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Effective Distraction Techniques During Immunizations for Pediatric Patients

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Effective Distraction Techniques During Immunizations for Pediatric Patients

Repetitive pain is problematic to the pediatric patient because it can create negative neuronal pathways leading to mismanaged pain responses, needle phobia, and post-traumatic stress disorder (Hamm, 2020). In both human and animal studies, it has been found that unalleviated pain in youth correlates to alterations in sensory perception, stress responsiveness, brain cognition, immune function, and overall emotional health (Grunau, 2020). Distraction techniques can be effective in reducing pain experienced by pediatric patients during needle-based procedures, such as immunizations.

Distraction Techniques are not a Standard of Care During Immunizations

Immunizations are the single most common painful procedure that a pediatric patient will experience during their lifetime (McMurty, 2015). The pain experienced during these procedures can lead to negative longitudinal effects spanning well into adulthood. Distraction techniques can be useful in diminishing the painful experience and can contribute to an overall better outcome. However, standardized practice does not utilize the techniques. The aim of this literature review is to highlight evidence-based research that emphasizes the benefit distraction techniques have in reducing painful experiences for pediatrics during immunizations.

PICO

In pediatric patients 3-17 years of age, receiving an immunization, does the use of distraction techniques, such as virtual reality, the Buzzy® device, and/or animation, as compared to standard of care, which is not using a distraction technique, decrease pain as measured by the Baker-Wong FACES pain rating scale?

Background and Significance

Pain has been a negative outcome to adverse stimuli since human life began. Raja et al. (2020) defines it as, “An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (p. 1972). It was further stated that pain is subjective and the inability to verbalize pain does not discount the experience from occurring (Raja et al., 2020). It was previously speculated that infants, aged from birth until three, were incapable of feeling pain (Hamm, 2020). Evidence throughout the years has found that pain, a negative stimulus, exhibited in infancy directly correlates to the formation of neuronal pathways that lay the groundwork for pain response in later years. Grunau (2020) discovered that repeated stress and painful experiences inflicted on newborns causes epigenetic changes, such as DNA methylation, in the patients. Furthermore, MRI scans of the brain have shown differences in volume of the limbic system and thalamus (Grunau, 2020). Repeated painful experiences from healthcare interventions have been found to contribute to decreased volume in the amygdala, thalamus, and hippocampal subregions (Grunau, 2020). The framework the infant brain has constructed from repetitive pain will follow the patient throughout childhood and into adulthood.

The early years of life are often when people first encounter their first painful experience due to the modernization of immunization schedules and regulations. The CDC (2020) lists the first recommended vaccine to be given at birth followed by a series of vaccines to be given throughout childhood. By the age of six years old, the child would have received 36 painful immunizations. McMurtry (2015) wrote that vaccines are the single most common painful procedure experienced during one’s lifespan. Borji et al. (2018) discussed that pain experienced in early life can develop into neurodevelopmental disorders, learning disabilities,

and altered behavior. In a review of the fields of psychology, nursing, pharmacology, medicine, and dentistry, it was found that 93% of children experience pain and stress during immunizations (Melrose, 2019). The repetitive pain can lead to post traumatic stress disorder in later years as evidenced by avoidance behaviors, hypersensitivity to stress and anxiety, and needle phobias (Hamm, 2020). The repetitive stress can lead to severe reactions such as hyperventilation, fainting, weakness, and seizures (McMurtry, 2015). Furthermore, the pain and stress experienced during immunizations have resulted in an increase in non-compliance with immunization scheduling and overall distrust of immunization effectiveness (McMurtry, 2015). In recent years, there have been outbreaks of previously eradicated illnesses, such as pertussis and measles, due to non-compliance with immunizations (Feemster & Szipszky, 2019). Creating a positive environment by diminishing pain can combat this ongoing problem and help prevent anxiety related to receiving immunization.

