was graded using the Melnyk and Fineout-Overholt system (2005). The Melnyk and Fineout-Overholt system rates evidence in a hierarchy format using seven total levels. Table 2 provides an overview of the hierarchy for the levels of evidence along with the number of articles identified for each level. Levels I through III are considered the highest levels of evidence, while Levels VI and VII are considered the lowest quality evidence. The breakdown of the evidence consists of a total of 37 articles with 14 articles at Level I, 19 articles at Level II, one article at Level VI, and three articles at Level VII.

Table 2

Levels of Evidence

Level of Evidence	Description	Number of Articles Found
Level I	Systemic reviews, meta-analysis, evidence based clinical practice guidelines	14
Level II	1 well-designed RCT	19
Level III	Controlled trial without randomization	0
Level IV	Case control or cohort study	0
Level V	Systemic reviews of descriptive or qualitative studies	0
Level VI	Single descriptive or qualitative study	1
Level VII	Opinions from authorities or reports from experts	3

Summary

In this section, I reviewed the practice-focused question, discussed the sources where the evidence was obtained, and identified the search terms used. The review methodology inclusion and exclusion criteria were identified to narrow the number of articles down for this review. Steps 1 through 3 of a systematic literature review have been completed up to this point. Step 4 and 5 will be completed in the following section. In Section 4, I will discuss the full data analysis of the literature including the synthesis of the literature, the implications and recommendations to practice, and the strengths and limitations of the systematic review.

Section 4: Findings and Recommendations

Introduction

Sucrose is an underused tool for pain management for young children. The focus of this project was to systematically determine if the current evidence supports the use of sucrose for children in primary care. In Section 4, a synthesis and summary of findings will be discussed. Articles that made it through the inclusion criteria and evaluation will be broken down and grouped, based on the level of evidence. Implications of this systematic review will be discussed and recommendations will be defined. Strengths and limitations will be identified and discussed in this section.

Summary of Findings

The evidence was graded using the Melnyk and Fineout-Overholt system (2005). There were 37 articles selected for inclusion. The 37 articles selected for inclusion were broken down into levels of evidence. There were 14 articles for Level I, 19 articles for Level II, one article for Level VI, and three articles for Level VII. Levels III, IV, V did not meet inclusion criteria for this systematic review. The complete literature review table may be found in Appendix A.

Level 1

Level I is considered the most powerful level of evidence, encompassing the highest quality of information (Melnyk & Fineout-Overholt, 2005). Level I evidence consists of systemic reviews, meta-analysis, and evidence-based clinical practice guidelines (Melnyk & Fineout-Overholt, 2005). These are all based on at least three or

more randomized controlled trials (RCT) with similar results (Melnik & Fineout-Overholt, 2005). Table 3 below provides an organized overview of the reference articles, method/design, sample size, population of the study, and a summary of findings.

Following Table 3 is a full synthesis of each of the 14 articles included in this level.

Table 3

Level I Evidence Table

Reference	Method/ Design	Sample size	Population	Findings
Cincinnati Children's Hospital Medical Center. (2013). Best evidence statement (BEST): Reducing pain for children and adolescents receiving injections. Retrieved from: https://www.guideline.gov/summaries/summary/39440	*National Guideline Clearinghouse *Systematic review		*Infants	*Strongly recommends sucrose solution to reduce pain during injections
Harrison, D. (2008b). Oral sucrose for pain management in the pediatric emergency department: A review. <i>Australian Emergency Nursing Journal</i> , 11, 72-79. doi: 10.1016/j.aenj.2008.02.004	*Systemic Review	*12 studies *N=1326	*Birth to 12 years old	* Sucrose use up to the age of 18 months is effective for minor painful procedures and may be combined with a pacifier or other comforting measures. * Inadequate evidence to support use in school age children.
Harrison, D., Beggs, S., & Stevens, B. (2012). Sucrose for procedural pain management in infants. <i>Pediatrics</i> , 130(5), 918-925. doi: 10.1542/peds.2011-3848	*Review	*44 RCT's	*Newborn to young infants	*Guidelines should include sucrose use for procedural pain
Harrison, D., Bueno, M., Yamada, J., Adams-Webber, T., & Stevens, B. (2010). Analgesic effects of sweet-tasting solutions for infants: Current state of equipoise. <i>Pediatrics</i> , 126(5), 894-902. doi: 10.1136/adc.2009.174227	*Review	-298 studies identified		*Concludes enough studies exist to support the use of sucrose in infants *Future studies should consist of methods of knowledge translation
Harrison, D., Stevens, B., Bueno, M., Uamada, J., Adams-Webber, T., Beyene, J., & Ohlsson, A. (2010). Efficacy of sweet solutions for analgesia in infants between 1 and 12 months of age: A systemic review. <i>Archives of Diseases in Childhood</i> , 95, 406-413. doi:10.1136/adc.2009.174227	*Systemic review	*14 RCT *N=1674	*1-12 months old	* Recommend sucrose or glucose for immunizations up to 12 months old. * With multiple injections, sucrose should be given before and between injections

(table continues)

Reference	Method/ Design	Sample size	Population	Findings
Harrison, D., Yamada, J., Adams-Webber, T., Ohlsson, A., Beyene, J., & Steven, B. (2015). Sweet tasting solutions for reduction of needle-related procedural pain in children aged one to 16 years (Review). <i>Cochran Database of Systemic Reviews</i> , 5, 1-50. doi:10.1002/14651858.CD008408.pub3	*Meta-analysis	*8 studies (1 un-published) *N=808	*Birth to age 16 years old	* There is no evidence in supporting the use of sweet solutions or substances for children over 12 months old.
Harrison, D., Yamada, J., & Stevens, B. (2010). Strategies for the prevention and management of neonatal and infant pain. <i>Current Pain and Headache Report</i> , 14(2), 113-123. doi: 10.1007/s11916-009-0091-0	*Review	*80 RCT's, reviews, systematic reviews and unpublished data	*1-12 months old	* Recommend 0.1-2mL of sucrose before immunizations up to 12 months old.
Hatfield, L. A., Chang, K., Bittle, M., Deluca, J., & Polomano, R. C. (2011). The analgesic properties of intraoral sucrose: An integrative review. <i>Advances in Neonatal Care: Official Journal of the National Association of Neonatal Nurses</i> , 11(2), 83-92. doi: 10.1097/ANC.0b013e318210d043	*Integrative review	*14 studies	*Newborn up to 6 months of age	*Guideline suggestion *Recommends the use of sucrose for up to 6 months of age
Kassab, M. I., Roydhouse, J. K., Fowler, C., & Foureur, M. (2012). The effectiveness of glucose in reducing needle-related procedural pain in infants. <i>Journal of Pediatric Nursing</i> , 27(1), 3-17. doi: 10.1016/j.pedn.2010.10.008	*Systemic Review	*20 RCT's	*Newborn up to 12 months of age	*Glucose is effective in reducing crying time and is recommended for use for pain management without adverse effects
McCall, J., DeCristofaro, C., & Elliot, L. (2013). Oral sucrose for pain control in non-neonate infants during minor painful procedures. <i>Journal of the American Association of Nurse Practitioners</i> , 25, 244-252 doi: 10.1111/j.1745-7599.2012.00783.x.	*Systemic Review	*14 studies *N=1237	*Birth to 12 months old *Outpatient clinic	* 24% sucrose concentration administered 2 minutes prior to painful procedure has been shown to reduce pain
Shah, V., Taddio, A., & Reider, M. (2009). Effectiveness and tolerability of pharmacologic and combined interventions for reduction injection pain during routine childhood immunizations: Systematic review and meta-analysis. <i>Clinical Therapeutics</i> , 31(Suppl. B), S104-2151. doi:10.1016/j.clinthera.2009.08.001	*Systemic Review *Meta-analysis	*Systemic Review -11 studies -N=1452 *Meta-analysis -6 studies -N=665	*Infants and Children	* Recommend the use of sucrose or cream for immunizations in combination with other interventions such as breastfeeding, distraction or non-nutritive sucking for immunizations
Taddio, A. (2011). New clinical practice guideline for pain management during routine childhood vaccination -- What pharmacists need to know. <i>Canadian Pharmacists Journal</i> , 144(3), 114-115. doi: 10.3821/1913-701X-144.3.114	*Clinical Practice Guideline		*Infants 12 months of age and younger	*Administration of sweet-tasting solution is indicated for the management of pain for immunizations up to 12 months

(table continues)

Reference	Method/ Design	Sample size	Population	Findings
Taddio, A., Appleton, M., Bortolussi, R., Chambers, C., Dubey, V., Halperin, S., & Shah, V. (2010). Reducing the pain in childhood vaccination: An evidence-based clinical practice guideline. <i>Canadian Medical Association Journal</i> , 182(18), E843-E855. doi:10.1503/cmaj.101720	*Systemic Review *Meta-analysis	*Systemic Review -11 studies -N=1452 *Meta-analysis -6 studies -N=665	*Infants and Children	* Recommend sweet tasting solutions for immunizations up to 12 months old if breastfeeding cannot be utilized.
Taddio, A., McMurtry, C. M., Shah, V., Pillai Riddell, R., Chambers, C. T., Noel, M., & ... Antony, M. M. (2015). Reducing pain during vaccine injections: Clinical practice guideline. <i>Canadian Medical Association Journal</i> , 187(13), 975-982. doi:10.1503/cmaj.150391	*National Guideline Clearinghouse *Clinical Practice Guidelines		*Children 2 years of age and under	*Canadian based guideline *Moderate confidence for the administration of sucrose 1-2 min before vaccinations

The Cincinnati Children's Hospital (2013) published a clinical practice guideline based on the best evidence available on how to reduce pain during injections for children and adolescents. The clinical guideline recommended the use of sucrose for infants during injections. The review of evidence was based on two systematic reviews and one randomized controlled trial. The researchers showed a moderate effect for the use of sucrose on infants. None of the evidence supported sucrose use beyond the infant years.