Burgess (2015) stated that in the primary care setting, where immunizations most commonly take place, there are rarely any methods taken to reduce experienced pain due inadequate knowledge of appropriate methods and/or time constraints. Reducing pain by using distraction techniques during scheduled immunizations in the primary care setting are convenient ways to greatly reduce the long-term sequelae of the painful experience (Burgess, 2015). According to Hamm (2020), there are seven powerful distraction methods that can be used: interactive games, music, reading, videos, light up stuffed animals, and deep breathing. Staff can utilize these methods to reduce pain in pediatric patients and reduce anxiety in caregivers who are present during the procedure.

Distraction techniques have been proven to diminish experienced pain in pediatric patients as measured by the Wong-Baker FACES pain rating scale. The scale has been widely

approved for the pain assessment of patients aged 3 to 18 years of age and consists of six illustrated faces correlating to numbers 0 to 10 (Cerne et al., 2018). The face assigned to zero indicates “no hurt” while the face assigned to ten indicates “worst hurt” (p. 29). The numbers on the scale progress in increments of two and the patient may point to the appropriate illustration correlating to their pain. The pain rating can be diminished by utilizing distraction techniques. Sucrose solutions and music have been used to distract infants during painful procedures while distraction cards and cartoons have been used to distract school-aged children and adolescents. Evidence proving the effectiveness of distraction techniques have allowed for advancements in audiovisual distraction techniques such the use of virtual reality (Mohanasundari et al., 2021). Thermomechanical stimulation has been observed as an effective distraction technique and paved the way for the creation of the Buzzy® device (Redfern et al., 2018). Numerous other distraction techniques have been studied with clear evidence showing that they all lead to a reduction in pain.

Strengths of the Intervention in the Population

In a randomized control trial conducted by Cerne et al. (2015), a sample of 35 six-year-old patients were randomized into two groups. One group of patients was receiving immunizations while watching cartoons as a distraction technique. The other group of patients was receiving immunizations while using the standard method without distractions. The Wong-Baker FACES pain rating scale was utilized to measure the effects of the distraction technique on pain responses during the immunizations. The results found that the group of patients watching cartoons as a distraction technique during immunizations had significantly lower pain scores when compared to the group receiving immunizations using the standard method.

In another randomized control study conducted by Shahiner & Ball (2016), a sample of

120 patients, aged 6 to 12 years old, were randomized into four groups to determine which distraction technique was most effective at reducing pain during phlebotomy. Apart from the control, groups were distracted with either music, balloon inflation, or distraction cards. Pain levels were assessed and measured using the FACES tool. The study found that all distraction techniques resulted in lower pain scores with the distraction cards being the most effective. Furthermore, the study found that the distraction techniques were effective in reducing anxiety perception.

Soares de silva et al. (2016) conducted a descriptive, exploratory, cross-sectional, and qualitative quantitative research study of children ages 3 to 6 undergoing venipuncture procedures. Data was gathered from questionnaires answered by parent/guardians as to whether dolls and puppets used during venipuncture changed their child's reaction to the procedure. The results were that the adult companions unanimously stated the use of toys coerced the children to accept and cooperate with the venipuncture procedure (Soares de silva et al., 2016).

Barriers to Implementing the Intervention

A study by Czarnecki et al. (2019) examined a sample of 808 nurses to identify what the barriers there were to pediatric pain management. The aim of the study was to “examine 6 Diminishing Pain Using Distraction Techniques barriers in different organizations using the same tool during the same period of time” (Czarnecki et al, 2019). The participants in the sample answered a survey that addressed what barriers existed for optimal pain management in children. The results of the survey disclosed that the most significant barriers were insufficient time before procedures and low priority to pain management by staff (Czarnecki et al., 2019).

Alotaibi et al. (2018) conducted an integrated peer review to evaluate the evidence health

care staff have related to barriers to effective pain assessment and management. The research found that the staff have inadequate knowledge of effective distraction techniques that can be utilized during the painful procedure. Barriers that have created this inadequacy can be attributed to absence of pain education and assessment tools (Alotaibi et al., 2018). If healthcare staff were to utilize effective distraction techniques during needle procedures, pain associated with immunizations can be diminished in the outpatient setting. The effectiveness can be measured by the Wong-Baker FACES pain scores of patients who have undergone immunization while utilizing the distraction techniques.