Harrison (2008b) discussed a clinical practice update on the use of sucrose for children in pediatric emergency departments. Harrison reviewed 12 studies all involving randomized controlled trials of sucrose, glucose, or sweet tasting gum use in children. There were a total of 10 studies that were conducted on children less than 18 months. The majority of the studies involved infants less than 6 months. The procedures were those done in the emergency room and varied including immunizations/injections either intramuscular or subcutaneous, heel lance, venipunctures, or urethral catheterization. The majority of the scholars showed a reduction in cry duration with the use of sucrose for

immunization/injection and heel lance. There was no statistical difference in the studies where urethral catheterization or venipunctures were performed. Two researchers who used a combination of interventions such as sucrose, non-nutritive sucking, and EMLA cream, as well as sucrose non-nutritive sucking and parental holding, each showed a significant reduction in crying time with injections. In addition to the 10 studies, two other studies of children ages 8 through 12 using sucrose or sweet gum were conducted for a cold pressor test, venipuncture, and immunization. The results of these all showed no significant differences between sucrose and a placebo. Harrison concluded that sucrose is effective for minor painful procedures up to 18 months of age and may be used with pacifier or other methods.

Harrison et al. (2012) discussed a systematic review on the use of sucrose in children. Harrison et al. identified 44 randomized controlled trials that showed that sucrose reduced cry duration, pain score, or facial actions such as grimacing in children up to 12 months. According to Harrison et al., this concept has not been translated into clinical practice and remains a practice gap. Harrison et al. suggested that small volumes of sucrose should be used for painful procedures. Harrison et al. recommended against using sucrose for prolonged procedures or for more than 10 doses in 24-hour period. In addition, sucrose should only be used for painful procedures and not to help calm an irritable infant.

Harrison, Bueno, Yamada, Adams-Webber, and Stevens (2010) published a systematic review on the use of sweet solutions and the current state of equipoise. The

review included 116 randomized controlled trials in which sucrose was used in some form. Most of the studies involved newborns or preterm infants. A total of 19 studies included infants beyond the neonatal period. Out of these 19 studies, only four showed negative results where sucrose was not effective. Out of the four studies, Harrison, Bueno et al. noted that only 12% sucrose was used for these studies. In the remaining studies (15 total), all showed a positive response to the use of sucrose in infants beyond the neonatal period. Harrison, Bueno et al. stated that “a state of clinical equipoise regarding analgesic effects of small volumes of sweet-tasting solutions no longer exists” (p. 899). Therefore, there was no justification for conducting additional randomized controlled trials with placebo or no-treatment groups for infants. Any further “investigations should focus on addressing these important research gaps regarding sucrose analgesia for our youngest patients” (Harrison, Bueno et al., 2010, p. 899).

Harrison, Stevens, Bueno, Uamada, Adams-Webber, Beyene, and Ohlsson (2010) conducted a systematic review on the use of sucrose for infants during immunizations. The review looked at 395 studies and identified 14 randomized controlled trials for inclusion. The trials involved a total of 1674 injections. All of the injections used sucrose or glucose when compared to water or no intervention. Harrison, Stevens et al. found that the use of either glucose or sucrose decreased crying time. Harrison, Stevens et al. concluded that sucrose or glucose should be used consistently during immunizations for infants.

Harrison, Yamada, Adams-Webber, Ohlsson, Beyene, and Stevens (2015) completed a meta-analysis on the use of sucrose for children age 1 to 16 during needle related procedures. Harrison, Yamada et al. reviewed eight different studies including one unpublished study at the time. The total number of participants was 808. The official conclusion of this analysis was that sucrose was successful for minor painful procedures in children up to the age of 12 months. There was no evidence in supporting the use of sweet solutions or substances for children over 12 months old.

Harrison, Yamada, and Stevens (2010) conducted a clinical review of 80 randomized controlled trials, systematic reviews, literature reviews, and unpublished data. Harrison, Yamada et al. concluded that 0.1mL to 2mL of sucrose should be given before and during minor painful procedures up to the age of 12 months for pain control. The evidence does not support the use of sucrose over the age of 12 months old.

Hatfield et al. (2011) conducted an integrative review on the use of sucrose in children. Hatfield et al. analyzed 14 randomized controlled trials on the use of sucrose. The ages ranged from preterm infants to infants up to 6 months. The procedures were immunizations, venipunctures, bladder catheterization, retinopathy of prematurity exam, or any procedure perceived to be painful. In all of the studies, except three, sucrose showed a significant difference in pain relief then for those who received a placebo. Those studies where a combination of sucrose and pacifier were used showed significant relief in pain and a quicker return to baseline. As a result of these studies, Hatfield et al. created a sucrose clinical practice guideline where the administration of sucrose is

suggested up to the age of 6 months for minor painful procedures. The suggestion was to administer the sucrose by pacifier or syringe approximately 2 minutes before the painful procedure

Kassab et al. (2012) conducted a systematic review without meta-analysis on the use of glucose for pain relief of needle related procedural pain. The systematic review looked at 20 studies with age ranges between preterm infants to 12 month old infants. For each study glucose was administered in concentrations ranging from 10% to as high as 50%. These studies were all randomized controlled trials. Kassab et al. concluded that glucose appeared effective for minor painful procedures. In addition, studies that combined glucose with other interventions such as skin to skin contact, non-nutritive sucking, or breastfeeding may be more effective than glucose alone. The final conclusion of this systematic review was that glucose was effective for needle related procedures and should be used for children up to 12 months.

McCall, DeCristofaro, and Elliot (2013) conducted a literature review for non-neonate infants up to 12 months during minor painful procedures such as venipuncture and immunizations. Ten studies, all randomized controlled trials, met the inclusion criteria with ages ranging up to 12 months. McCall et al. concluded that “oral sucrose in a 24% concentration at a dose of 2mL approximately two minutes prior to the painful procedures has been shown effective in reducing pain during immunizations and venipuncture in the outpatient setting in infants age 1 month to 12 months old” (p. 244).

Shah, Taddio, and Reider (2009) conducted a systematic review and meta-analysis on interventions to reduce injection pain during immunizations. A total of 32 studies were included in the review, of which 23 were included in the meta-analysis. There were 11 studies on the review that pertained to the use of sucrose with six of those studies included in the meta-analysis. The meta-analysis of six studies showed a moderate effect with sucrose use on pain reduction. Shah et al. went on to report that there appears to be an enhanced effect when sucrose was used in conjunction with a pacifier or non-nutritive sucking. In conclusion, there was a final recommendation of the routine use of sucrose to reduce immunization pain.

Taddio (2011) published an additional practice guideline that is an extension of the 2010 practice guideline discussed above. Taddio stated that “infants up to 12 months who cannot be breastfed during vaccination should be administered a sweet-tasting solution” such as sucrose (p. 114). In addition to the original recommendation of 2mL of 25% sucrose, Taddio clarified that only a single dose is required, even when multiple vaccines are administered, since the duration of action is approximately 10 minutes.

Taddio, Appleton, Cortolussi, Chambers, Dubey, Halperin, and Shah (2010) provided a review on evidence based clinic practice guidelines during childhood vaccinations. It was estimated that about 10% of the population avoids vaccinations due to needle fears. By providing a more positive experience through pain reduction techniques, providers can help to maintain and promote trust. This clinical practice guideline covers many techniques including the use of sucrose. The supporting evidence

for this guideline includes 11 trials with a total of 1452 infants and children. In addition, six trials were included in a meta-analysis which included 665 infants up to 12 months of age. These trials all showed a positive response to the use of sucrose during vaccinations. Based on this evidence Taddio et al. concluded that sucrose is effective for infants up to 12 months of age. This is considered a grade A recommendation based on level 1 evidence. The guideline goes on further to recommend 2mL of 25% sucrose two minutes before injection, and it may be used with a pacifier.