Pain experienced during immunization is, unfortunately, one of the most common negative experiences pediatric patients will have to undergo. Reviews by Borji et al. (2018) provided evidence that experienced pain in early life affects the patient's neurological framework and cognition throughout their lifespan. Pain can lead to post-traumatic stress disorder that can be attributed to avoidance behavior and non-adherence to immunization schedules in the future (Hamm, 2020). Studies by Cerne et al. (2015) and Shahiner & Ball (2016) have found that distraction techniques, such as watching cartoons and using distraction cards, during immunizations correlate to lower pain scores as measured with the Wong-Baker FACES pain rating scale. Soares de silva et al. (2016) discovered that simply using dolls and toys will diminish pain and reduce anxiety related to immunizations. Evidence providing for favorable use of distraction techniques has paved the way for new methods of distraction like virtual reality and the Buzzy® device. The utilization of distraction techniques during immunizations can dramatically diminish pain felt by the pediatric population and contribute to an enhanced patient experience. The holistic comfort of a patient and the multidimensional aspect of their symptoms are discussed in nursing theories.

Nursing Theories

Nursing theories can provide structure to the field of nursing and enhance the patient's experience. Kolcaba's theory of comfort described holistic comfort existing in three forms: relief, ease, and transcendence (Bice et al., 2019). When the patient's specific needs for comfort are met, the patient experiences a sense of relief. The theory of unpleasant symptoms is a holistic middle-range theory that recognizes multidimensional aspects of a patient's symptoms (Blakeman, 2018). By understanding the dimensions of the symptoms, caregivers may reduce factors that the symptoms originate from (Blakeman, 2018).

Theory of Comfort

The theory of comfort is a middle-range nursing practice theory created by Katharine Kolcaba that defines holistic comfort as existing in three forms: relief, ease, and transcendence (Bice et al., 2019). Relief is achieved when comfort needs are met while ease is when discomfort no longer occurs (Yeager, 2019). Transcendence is when the patient can rise above the discomfort when the discomfort has not yet been relieved (Yeager, 2019). These three forms are experienced in the four holistic aspects of a person: spiritual, psychosocial, social, and environmental (Yeager, 2019). The primary strength of the theory of comfort is that patient's involvement is prioritized in order to implement subjective interventions that may lead to their enhanced comfort. This theory has paved the way for the measurement, assessment, and reevaluation of comfort in patients (Petiprin, 2020).

Theory of Unpleasant Symptoms

The theory of unpleasant symptoms, developed by Elizabeth Lenz and Linda Pugh, is a type of middle-range theory that focuses on the root causes of symptoms and their holistic effect on the patient (Blakeman, 2018). The theory recognizes the four measurable dimensions of

symptoms: timing, intensity, quality, and distress (Blakeman, 2018). The effects of the symptoms on the patient are carefully observed by assessing the physical, psychological, and situational influencing factors (Blakeman, 2018). Gholami et al. (2020) mentions that physical factors are those in which symptoms can lead to an established diagnosis. Situational factors can be attributed to those symptoms which are affected by the social aspect and physical environment (Gholami et al., 2020). Psychological factors are those that include the mental state, the knowledge of the symptoms, and the reaction to the illness (Gholami et al., 2020). The theory also pays special attention to the complexity and interrelations between symptoms. Specifically, the theory illustrates that symptoms may interact or even catalyze one another (Blakeman, 2018).

How Theories Have Influenced the Advanced Practice of Nursing

Nursing theories have paved the way for advanced practice nursing by providing structure and enhanced patient assessments. Kolcaba's theory of comfort has influenced various fields of nursing. The American Society of Perianesthesia Nurses (ASPAN) utilized the theory of comfort to gain understanding of the needs and interventions related to comfort in the perianesthesia setting (Kolcaba & Demarco, 2005). The organization used the information to develop practical measures of comfort, and to write ASPAN Pain and Comfort Clinical Guideline (Kolcaba & Demarco, 2005).