Taddio, McMurtry, Shah, Pillai Riddell, Chambers, Noel, and Antony (2015) published an expansion on the original 2010 guidelines based on past and new available evidence. In this expanded guideline, also a National Clearinghouse Guideline, Taddio et al. has moderate confidence for sucrose use before procedural pain for children 2 and under, with the three confidence levels being high, moderate, or low. They also reviewed the evidence on sucrose with non-nutritive sucking and sucrose with breastfeeding and found the evidence to be low for both. The original recommendation of 2mL of 25% sucrose two minutes before procedures for those infants unable to breastfeed was expanded to include infants from 12 months to 2 years in addition to those up to 12 months.

Level 2

Level II is considered the second most powerful level of evidence. This level includes at least one well designed, quantitative, randomized controlled trial (Melnik & Fineout-Overholt, 2005). These controlled trials may later be used for evidence in

systematic reviews or meta-analysis'. Table 4 below provides an organized overview of the included reference articles, method/sample size, population/setting, variables, and a summary of findings. Following table 4 is a full synthesis of each of the 19 articles included in this level. The first study noted is the landmark study which brought about the use of sucrose in newborn nurseries around the world.

Table 4

Level II Evidence Table

Reference	Method/Sample size	Population/Setting	Variables	Findings
Blass, E. M., & Hoffmeyer, L. B. (1991). Sucrose as an analgesic for newborn infants. <i>Pediatrics</i> , 87(2), 215-218. doi: 10.1097/00132586-199112000-00033	*RCT *N=54 ** Landmark Study	*24-58 hours old *Inpatient unit	*Heel lance - 2mL 12% sucrose or sterile water *Circumcision -Sucrose or water flavored pacifier prior/during procedure	* Heel lance sucrose group cried 50% less and returned to baseline faster than control group * Sucrose flavored pacifier before and during circumcision cried 70% less then control group
Allen, K., White, D., & Walburn, J. (1996). Sucrose as an analgesic agent for infants during immunization injections. <i>Archives of Pediatric and Adolescent Medicine</i> , 150, 270-274. doi: 10.1001/archpedi.1996.02170280040007	*Double Blind RCT *N=285	*2 weeks, 2, 4, 6, 9, 15, and 18 month old *Unknown setting	*1- 2 injections *12% sucrose or sterile water *2ML of either solution 2 min before injection	* No significant difference found between sucrose or sterile water
Barr, R., Young, S., Wright, J., Cassidy, K., Hendricks, L., Bedard, Y., & Treherne, S. (1995). Sucrose analgesia and diphtheria-tetanus-pertussis immunizations at 2 and 4 months. <i>Developmental and Behavioral Pediatrics</i> , 16(4), 220-225. doi: 10.1097/00004703-199508000-00002	*Longitudinal RCT *N=57	*2 months old and repeat of same participants with same solution at 4 month old *Outpatient Clinic	*Single immunization *50% sucrose or sterile water *3 doses of solution prior to injection	* Sucrose superior to sterile water in terms of length of crying time post injection. * No difference in crying time during injection

(table continues)

Reference	Method/Sample size	Population/Setting	Variables	Findings
Curtis, S., Jou, H., Ali, S., Vandermeer, B., & Klassen, T. (2007). A randomized controlled trial of sucrose and/or pacifier as analgesia for infants receiving venipuncture in a pediatric emergency department. <i>BioMed Central Pediatrics</i> , 7(27). doi:10.1186/1471-2431-7-27	*Double blind, placebo RCT *N=84	*Birth to 6 month old *Emergency Room	*1 venipuncture *44% sucrose or sterile water followed by pacifier *2mL of solution followed by pacifier prior to procedure	* No significant difference between any group * Regression analysis showed crying time less sucrose and pacifier group then with sterile water and pacifier alone
Despree, A., & Langeland, E. (2016). The effect of sucrose as pain relief/comfort during immunizations of 15 month old children in health care centres: A randomized controlled trial. <i>Journal of Clinical Nursing</i> , 25(3-4), 372-380. doi:10.1111/jocn.13057	*RCT *N=114	*15 months old *Outpatient clinic	*30% sucrose or sterile water. *2mL of solution prior to injection	* Sucrose group resulted in a shorter cry duration then sterile water group
Dilli, D., Kucuk, I., & Dallar, Y. (2009). Interventions to reduce pain during vaccination in infancy. <i>Journal of Pediatrics</i> , 154, 385-390. doi: 10.1016/j.jpeds.2008.08.037	* Prospective, RCT *N=243	*Birth to 4 years old *Outpatient clinic	*1- 3 injections age dependent *Group 1: Breastfeeding or no intervention *Group 2: 2mL of 12% sucrose given 2 minutes before, 1gm lidocaine-prilocaine cream applied 1 hour before or no intervention	* 0-6 months, breastfeeding reduced crying time and pain scores during immunization * 6-48 months, reduced cry time and pain scores with sucrose or cream compared to no intervention group
Harrington, J., Logan, S., Harwell, C., Gardner, J., Swingle, J., McGuire, E., & Santos, R. (2012). Effective analgesia using physical interventions for infant immunizations. <i>Pediatrics</i> , 129(5), 815-822. doi: 10.1542/peds.2011-1607	* Placebo RCT *N=230	*2-4 months old *Outpatient Clinic	*3 injections *4 groups: 2mL of 24% sucrose with standard of care comfort, 2mL of 24% sucrose with 5 S's, 2mL of sterile water with standard of care comfort, or 2mL of sterile water with 5 S's	* The 5 S's (swaddle, side/stomach position, shushing, swinging and sucking) was superior to all methods. * The 5 S's in combination with sucrose was not statistical different from 5 S's alone.

(table continues)

Reference	Method/Sample size	Population/Setting	Variables	Findings
Harrison, D, Elia, S., Royle, J., & Manias, E. (2014). Sucrose and lollipops to reduce immunization pain in toddlers and young children: Two pilot randomized controlled trials. <i>Neonatal, Paediatric, and Child Health Nursing</i> , 17(1), 19-26. doi: 10.1111/jpc.12161	*Study 1 -double blind RCT -N=30 *Study 2 -non blinded RCT -N=31	*Study 1 -12-18 months old *Study 2 -3-5 years old *Unknown Setting	*Group 1 -33% sucrose or sterile water -1-3 injections Age dependent *Group 2 - lollipop before injection or active distraction -1 to 2 injections	* No statistical difference in either group between intervention and control for both studies
Hatfield, L. (2008). Sucrose decreases infant bio-behavioral pain response to immunizations: A randomized controlled trial. <i>Journal of Nursing Scholarship</i> , 40(3), 219-225. doi: 10.1111/j.1547-5069.2008.0029.x	* Double blind, placebo RCT *N=40	*2 and 4 month old *Outpatient Clinic	*3 sequential injections *24% sucrose or sterile water *2mL of solution prior to injection	* Lower pain scores in groups with sucrose use * No difference in response with age
Hatfield, L., Gusic, M., Dyer, A., & Polomano, R. (2008). Analgesic properties of oral sucrose during routine immunizations at 2 and 4 months of age. <i>Pediatrics</i> , 122(2), e327-e334. doi: 10.1542/peds.2006-3719	* Prospective, placebo RCT *N=100	*2 and 4 month Old *Outpatient Clinic	*3 injections separated by few minutes *24% sucrose or sterile water with pacifier *2mL of solution with pacifier	* Sucrose superior to sterile water at 2 minute, 7 minute and 9 minute * Return to baseline sooner than sterile water
Kassab, M., Sheehy, A., King, M., Fowler, C., & Foureur, M. (2012). A double-blind randomized controlled trial of 25% oral glucose for pain relief in 2-month old infants undergoing immunizations. <i>International Journal of Nursing Studies</i> , 49(3), 249-256. doi: 10.1016/j.ijnurstu.2011.09.013	*Double blind RCT *N=120	*2 months old *Unknown Setting	*3 injections *25% oral glucose or sterile water. *2mL of solution prior to injection	* Statistically significant reduction in behavioral pain response and crying time.
Lewindon, P., Harkness, L., & Lewindon, N. (1998). Randomized controlled trial of sucrose by mouth for the relief of infant crying after immunization. <i>Archives of Diseases in Childhood</i> , 78, 453-456. doi: 10.1136/adc.78.5.453	*Double blind RCT *N=107	*2, 4, and 6 month old *Outpatient Clinic	*2 injections *75% sucrose or sterile water *2mL of either solution 2 min before injection	* Significant difference in all measures of crying with sucrose

(table continues)