The theory of unpleasant symptoms, developed by Lenz and Pugh, has influenced the development of pain management techniques. Gholami et al. (2020) described the use of the theory of unpleasant symptoms in a descriptive-correlational study where data on 153 children were collected using the Coping Strategies Questionnaire, the Child Pain Anxiety Symptoms Scale, and a Visual Analogue Scale for Pain. The focus of the study was to identify the contributing factors related to post-operative pain and facilitate management of pain (Gholami et

al, 2020). The theory allowed them to discover that heart rate, preoperative pain, surgery duration, anxiety and coping are predictive factors for post-operative pain and strategies can be developed to minimize these factors (Gholami et al., 2020).

Theoretical Framework for Project

The theory of comfort and the theory of unpleasant symptoms are related to the PICO question: In pediatric patients ages 3 – 17 years of age receiving an immunization, does the use of the distraction techniques such as virtual reality, the Buzzy® and/or animation as compared to standard of care, which is not using a distraction technique, decrease pain as measured by the Baker-Wong FACES scale? The theory of comfort will allow the opportunity to assess the comfort needs of pediatric patients during venipuncture on a subjective basis so that transcendence can be achieved (Yeager, 2019). The use of distractors for the pediatric patients during the negative experience of immunization can be better utilized if the performer can gauge which specific method best works for the patient (Yeager, 2019). When comfort is enhanced either during or immediately after the procedure, the pediatric patient will potentially be more willing to undergo the procedure in the future (Yeager, 2019).

The theory of unpleasant symptoms can have a profound impact on the initial assessment prior to the venipuncture procedure, the measurement in which pain is assessed, and the evaluation of whether the distractors allowed comfort to be achieved (Blakeman, 2018). The timing, intensity, quality, and distress of the symptoms can be reviewed and can contribute to the development of techniques which minimize the factors associated with the unpleasant symptoms in the future (Blakeman, 2018). By understanding the contributing factors and interrelation of the symptoms, healthcare personnel may enhance the experience for the pediatric patient (Blakeman, 2018).

Theoretical Contribution to the Profession

The MSN project proposal may contribute to the advanced practice nursing field by creating an enhanced patient experience for pediatric patients during immunization and decrease negative sequelae that may occur. A better understanding of the use of distractors and utilize them subjectively for pediatric patients. This could lead to not only an enhanced patient experience but may contribute to more compliance with procedures requiring venipuncture. Pediatric patients may have less fear undergoing procedures, which will lead to a more positive perspective during their adult years. Furthermore, the MSN proposal may lead to the development of new assessment tools or methods of measuring pain in pediatric patients. Instead of only measuring pain before and after a procedure, perhaps the distractors will allow for a more thorough assessment of pain during the procedure.

How Chosen Theories will Guide Personal Practice

The theory of comfort and the theory of unpleasant symptoms can act as guidance in advanced nursing practice. Healthcare personnel may be able to holistically assess patients' experiences with their illness more thoroughly and develop strategies to help them cope with their symptoms. The theory of comfort can allow a discussion with patients on what their specific requirements are to feel comfort in terms of their spiritual, psychosocial, social, and environmental well-being. Together, interventions can be developed that are measurable and achievable.

The theory of unpleasant symptoms can act as guidance in advanced nursing practice by measuring the dimensions of symptoms and their consequential effects on the holistic person. This theory will open a discussion with the patient on what impact these symptoms make on their well-being and steps to recovery. A better understanding of the complexity of not only the

patient's condition, but the patient's specific needs can be made. Enhanced treatment options, including both pharmacological and non-pharmacological, can be established.

The theory of comfort and the theory of unpleasant symptoms are both middle-range theories that have made contributions to the field of nursing. The theory of comfort discussed the three forms of comfort and the subjective interventions that may be implemented to achieve comfort (Bice et al., 2019). The theory of unpleasant symptoms illustrated the measurable, multidimensions of symptoms and how they may be interrelated with one another (Blakeman, 2018). Both theories pay special attention to the holistic aspect of an individual and recognize how each person may need an individualistic approach to their care. The theories can provide guidance in the journey into advanced practice nursing so that patient experiences can be elevated (Rezai et al, 2016). Limiting immunization pain by using distraction techniques support both the theory of comfort and the theory of unpleasant symptoms. Studies have been conducted to support the use of distraction techniques in pediatric patients as revealed in the following literature review.

Literature Search

A literature search was conducted to review if distraction techniques used during pediatric immunizations led to a decrease in pain as measured by the Wong-Baker FACES pain scale. The databases that were utilized for the search were PubMed, Cochrane Library, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The initial search yielded 468 results when using search terms: "Distraction Techniques AND Pediatric Pain." After adding "Immunizations" to the search terms, 34 results were yielded. The search terms "Audiovisual techniques AND FACES Scale" were further added but yielded 0 results. The search was narrowed by filtering articles from the past eight years, 2014 – 2022, and omitting

articles that were part of a systematic review. Articles that were not accessible in the English language or did not allow full-text review were also disregarded. The final search yielded seven randomized-controlled trials (Bergomi et al., 2018; Canbulat et al., 2014; Cerne et al., 2014; Mohanasundari et al., 2021; Redfern et al., 2021; Sahinir & Turkman, 2019; and Susam et al., 2018).

Definitions:

1) **Distraction techniques** are methods causing attention to be diverted from a painful procedure, such as virtual reality, Buzzy®, or animations, in which distress is attempted to be relieved (Hui-Chen et al., 2018).

2) **Virtual reality** is a computerized technology in which a user may be immersed in an artificial, 3-dimensional, simulation environment (Mohanasundari et al., 2021).

3) **Buzzy®** is a thermomechanical, non-invasive medical device that delivers a combination of vibration with cryotherapeutic topical analgesia to reduce pain in needle-based procedures (Bergomi et al., 2018).

4) **Needle-based procedures** are medical interventions involving puncture of the tissue with a sharp medical device, such as in immunizations or venipuncture (Bergomi et al., 2018).

5) **Pain** is a physical and emotional experience perceived and processed by the brain which may be inflicted by medical interventions (Mohanasundari et al., 2021).

6) **Immunizations** are intramuscular injections, also known as vaccinations, given to people of all ages to help the body's immune system combat disease (Freidrichsdorf et al., 2018).

7) **Pediatrics** are a population of people 17 years of age or younger (Kuntz et al., 2019).

8) **Wong-Baker FACES** pain rating scale is an assessment tool used to evaluate pain utilizing visual images in which patients three-years-old and greater can match their pain level to a corresponding score (Cerne et al., 2014).

Literature Review

The aim of this literature review is to highlight evidence-based research that emphasizes the benefit distraction techniques have in reducing painful experiences for pediatric patients during immunizations. Distinct themes were seen in the chosen studies to include the different types of distraction techniques, types of painful procedures, and perspective on how distraction techniques decrease pain. Each theme offered reinforcement to the importance of distraction during painful procedures.

Types of Distraction Techniques

A majority of studies that were reviewed discussed the use of visual distraction techniques versus thermomechanical stimulation in decreasing pain scores measured by the Wong-Baker FACES pain rating scale. Visual distraction techniques that were utilized in the studies were distraction cards, kaleidoscopes, cartoons, and virtual reality. Sahinir & Turkman (2019) found that distraction cards were tremendously more effective at reducing pain during immunizations when compared to no intervention. Canbulat et al. (2014) compared the effectiveness of kaleidoscopes and distraction cards on pain response versus no intervention. It was found that the distraction cards were more effective than kaleidoscopes in reducing pain. This method was further evaluated by Mohanasundari et al. (2021) when distraction cards were compared to virtual reality in reducing pain during immunization. Virtual reality reduced pain significantly more than distraction cards. The distraction cards offered more interaction with the patients than simply observing a kaleidoscope. Furthermore, virtual reality provided interaction

to an even higher degree than the other methods used which may provide insight into the combination of using multiple methods of distraction versus one method alone. Much like virtual reality, thermomechanical stimulation is a relatively new method used as a distraction technique.