Reference	Method/Sample size	Population/Setting	Variables	Findings
Miles Curry, D., Brown, C., & Wrona, S. (2012). Effectiveness of oral sucrose for pain management in infants during immunizations. <i>Pain Management Nursing</i> , 13(3), 139-149. doi: 10.1016/j.pmn.2010.07.008	*RCT *N=113	*2 to 6 months old *Outpatient Clinic	*50% sucrose, 75% sucrose, or sterile water. *2mL of solution prior to injection	* No significant difference noted for any group
Ramenghi, L. A., Webb, A. V., Shevlin, P. M., Green, M., Evans, D. J., & Levene, M. I. (2002). Intra-oral administration of sweet-tasting substances and infants' crying response to immunization: A randomized, placebo-controlled trial. <i>Biology of the Neonate</i> , 81(3), 163-169. doi: 10.1159/000051529	*RCT, non-blinded *N=184	*2, 3 and 4 month old *Outpatient Clinic	*2 injections at 2 months, 3 months and 4 months of age. *25% sucrose, 50% sucrose, and sterile water. *2mL of solution prior to injection	* Lower crying time in 4 month group with 50% sucrose * Placebo group at all ages had highest crying time
Reis, E., Roth, E., Syphan, J., Tarbell, S., & Holubkov, R. (2003). Effective pain reduction for multiple immunization injections in young infants. <i>Archives of Pediatric and Adolescent Medicine</i> , 157, 1115-1120. doi: 10.1001/archpedi.157.11.1115	*RCT *N=116	*2 month old *Outpatient Clinic	*4 sequential injections *25% sucrose with pacifier and parental holding or no intervention just standard practice *10mL of solution with pacifier 2 minutes before injections	* Duration of crying time lower with sucrose * No difference in heart rate with sucrose compared to no intervention
Taddio, A., Flanders, D., Weinberg, E., Lamba, S., Vyas, C., Ilersich, A., ... McNair, C. (2015). A randomized trial of rotavirus vaccine versus sucrose solution for vaccine injection pain. <i>Vaccine</i> , 33, 2939-2943. doi: 10.1016/j.vaccine.2015.04.057	*RCT *N=120	*2-4 months old *Outpatient Clinic	*Oral rotavirus and 2 injections *Rotavirus followed by 2 injections with 24% sucrose after or 24% sucrose followed by 2 injections and rotavirus after. *2mL of solution prior to injection and after injection	* There was no significant difference in pain scores between either group
Thyr, M., Sundholm, A., Teeland, L., & Rahm, V. (2007). Oral glucose as an analgesic to reduce infant distress following immunization at the age of 3, 5 and 12 months. <i>Acta Paediatrica</i> , 96(2), 233-236. doi: 10.1111/j.1651-2227-2007-00021.x	* Prospective, placebo RCT *N=110	*3, 5, 12 months old *Outpatient Clinic	*2ml of 30% glucose or sterile water administered 2 min before vaccination *Same solution given at 3 months, 5 months and 12 months of age	*Significant crying time reduction seen in 5 and 12 month groups with the use of glucose

(table continues)

Reference	Method/Sample size	Population/Setting	Variables	Findings
Wilson, S., Bremner, A., Matthews, J., & Pearson, D. (2013). The use of oral sucrose for procedural pain relief in infants up to six months of age: A randomized controlled trial. <i>Pain Management Nursing, 14</i> (4), e95-e105. doi: 10.1016/j.pmn.2001.08.002	*Blinded RCT *N=64	*1 to 6 months old *Inpatient Unit	*25% or sterile water. *2mL of solution prior to painful procedure	* Sucrose did lower the pain scores although there was no statistical difference noticed. * Non-nutritional sucking did also appear to help lower pain scores as well.
Yilmaz, G., Caylan, N., Oguz, M., & Demir Karacan, C. (2014). Oral sucrose administration to reduce pain response during immunization in 16-19 month infants: A randomized placebo-controlled trial. <i>European Journal of Pediatrics, 173</i> , 1527-1532. doi:10.1007/s00431-014-2358-7	*Double blind RCT *N=537	*16-19 months old *Outpatient Clinic	*3 injections *25% sucrose, 75% sucrose, or sterile water. *2mL of solution prior to injection	* 75% sucrose was superior to both 25% sucrose and sterile water * 25% sucrose was superior to sterile water as well

Blass and Hoffmeyer (1991) performed the first study on the use of sucrose and is considered the landmark study that brought about the use of sucrose in newborn nurseries around the world. The study was a randomized controlled trial of 54 neonates between 24 and 58 hours old. Neonates were given either 2mL of 12% sucrose or 2mL of sterile water before heel lance and a pacifier dipped in either 2mL of 12% sucrose or 2mL of sterile water before and during circumcision. For those in the heel lance group, there was a 50% reduction in cry time and a faster return to baseline with the use of sucrose. For those in the circumcision group, when a pacifier dipped in sucrose was used, those in this group cried 70% less than the control group. Sucrose was shown to be an effective method of analgesic in both study groups.

Allen, White, and Walburn (1996) performed a double blind randomized controlled trial to assess the effectiveness of sucrose during immunizations on infants 2 weeks to 18 months old. There were 285 infants involved in this trial, divided into 3 groups: no intervention, 2mL of sterile water, or 2mL of 12% sucrose. Sterile water or sucrose was administered two minutes before the injection or injections. Participants were videotaped for later review and study. The final results were inconclusive. Sucrose and sterile water were found to be more effective than no intervention, but there was no significant difference between the two. The authors concluded that 12% sucrose was not an effective analgesic and that further studies were required.

Barr, Young, Wright, Cassidy, Hendricks, Bedard, and Treherne (1995) conducted a longitudinal randomized controlled trial on infants 2 months old and repeated at 4 months old on the use of sucrose during immunizations. The immunization given at both visits was DTP (diphtheria, tetanus, and pertussis). The infants were split into two groups and remained in the same group at 4 months: sterile water or 50% sucrose. 2mL's of either solution was given two minutes before the procedure, for a total of three doses, given 30 seconds apart. Those in the sucrose group had a reduction of crying time post injection at both 2 months and 4 months versus those in sterile water group. There was no change in cry duration during the injection for either group.

Curtis, Jou, Ali, Vandermeer, and Klassen (2007) completed a randomized double-blind, placebo-controlled trial on 84 children from birth to 6 months old during venipuncture in the setting of a pediatric emergency room. Infants were divided into four

groups given either 2mL of 44% sucrose, 2mL of 44% sucrose followed by a pacifier, 2mL of sterile water, or 2mL of sterile water followed by a pacifier. The findings showed there was no change in FLACC score, crying time, or heart rate in any of the four groups. However, a subgroup analysis showed that for children 3 months and under, there was a reduction in crying time for those who used sucrose and a pacifier. One limitation with this study was that out of the 84 infants, only 20 were in the 3 to 6 month age group leaving this age group greatly under-represented.

Desprée and Langeland (2016) investigated the use of 30% sucrose during 15 month immunizations for this randomized controlled trial. 114 participants receiving the measles, mumps, and rubella (MMR) vaccine were divided into two groups: 2mL of sterile water or 2mL of 30% sucrose. Cry duration was the outcome measure. Those in the sucrose group cried for an average of 18 seconds while those in the control group cried for an average of 33 seconds. The results show that 30% sucrose was effective for pain management during immunizations.

Dilli, Kucuk, and Dallar (2009) conducted a prospective randomized controlled trial of infants from birth to children 4 years old during immunizations. This study consisted of two parts. For the first part, 158 infant under 6 months were divided into two groups: breastfeeding during immunization or no intervention during immunization. The second part consisted of 85 infants and children divided into three groups: 2mL of 12% sucrose given two minutes before immunizations, 1 gram of lidocaine-prilocaine cream applied one hour before immunizations, or no intervention. Results for the first

group showed breastfeeding reduced crying time and pain scores compared to control groups. In the second group, both sucrose and lidocaine-prilocaine cream reduced cry time and pain score compared to no interventions. There was found to be no statistical difference between the sucrose and lidocaine-prilocaine cream groups.

Harrington, Logan, Harwell, Gardner, Swingle, McGuire, and Santos (2012) worked with 230 infants between the ages of 2 and 4 months old. In this placebo controlled randomized controlled trial participants were divided into four groups: 2mL of 24% sucrose with standard of care comfort, or 2mL of 24% sucrose with 5 S's (swaddling, side/stomach position, shushing, swinging, and sucking), 2mL of sterile water with standard of care comfort, or 2mL of sterile water with 5 S's. Standard of care comfort was defined as comfort provided by parent after immunizations. The 5 S's which included swaddling, side/stomach position, shushing, swinging, and sucking were provided after each immunization as well. According to Harrington et al. the 5 S's alone was superior to all methods, but the 5 S's with sucrose followed closely behind and was not statistically different from the 5 S's alone.

Harrison, Elia, Manias, and Royle (2014) completed a parallel design study with two different age groups. The first study was a double blind randomized controlled trial with toddlers 12 to 18 months old. This study consisted of 30 participants and used 33% sucrose or sterile water as the intervention. The second group was a non-blinded randomized controlled trial with a total of 31 participants. The intervention in this group was either a lollipop or active distraction using bubbles and pin wheel blowing. The

final results for all groups in both studies showed that there was no statistical difference between any of the groups. Harrison et al. identified that a major limitation of this study was that the groups were not stratified according to number of injections. By not stratifying the groups, the 12 and 18 month old infants, even though they were in the same group, received a different number of injections. Those in the 12-month old group received three to four injections and 18-month old received two injections.

Hatfield (2008) performed a randomized double-blind, placebo-controlled trial with a total of 40 infants between 2 and 4 months old. This trial was done consecutively meaning that the infant received the same solution at 2 months and then again at 4 months with the same number of injections given at both, each getting three sequential injections. The infants were divided into two groups: 2mL of 24% sucrose or 2mL of sterile water both given two minutes before the injections were administered. Results showed that those in the sucrose group at both 2 and 4 months of age had shorter cry duration than those in the sterile water group.

Hatfield, Gusic, Dyer, and Polomano (2008) completed a similar trial to Hatfield (2008), but expanded the trial to include 100 participants and different infants were used at 2 and 4 months. This trial was a prospective randomized placebo-controlled trial with infants 2 and 4 months old. Participants were placed into two groups based on age: 2 months old or 4 months old. Then each age group was divided into two additional groups consisting of those who would receive 2mL of 24% sucrose and a pacifier or those receiving 2mL of sterile water and a pacifier. The intervention was given 2 minutes

before the injections. All participants received a total of three injections. In both age groups, those who received sucrose had lower pain scores and returned to baseline sooner than those who received sterile water. Hatfield et al. concluded that sucrose was superior to sterile water for pain reduction for infants up to 4 months of age during immunizations.

Kassab, Roydhouse, Fowler, and Foureur (2012) conducted a double blind randomized controlled trial on the use of sucrose for 2 month olds during immunizations. This study involved 120 infants divided into two groups: 2mL of 25% sucrose given two minutes before three injections or 2mL of sterile water given two minutes before three injections. Kassab et al. found infants in the sucrose group “experienced statistically and clinically significant reduction in behavioral pain responses and spent less time crying” (p. 256). This shows sucrose to be superior to sterile water.

Lewindon, Harkness, and Lewindon (1998) conducted a double blind randomized controlled trial of 107 infants during the 2 month, 4 month, or 6 month immunization visits. Each group received oral polio and two intramuscular injections: diphtheria, tetanus, and pertussis (DTP), and Haemophilus influenza type b (HIB). Each age group was divided into two groups: 2mL of 75% sucrose or 2mL of sterile water both, each given two minutes before the injections. The results showed that the sucrose group in all age groups had cry time and distress scores that were significantly less.

Miles Curry, Brown, and Wrona (2012) completed a randomized controlled trial involving 113 infants between the age of 2 and 6 months old. Infants were divided into one of three groups: 2mL of 50% sucrose, 2mL of 75% sucrose, or 2mL of sterile water.

All interventions were done two minutes before injections were given. The results of this study showed no significant difference in the FLACC scores or crying time of all age groups and interventions.

Ramenghi, Webb, Shevlin, Green, Evans, and Levene (2002) performed a non-blinded randomized controlled trial of infants 2 months, 3 months, and 4 months old. Each infant started with immunizations at 2 months and was placed in a group receiving either 2mL of 25% sucrose, 2mL of 50% sucrose, or 2mL of sterile water. The infants were then brought back at 3 months and 4 months for their second and third round of injections, remaining in the same group throughout the trial. The trial consisted of 184 infants. Each group was given 2mL of a solution two minutes before the injections with a total of two injections administered to each participant. Crying time was measured for all groups post injection. Those in the placebo group were found to have the longest crying time. When compared to the placebo, 50% sucrose had the greatest difference in crying time, especially at the 4 month injections, concluding that sucrose was superior.

Reis, Roth, Syphan, Tarbell, and Holubkov (2003) completed a randomized controlled trial with 116 two month old infants for their immunizations. Four immunizations were administered at this visit and the participants were divided into two groups: 10mL of 25% sucrose administered with a pacifier and parental holding two minutes prior to injections or no intervention except parental holding. The study found that the combination of sucrose, non-nutrient sucking, and parental comfort lowered the

crying time compared to the group with no intervention. The study did note that there was no change in heart rate with either group.

Taddio, Flanders, Weinberg, Lamba, Vyas, Ilersich, ... McNair (2015) conducted a randomized controlled trial of 120 infant between 2 and 4 months old. The trial was done to determine if rotavirus oral vaccine (which has a sucrose base) was comparable to using regular sucrose before immunizations. For this trial the participants were separated into two groups. The first group received rotavirus oral solution followed two minutes later by two injections and then 2mL of 24% sucrose. The second group received 2mL of 24% sucrose followed two minutes later by two injections and then by rotavirus. The results found that there was no significant difference between either of the groups. The recommendation based on these results is that rotavirus oral vaccine should be administered first, 2 minutes before any injections. If rotavirus oral vaccine is not part of the vaccines being administered, then oral sucrose should be given 2 minutes before injections.

Thyr, Sundholm, Teeland, and Rahm (2007) performed a prospective randomized placebo-controlled trial of 110 infants at their 3 month, 5 month, and 12 month old immunizations visits. Infants were divided into two groups: 2mL of 30% glucose or 2mL sterile water both administered two minutes before vaccination. The same solution given at the 3 month immunization visit was repeated for the 5 month and 12 month immunization visit. The immunization nurse and the parents were blinded to which

solution was given. Glucose was found to significantly reduce crying time only for the 5 and 12 month groups. There was no statistical difference found in the 3 month group.

Wilson, Bremner, Matthews, and Pearson (2013) conducted a blinded randomized controlled trial on 64 infants between 1 and 6 months old. The study was conducted on infants undergoing painful procedures consisting of venipuncture, heel lance, or intravenous cannulation. Infants were divided into two groups: 2mL of 25% sucrose or 2mL of sterile water both administered two minutes before the painful procedure. Infants were also allowed to have parental comfort and non-nutritive sucking per hospital guidelines. The results showed that sucrose lowered pain scores, but not statistically. It was also noted that infants who were non-nutritive sucking during the trials were found to have lower pain scores.

Yilmaz et al. (2014) completed a double blinded, randomized controlled trial on 537 toddlers between the ages of 16 to 19 months during immunizations. All participants underwent three immunizations each. The participants were divided into three groups: 2mL of 25% sucrose, 2mL of 75% sucrose, or 2mL of sterile water, with each administered two minutes before immunizations were given. The results of the study showed that out of all three solutions, 75% sucrose was considered superior to both sterile water and 25% sucrose, but 25% sucrose was found to be superior to sterile water.

Level 6

Level VI is considered the second lowest form of evidence. This level uses evidence from either a descriptive or qualitative study (Melnyk & Fineout-Overholt,

2005). For this level, only one descriptive study was identified pertaining to sucrose use in children. Table 5 below provides an organized overview of the included reference article, method/sample size, population/setting, variables, and a summary of findings. Following table 5 is a synthesis of the article included in this level.

Table 5

Level VI Evidence Table

Reference	Design/Sample size	Population	Variables	Findings
Harrison, D., Elia, S., Royle, J., & Manias, E. (2013). Pain management strategies used during early childhood immunization in Victoria. <i>Journal of Paediatrics & Child Health</i> , 49(4), 313-318. doi: 10	*Descriptive study *Survey method *N=125	*Nurses that provide pain management in early childhood	*Email survey to assess policies regarding pain management and strategies used during immunizations	*Survey found that many types of distraction methods are utilized during immunizations, but sweet solutions such as sucrose were rarely used

Harrison, Elia, Royle, and Manias (2013) sought out to identify pain management practices used during immunizations. Harrison et al. emailed 274 nurses within an immunization special interest group in Victoria, Australia. A total of 125 surveys were returned completed. The survey identified that rapid injection and distraction techniques were the most common methods used during immunizations. Sucrose, breastfeeding, and topical anesthetics were infrequently used in practice.

Level 7

Level VII is considered the lowest form of evidence. This level uses opinions of those whom are considered expertise or authorities in their field (Melnik & Fineout-Overholt, 2005). While the opinions are from experts in their field, this quality of evidence considered the lowest form as the information is not always backed up by the

required qualified studies. For this level, only three articles were found. Table 6 below provides an organized overview of the included reference article, design, population, and a summary of findings. Following table 6 is a synthesis of the three articles included in this level.

Table 6

Level VII Evidence Table

Reference	Design	Population	Findings
Harrison, D. (2008a). Oral sucrose for pain management in infants: Myths and misconceptions. <i>Journal of Neonatal Nursing</i> , 14, 39-46. doi: 10.1016/j.jnn.2007.12.002	Evidence from expert opinion	*Infants	* Large body of evidence showing sucrose effective for minor painful procedures yet underutilized. * Sucrose should be utilized for infants up to age 18 months during minor painful procedures.
Rishovd, A. (2014). Pediatric intramuscular injections: Guidelines for best practice. <i>Maternal Child Nursing</i> , 39(2), 107-112. doi:10.1097/NMC.000000000000009	Evidence from expert opinions	*Infants	* Many methods can be used to prevent or reduce pain during injections. * Sucrose can be used when breastfeeding is not an available option.
Russell, K., & Harrison, D. (2015). Managing pain in early childhood immunizations. <i>Kai Tiaki Nursing New Zealand</i> , 21(2), 22-24. Retrieved from http://www.nzno.org.nz/resources/kai-tiaki	Evidence from expert opinions	*Infants	* Sucrose can be used for infants before immunizations. If using rotavirus vaccine, this should be given first before injections.