Redfern et al. (2018) found that thermomechanical stimulation, using the Buzzy® device, prevailed over no intervention in reducing pain during immunizations. In agreement, Bergomi et al. (2018) discovered that the Buzzy® device indeed reduced pain during immunizations when compared to no intervention. It was also suggested that multiple distraction techniques are more successful in reducing pain scores than one method alone. Susam et al. (2018) and Bergomi et al. (2018) discovered that a combination of the Buzzy® device and distraction cards was far more superior at reducing pain than the Buzzy® device used alone or cartoons used alone as a distraction technique. Bergomi et al. (2018) speculated this is due to the inability of the patient to focus on the cartoon while the Buzzy® device distracts with its light up features and sounds.

The studies demonstrated that the use of distraction techniques decreased pain response more than the standard of having no intervention. The Buzzy® device, which was created for the purpose of reducing pain during needle-based procedures, was superior in pain reduction when compared to visual devices used alone (Bergomi et al., 2018). Virtual reality had similar results of decreased pain response when compared to the other visual devices (Mohanasundari et al., 2021). It was suggested that combining several methods of distraction, such as using the Buzzy® device with distraction cards, can yield improved results (Susam et al., 2018). This may be that utilizing distraction techniques that involves communication or emotional interaction may provide better pain reduction. Perhaps utilizing the Buzzy® device in addition to virtual reality are two available distraction methods that would provide optimal results in pain reduction during immunizations.

Types of Painful Procedures

The studies differed in which painful procedures were evaluated. Bergomi et al. (2018), Canbulat et al. (2014), and Susam et al. (2018) conducted randomized control trials on patients undergoing venipuncture procedures. Bergomi et al. (2018) and Susam et al. (2018) evaluated children in the outpatient setting while Canbulat et al. (2014) observed children in the inpatient setting. Similarly, Mohanasundari et al. (2021) evaluated children in the inpatient setting undergoing venipuncture, but additionally observed children receiving intravenous catheterization and intramuscular injection. Cerne et al. (2014), Redfern et al. (2018), and Sahinir & Turkman (2019) evaluated children receiving intramuscular injections. However, Cerne et al. (2014) and Redfern et al. (2018) conducted their research in the outpatient setting while Sahinir & Turkman (2019) utilized the inpatient setting.

Although the studies differed in their method of painful procedures, the end results were all the same – distraction techniques reduced the perception of pain felt by the patient during needle-based procedures. Bergomi et al. (2018) mentioned that needle-based procedures are the most feared in the healthcare setting. Canbulat et al. (2014) agreed when mentioning that needle-based procedures are the most common sources of pain and distress for pediatrics in the medical setting. Cerne et al. (2014) provided a unique perspective when stating that perception of pain felt during needle-based procedures can lead to reduced effectiveness of analgesics in subsequent procedures. Sahinir & Turkman (2018) and Susam et al. (2018) agreed that anxiety and fear of future medical procedures can be a result of persistent pain experienced during needle-based procedures. Redfern et al. (2018) added that the fear and anxiety can lead to needle phobias which may result in avoidance in treatment or immunization non-adherence.

All the aforementioned studies discussed that needle-based procedures were the most common painful experience that pediatrics are subjected to in the healthcare environment. Distraction techniques have the potential to be used in both inpatient and outpatient environments and during most needle-based procedures. Utilizing distraction techniques for pain reduction can minimize the potential for patients to have needle phobias and avoidance of medical treatments in the future.