Harrison (2008a) discussed myths and misconceptions in pain management of infants. She noted that the use of sweet substances have been documented for pain all the way back to 632AD. Harrison identified eight myths and misconceptions about sucrose including sucrose not being baby friendly, causing bacterial growth, increasing risk of dental caries, increasing risk of poor neurological outcomes, increasing risk of necrotizing enterocolitis, causing hyperglycemia, ineffective in older babies, and repetitive doses leading to tolerance of sucrose decreasing effectiveness. She effectively presents evidence for each concern that supports the use of sucrose and discounted each

myth. She concluded that sucrose is safe and effective in small amounts for pain management for infants and that “as health professionals caring for infants, we have an ethical responsibility to consistently utilize evidence-based pain reduction strategies such as oral sucrose, during acute minor painful procedures” (Harrison, 2008a, p. 45).

Rishovd (2014) discussed pediatric intramuscular injections and presented guidelines for best practice. In this article, multiple measures were recommended, including avoidance of syringe aspiration, rapid injection, 5 S’s (swaddling, side/stomach position, shushing, swinging and sucking), breastfeeding, sucrose, and EMLA cream. Pertaining to sucrose, the article recommended sucrose use only when breastfeeding cannot be used for infants. Rishovd reported that sucrose has been found to be safe and effective in reducing crying time and pain related behaviors such as grimacing.

Russell and Harrison (2015) discussed interventions to manage pain in early childhood immunizations. They noted six recommendations for practice: breastfeeding during immunization, sucrose before vaccination for infants, topical anesthetics such as EMLA cream, age-appropriate distraction, vibration devices for children over four, and the institution of pain management policies for immunizations. Russell and Harrison stated that “education is needed for clinicians and parents about these techniques to encourage their use” (p. 24).

Implications and Recommendations

The use of sucrose for young children has been well documented and studied, yet often not used in practice. Numerous studies have shown sucrose to be safe and effective

up to the age of 18 months and may still be effective into the late toddler years. This systematic review gives a final recommendation that sucrose should be used for pain relief during minor painful procedures for children up to 18 months of age.

To bring about a positive social change, guidelines should be developed to use sucrose before procedures considered to be painful for infants up to the age of 18 months of age based on the supporting evidence. While there was no general consensus on dosing, concentrations of 24% sucrose up to 75% sucrose have been shown to be effective. Concentration should be reflective of this range, but may be dependent on commercial availability.

Strengths and Limitations

The largest strength of this systematic review was the sheer number of level I and level II peer reviewed scholarly articles utilized. Level I and II articles are considered the highest levels of quality evidence, and in this review a total of 89% of the were level I and level II graded evidence. Half of the presenting articles were randomized controlled trials with another third of the articles consisting of systematic reviews and meta-analysis. Another presenting strength of this systematic review was the small time frame for the presenting evidence. Since the earliest landmark study was conducted just over 25 years ago, most of the available evidence (within the inclusion criteria) was included.

Limitations included studies that were not in the English language or in online format. Studies done in a foreign language that may have contributed to this subject were excluded due to the inability to translate these articles. Also, when searching for the

available evidence, this search was done entirely online. Articles only available in paper format may have been left out. Articles that did not support the use of sucrose or found to be inconclusive were not excluded, providing a well-rounded review and helping to reduce bias. Since the number of supporting articles outnumbered the number of unsupportive articles, there was little impact of the non-supportive articles on this review. A final limitation identified was that only one person was reviewing and eliminating article rather than the usual two or more-person approach. This may also create a bias.

Summary

In summary, this section summarized the findings while identifying the implication for further practice and recommendations. Strengths and weaknesses of the review were identified and discussed as well. In the next section, which will conclude this systematic review, the dissemination plan will be discussed and an analysis of self will be provided.

Section 5: Dissemination Plan

Introduction

Sucrose is an effective but underused tool for pain management for young children. In this systematic review, I focused on the available evidence to support the use of sucrose in practice. Scholars have shown sucrose to be effective for children up to 18 months old for minor painful procedures. In the final section of this systematic review, the dissemination plan will be discussed. In addition to the dissemination plan, there will be a self-analysis provided. This final section concludes this systematic review.

Dissemination Plan

Upon completion of any systematic review, the information needs to be disseminated to the medical and nursing community. There are a multitude of possibilities when it comes to disseminating information. In my local area, I intend to share this information with the providers in the pediatric office in which I work at our annual provider meeting in December of 2017. This office was also my practicum site. The information from this capstone will be placed into a PowerPoint® presentation and presented during the meeting. The final recommendation of using sucrose for our practice for children up to 18 months will be given.

Postgraduation, my plan is to revise this DNP project and set it up for journal publication, preferably in the *Journal of Pediatric Health Care*. The *Journal of Pediatric Health Care* is a publication by the National Association of Pediatric Nurse Practitioners. Another potential postgraduation plan will be to take this information and work towards

creating a guideline for sucrose use in children for primary care and published in *The Journal of Pediatric Health Care*.

Analysis of Self

The undertaking of writing this systematic review was eye opening. The process of a systematic review is more than just reading articles and summarizing. A systematic review is a step-by-step process that can be difficult and time consuming. Yet, the work is interesting, valuable, and rewarding in the end when the process is done. This journey has provided me with the ability to understand how to evaluate an article for quality and how to synthesize the information for further use.

Completing this review helped me to understand the process to be able to identify gaps in literature and practice. I have learned how to generate ideas on what needs to come next. These skills will hopefully serve me well in future practice. I hope to be able to continue with this concept and begin the process of translating this information into practice by creating a guideline to be used in primary care in my own practice and for other providers to use in theirs.

Summary

This final section concludes the systematic review on the use of sucrose in children and the recommendation for its use in young children in daily practice for pain management. A discussion on the plan for dissemination was reviewed. In addition, I provided an analysis of self, discussing the growth of the provider and the professional development concluding the final section of this systematic review.

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Appendix A: Literature Review

Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Allen, K., White, D., & Walburn, J. (1996). Sucrose as an analgesic agent for infants during immunization injections. <i>Archives of Pediatric and Adolescent Medicine</i> , 150, 270-274. doi: 10.1001/archpedi.1996.02170280040007	*Double Blind RCT *N=285	*2 weeks, 2, 4, 6, 9, 15, and 18 month old *Unknown Setting	*1- 2 injections *12% sucrose or sterile water *2mL of either solution 2 min before injection	* No significant difference found between sucrose or sterile water	II
Barr, R., Young, S., Wright, J., Cassidy, K., Hendricks, L., Bedard, Y., & Treherne, S. (1995). Sucrose analgesia and diphtheria-tetanus-pertussis immunizations at 2 and 4 months. <i>Developmental and Behavioral Pediatrics</i> , 16(4), 220-225. doi: 10.1097/00004703-1995-08000-0002	*Longitudinal RCT *N=57	*2 months old and repeat of same participants with same solution at 4 month old *Outpatient clinic	*Single immunization *50% sucrose or sterile water *3 doses of solution prior to injection	* Sucrose superior to sterile water in terms of length of crying time post injection. * No different in crying time during injection	II
Blass, E. M., & Hoffmeyer, L. B. (1991). Sucrose as an analgesic for newborn infants. <i>Pediatrics</i> , 87(2), 215-218. doi: 10.1097/00132586-199112000-00033	*RCT *N=54 ** Landmark Study	*24-58 hours old *Inpatient Unit	*Heel lance - 2mL 12% sucrose or sterile water *Circumcision -Sucrose or water flavored pacifier prior/during procedure	* Heel lance sucrose group cried 50% less and returned to baseline faster than control group * Sucrose flavored pacifier before and during circumcision cried 70% less then control group	II
Cincinnati Children's Hospital Medical Center. (2013). Best evidence statement (BEST): Reducing pain for children and adolescents receiving injections. Retrieved from: https://www.guideline.gov/summaries/summary/39440	*National Guideline Clearinghouse *Clinical Practice Guideline *Systematic review	*Infants *Unknown Setting		*Strongly recommends sucrose solution to reduce pain during injections	I

(table continues)

Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Curtis, S., Jou, H., Ali, S., Vandermeer, B., & Klassen, T. (2007). A randomized controlled trial of sucrose and/or pacifier as analgesia for infants receiving venipuncture in a pediatric emergency department. <i>BioMed Central Pediatrics</i> , 7(27). doi:10.1186/1471-2431-7	*Double blind, placebo-controlled RCT *N=84	*Birth to 6 month old *Emergency Room	*1 veni-puncture *44% sucrose or sterile water followed by pacifier *2mL of solution followed by pacifier prior to procedure	* No significant different between any group * Regression analysis did show less crying time with sucrose and pacifier group then sterile water and pacifier alone	II
Desprée, A., & Langeland, E. (2016). The effect of sucrose as pain relief/comfort during immunizations of 15 month old children in health care centres: A randomized controlled trial. <i>Journal of Clinical Nursing</i> , 25(3-4), 372-380. doi:10.1111/jocn.13057	*RCT *N=114	*15 months old *Outpatient clinic	*30% sucrose or sterile water. *2mL of solution prior to injection	* Sucrose group resulted in a shorter cry duration then sterile water group	II
Dilli, D., Kucuk, I., & Dallar, Y. (2009). Interventions to reduce pain during vaccination in infancy. <i>Journal of Pediatrics</i> , 154, 385-390. doi: 10.1016/j.jpeds.2008.08.037	* Prospective, RCT *N=243	*birth to 4 years old *Outpatient clinic	*1- 3 injections age dependent *Group 1: Breastfeeding or no intervention Group 2: 2mL of 12% sucrose given 2 minutes before, 1gm lidocaine-prilocaine cream applied 1 hour before or no intervention	* 0-6 months, breastfeeding reduced crying time and pain scores during immunization * 6-48 months, reduced cry time and pain scores with sucrose or cream compared to no intervention group	II
Harrington, J., Logan, S., Harwell, C., Gardner, J., Swingle, J., McGuire, E., & Santos, R. (2012). Effective analgesia using physical interventions for infant immunizations. <i>Pediatrics</i> , 129(5), 815-822.	* Placebo controlled RCT *N=230	*2-4 months old *Outpatient clinic	*3 injections *4 groups: 2mL of 24% sucrose with standard of care comfort, 2mL of 24% sucrose with 5 S's, 2mL of sterile water with standard of care comfort, or 2mL of sterile water with 5 S's	* The 5 S's (swaddle, side/stomach position, shushing, swinging and sucking) was superior to all methods. * The 5 S's in combination with sucrose was not statistical different from 5 S's alone.	II

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Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Harrison, D, Elia, S., Royle, J., & Manias, E. (2014). Sucrose and lollypops to reduce immunization pain in toddlers and young children: Two pilot randomized controlled trials. <i>Neonatal, Paediatric, and Child Health Nursing</i> , 17(1), 19-26. doi: 10.1111/jpc.12161	*Study 1 -double blind RCT -N=30 *Study 2 -non blinded RCT -N=31	*Study 1 -12-18 months old *Study 2 -3-5 years old *Unknown Setting	*Group 1 -33% sucrose or sterile water -1-3 injections Age dependent *Group 2 - lollypop before injection or active distraction -1 to 2 injections	* No statistical difference in either group between intervention and control for both studies	II
Harrison, D. (2008a). Oral sucrose for pain management in infants: Myths and misconceptions. <i>Journal of Neonatal Nursing</i> , 14, 39-46. doi: 10.1016/j.jnn.2007.12.002	Evidence from expert opinion	*Infants *Unknown Setting		* Large body of evidence showing sucrose effective for minor painful procedures yet underutilized. * Sucrose should be utilized for infants up to age 18 months during minor painful procedures.	VII
Harrison, D. (2008b). Oral sucrose for pain management in the paediatric emergency department: A review. <i>Australian Emergency Nursing Journal</i> , 11, 72-79. doi: 10.1016/j.aenj.2008.02.004	*Systemic Review -12 studies -N=1326	*Birth to 12 years old *Emergency Room		* Sucrose use up to the age of 18 months is effective for minor painful procedures and may be combined with a pacifier or other comforting measures. * Inadequate evidence to support use in school age children.	I
Harrison, D., Beggs, S., & Stevens, B. (2012). Sucrose for procedural pain management in infants. <i>Pediatrics</i> , 130(5), 918-925. doi: 10.1542/peds.2011-3848	*Review *44 RCT's	*Newborn to young infants *Unknown Setting		*Guidelines should include sucrose use for procedural pain	I
Harrison, D., Bueno, M., Yamada, J., Adams-Webber, T., & Stevens, B. (2010). Analgesic effects of sweet-tasting solutions for infants: Current state of equipoise. <i>Pediatrics</i> , 126(5), 894-902. doi: 10.1542/peds.2010-1593	*Review -298 studies identified	*Unknown Setting		*Concludes enough studies exist to support the use of sucrose in infants *Future studies should consist of methods of knowledge translation	I

(table continues)

Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Harrison, D., Elia, S., Royle, J., & Manias, E. (2013). Pain management strategies used during early childhood immunization in Victoria. <i>Journal of Paediatrics & Child Health</i> , 49(4), 313-318. Retrieved from http://www.cambridgepublishing.com/au/publications/neonatal,-paediatric-child-health-nursing.aspx	*Descriptive study *Survey method *N=125	*Nurses that provide pain management in early childhood *Unknown Setting	*Email survey to assess policies regarding pain management and strategies used during immunizations	*Survey found that many type of distraction methods are utilized during immunizations, but sweet solutions such as sucrose rarely used	VI
Harrison, D., Stevens, B., Bueno, M., Umada, J., Adams-Webber, T., Beyene, J., & Ohlsson, A. (2010). Efficacy of sweet solutions for analgesia in infants between 1 and 12 months of age: A systemic review. <i>Archives of Diseases in Childhood</i> , 95, 406-413. doi:10.1136/adc.2009.174227	*Systemic review *14 RCT *N=1674	*1-12 months old *Unknown Setting		* Recommend sucrose or glucose for immunizations up to 12 months old. * With multiple injections, sucrose should be given before and between injections	I
Harrison, D., Yamada, J., & Stevens, B. (2010). Strategies for the prevention and management of neonatal and infant pain. <i>Current Pain and Headache Report</i> , 14(2), 113-123. doi: 10.1007/s.11916-009-0091-0	*Review *80 RCT's, reviews, systematic reviews and unpublished data	*1-12 months old *Unknown Setting		* Recommend 0.1-2mL of sucrose before immunizations up to 12 months old.	I
Harrison, D., Yamada, J., Adams-Webber, T., Ohlsson, A., Beyene, J., & Steven, B. (2015). Sweet tasting solutions for reduction of needle-related procedural pain in children aged one to 16 years (Review). <i>Cochran Database of Systemic Reviews</i> , 5, 1-50. doi:10.1002/14651858.CD008408.pub3	*Meta-analysis -8 studies (1 unpublished) -N=808	*Birth to age 16 years old *Unknown Setting		* There is no evidence in supporting the use of sweet solutions or substances for children over 12 months old.	I

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Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Hatfield, L. (2008). Sucrose decreases infant bio-behavioral pain response to immunizations: A randomized controlled trial. <i>Journal of Nursing Scholarship</i> , 40(3), 219-225. doi: 10.1111/j.1547-5069.2008.00229.x	* Double blind, placebo-controlled RCT *N=40	*2 and 4 month old *Outpatient clinic	*3 sequential injections *24% sucrose or sterile water *2mL of solution prior to injection	* Lower pain scores in groups with sucrose use * No difference in response with age	II
Hatfield, L. A., Chang, K., Bittle, M., Deluca, J., & Polomano, R. C. (2011). The analgesic properties of intraoral sucrose: An integrative review. <i>Advances in Neonatal Care: Official Journal of the National Association of Neonatal Nurses</i> , 11(2), 83-92. doi: 10.1097/ANC.0b013e318210d043	*Integrative review -14 studies	*Newborn up to 6 months of age *Unknown Setting		*Guideline suggestion *Recommends the use of sucrose for up to 6 months of age	I
Hatfield, L., Gusic, M., Dyer, A., & Polomano, R. (2008). Analgesic properties of oral sucrose during routine immunizations at 2 and 4 months of age. <i>Pediatrics</i> , 12(2), e327-e334. doi: 10.1542/peds.2003-3719	* Prospective, placebo RCT *N=100	*2 and 4 month old *Outpatient Clinic	*3 injections separated by few minutes *24% sucrose or sterile water with pacifier *2mL of solution with pacifier	* Sucrose superior to sterile water at 2 minute, 7 minute and 9 minute * Return to baseline sooner then sterile water	II
Hensel, D., Leigh Morson, G., & Preuss, E. (2013). Best practices in newborn injections. <i>Maternal Child Nursing</i> , 38(3), 163-167. doi:10.1097/NMC.0b013c31827cac59	Evidence from expert opinions	*Newborn *Unknown Setting		* Recommend breastfeeding during immunizations. If no able or available, then sucrose administration along with skin to skin contact.	VII
Kassab, M. I., Roydhouse, J. K., Fowler, C., & Foureur, M. (2012). The effectiveness of glucose in reducing needle-related procedural pain in infants. <i>Journal of Pediatric Nursing</i> , 27(1), 3-17. doi: 10.1016/j.pedn.2010.10.008	*Systemic Review -20 studies	*Newborn up to 12 months of age *Unknown Setting		*Glucose is effective in reducing crying time and is recommended for use for pain management without adverse effects	I

(table continues)

Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Kassab, M., Sheehy, A., King, M., Fowler, C., & Foureur, M. (2012). A double-blind randomized controlled trial of 25% oral glucose for pain relief in 2-month old infants undergoing immunizations. <i>International Journal of Nursing Studies</i> , 49(3), 249-256. doi: 10.1016/j.ijnurstu.2011.09.013	*Double blind RCT *N=120	*2 months old *Outpatient clinic	*3 injections *25% oral glucose or sterile water. *2mL of solution prior to injection	* Statistically significant reduction in behavioral pain response and crying time.	II
Lewindon, P., Harkness, L., & Lewindon, N. (1998). Randomized controlled trial of sucrose by mouth for the relief of infant crying after immunization. <i>Archives of Diseases in Childhood</i> , 78, 453-456. doi: 10.1136/adc.78.5.453	*Double blind RCT *N=107	*2, 4, and 6 month old *Outpatient clinic	*2 injections *75% sucrose or sterile water *2mL of either solution 2 min before injection	* Significant difference in all measures of crying with sucrose	II
McCall, J., DeCristofaro, C., & Elliot, L. (2013). Oral sucrose for pain control in non-neonate infants during minor painful procedures. <i>Journal of the American Association of Nurse Practitioners</i> , 25, 244-252. doi: 10.1111/j.1745-7599-2012-00783.x	*Systemic Review -14 studies -N=1237	*Birth to 12 months old *Outpatient clinic		* 24% sucrose concentration administered 2 minutes prior to painful procedure has been shown to reduce pain	I
Miles Curry, D., Brown, C., & Wrona, S. (2012). Effectiveness of oral sucrose for pain management in infants during immunizations. <i>Pain Management Nursing</i> , 13(3), 139-149. doi: 10.1016/j.pmn.2010.07.008	*RCT *N=113	*2 to 6 months old *Outpatient clinic	*50% sucrose, 75% sucrose, or sterile water. *2mL of solution prior to injection	* No significant difference noted for any group	II
Ramenghi, L. A., Webb, A. V., Shevlin, P. M., Green, M., Evans, D. J., & Levene, M. I. (2002). Intra-oral administration of sweet-tasting substances and infants' crying response to immunization: A randomized, placebo-controlled trial. <i>Biology of the Neonate</i> , 81(3), 163-169. doi: 10.1159/000051529	*RCT, non-blinded *N=184	*2, 3 and 4 month old *Outpatient clinic	*2 injections at 2 months, 3 months and 4 months of age. *25% sucrose, 50% sucrose, and sterile water. *2mL of solution prior to injection	* Lower crying time in 4 months group with 50% sucrose * Placebo group at all ages had highest crying time	II

(table continues)

Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Reis, E., Roth, E., Syphan, J., Tarbell, S., & Holubkov, R. (2003). Effective pain reduction for multiple immunization injections in young infants. <i>Archives of Pediatric and Adolescent Medicine</i> , 157, 1115-1120. doi: 10.1001/archpedi.157.11.1115	*RCT *N=116	*2 month old * Outpatient clinic	*4 sequential injections *25% sucrose with pacifier and parental holding or no intervention just standard practice *10mL of solution with pacifier 2 minutes before injections	* Duration of crying time lower with sucrose * No difference in heart rate with sucrose compared to no intervention	II
Rishovd, A. (2014). Pediatric intramuscular injections: Guidelines for best practice. <i>Maternal Child Nursing</i> , 39(2), 107-112. doi:10.1097/NMC.000000000000009	Evidence from expert opinions	*Infants *Outpatient clinic		* Many methods can be used to prevent or reduce pain during injections. * Sucrose can be used when breastfeeding is not an available option.	VII
Russell, K., & Harrison, D. (2015). Managing pain in early childhood immunizations. <i>Kai Tiaki Nursing New Zealand</i> , 21(2), 22-24. Retrieved from http://www.nzno.org.nz/resources/kai_tiaki	Evidence from expert opinions	*Infants *Unknown Setting		* Sucrose can be used for infants before immunizations. If using rotavirus vaccine, this should be given first before injections.	VII
Shah, V., Taddio, A., & Reider, M. (2009). Effectiveness and tolerability of pharmacologic and combined interventions for reduction injection pain during routine childhood immunizations: Systematic review and meta-analysis. <i>Clinical Therapeutics</i> , 31(Suppl. B), S104-2151. doi:10.1016/j.clinithera.2009.08.001	*Systemic Review -11 studies -N=1452 *Meta-analysis -6 studies -N=665	*Infants and Children *Unknown Setting		* Recommend the use of sucrose or cream for immunizations in combination with other interventions such as breastfeeding, distraction, or non-nutritive sucking for immunizations.	I
Taddio, A. (2011). New clinical practice guideline for pain management during routine childhood vaccination -- What pharmacists need to know. <i>Canadian Pharmacists Journal</i> , 144(3), 114-115. doi: 10.3821/1913-701X-144.3.114	*Clinical Practice Guideline	*Infants 12 months of age and younger *Unknown Setting		*Administration of sweet-tasting solution is indicated for the management of pain for immunizations	I

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Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Taddio, A., Appleton, M., Bortolussi, R., Chambers, C., Dubey, V., Halperin, S., & Shah, V. (2010). Reducing the pain in childhood vaccination: An evidence-based clinical practice guideline. <i>Canadian Medical Association Journal</i> , 182(18), E843-E855. doi:10.1503/cmaj.101720	*Systemic Review -11 studies -N=1452 *Meta-analysis -6 studies -N=665	*Infants and Children *Unknown Setting		* Recommend sweet tasting solutions for immunizations up to 12 months old if breastfeeding cannot be utilized.	I
Taddio, A., Flanders, D., Weinberg, E., Lamba, S., Vyas, C., Ilersich, A., ... McNair, C. (2015). A randomized trial of rotavirus vaccine versus sucrose solution for vaccine injection pain. <i>Vaccine</i> , 33, 2939-2943. doi: 10.1016/j.vaccine.2015.04.057	*RCT *N=120	*2-4 months old *Outpatient Clinic	*Oral rotavirus and 2 injections *Rotavirus followed by 2 injections with 24% sucrose after or 24% sucrose followed by 2 injections and rotavirus after. *2mL of solution prior to injection and after injection	* There was no significant difference in pain scores between either group	II
Taddio, A., McMurtry, C. M., Shah, V., Pillai Riddell, R., Chambers, C. T., Noel, M., & ... Antony, M. M. (2015). Reducing pain during vaccine injections: Clinical practice guideline. <i>Canadian Medical Association Journal</i> , 187(13), 975-982. doi: 10.1503/cmaj.150391	*National Guideline Clearinghouse *Clinical Practice Guidelines	*Children 2 years of age and under *Unknown Setting		*Canadian based guideline *Moderate confidence for the administration of sucrose 1-2 min before vaccinations	I
Thyr, M., Sundholm, A., Teeland, L., & Rahm, V. (2007). Oral glucose as an analgesic to reduce infant distress following immunization at the age of 3, 5 and 12 months. <i>Acta Paediatrica</i> , 96(2), 233-236. doi: 10.1111/j.1651-2227.2007.00021.x	* Prospective, placebo RCT *N=110	*3, 5, 12 months old *Outpatient Clinic	*2mL of 30% glucose or sterile water administered 2 min before vaccination *Same solution given at 3 months, 5 months and 12 months of age	*Significant crying time reduction seen in 5 and 12 month group with the use of glucose	II

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Reference	Design/Sample size	Population/Setting	Variables	Findings	Evidence Grade
Wilson, S., Bremner, A., Matthews, J., & Pearson, D. (2013). The use of oral sucrose for procedural pain relief in infants up to six months of age: A randomized controlled trial. <i>Pain Management Nursing</i> , 14(4), e95-e105. doi: 10.1016/j.pmn.2011.08.002	*Blinded RCT *N=64	*1 to 6 months old *Inpatient Unit	*25% or sterile water. *2mL of solution prior to painful procedure	* Sucrose did lower the pain scores although there was no statistical difference noticed. * Non-nutritional sucking did also appear to help lower pain scores as well.	II
Yilmaz, G., Caylan, N., Oguz, M., & Demir Karacan, C. (2014). Oral sucrose administration to reduce pain response during immunization in 16-19 month infants: A randomized placebo-controlled trial. <i>European Journal of Pediatrics</i> , 173, 1527-1532. doi:10.1007/s00431-014-2358-7	*Double blind RCT *N=537	*16-19 months old *Outpatient Clinic	*3 injections *25% sucrose, 75% sucrose, or sterile water. *2mL of solution prior to injection	* 75% sucrose was superior to both 25% sucrose and sterile water * 25% sucrose was superior to sterile water as well	II