How Distraction Techniques Decrease Pain

The mechanism in which distraction techniques affects pain response is not fully understood, but some studies offered insight into potential origins. Bergomi et al. (2018) hypothesized that distractors decrease the perception of pain by modifying the nervous system's nociceptive pathway. An example was provided that the Buzzy® device, with its thermomechanical stimulation, may affect the A β nociceptive fibers by producing the endogenous opioid enkephalin, thus preventing the transport of pain signals from reaching the brain (Bergomi et al., 2018). Similarly, Redfern et al. (2018) and Susam et al. (2018) discussed that the Buzzy® device decreases pain due to the gate-control theory, discovered by Melzack and Wall in 1965. This is the hypothesis that the cold feature of the Buzzy® device causes the fast pain gate to "close" while the vibration feature stimulates the A β nociceptive fibers causing presynaptic inhibition at the dorsal horn (Redfern et al., 2018). In another example, Canbulat et al. (2014) discussed that an interactive distraction, such as a kaleidoscope, created more attention diversion from the painful stimulus than a non-interactive distractor, such as distraction cards. Cerne et al. (2014) rationalized that active involvement of the child in the distraction introduces a positive stimulus that subdues the negative stimulus to makes the experience more pleasant.

Mohanasundari et al. (2021) and Sahinir & Turkman et al. (2019) did not discuss the gate-control theory and instead postulated that reducing emotional stress contributes to a reduction in pain. Mohanasundari et al. (2021) discussed that pain is not only a physical, but also an emotional experience that is processed in the brain. It was stated that distraction techniques divert attention away from the negative stimulus, which decreases anxiety related to the stimulus, thereby reducing pain (Mohanasundari et al, 2021). A coinciding perspective was when Sahinir & Turkman et al. (2019) mentioned that reducing stress related to a painful procedure in effect reduces perceived pain.

The studies were in complete accord that distraction techniques decrease pain in pediatric patients. Although the exact mechanism of pain reduction is not fully understood, there is strong evidence showing that distraction is more effective than no intervention. The use of the Buzzy® device's thermomechanical stimulation as a distraction technique may hinder the painful stimuli from transporting to the brain as seen in the gate-control theory. In the same effect, the positive stimulus introduced during interactive distraction may subdue the negative stimulus resulting in pain reduction. The cognitive benefit to distraction is a decrease in anxiety and emotional stress related to the painful experience. Regardless of the mechanism in which pain is decreased, the outcome remains constant. Distraction techniques effectively lead to pain reduction in pediatric patients during needle-based procedures.

Limitations and Strengths of the Studies

Limitations were found upon review of the studies. The first limitation was a range of sample sizes. Cerne et al. (2014) used a small sample size of 35 pediatric patients, Redfern et al. (2018) had 50 patients, and Susam et al. (2018) had 75 patients. This is significantly smaller than the remainder of the studies which had greater than 100 patients that were evaluated. The second

limitation was that all of the studies did not have a double blinded research design. Researchers were aware which patients were in the control group and which had a distraction intervention which may have created an unconscious bias when obtaining results. The last limitation was the fluctuation of personnel who were conducting the needle-based procedures. The healthcare staff each had varying experience and technique involved in administering immunizations and performing venipuncture which may have affected the perception of pain by the patient. Lastly,

Strengths were numerous in the studies. All demonstrated the effectiveness of distraction techniques on pain reduction during needle-based procedures when compared to no intervention, regardless of which distraction method was used. Pain was found to be decreased in both inpatient and outpatient settings as well as affecting a range of pediatric ages. Furthermore, it was found that a decrease in anxiety and distress were associated with the use of distraction techniques during the procedures. This finding was also evident in caregivers accompanying the pediatric patient and healthcare staff performing the procedure. Lastly, all studies used a standardized measurement when evaluating pain response. The Wong-Baker FACES pain rating scale was used to evaluate pain response according to the patient, caregiver, and healthcare personnel. The assessment tool was incremental in demonstrating the effectiveness of distraction techniques on pain response.

Gaps in the Literature

Gaps in the literature were analyzed. One finding was that Bergomi et al. (2018) disclosed that the Buzzy® device is inappropriate for venipuncture procedures testing for plasma proteins, albumin, and transferrin levels. The cold feature causes an increased molecular concentration at the venipuncture site which may skew the results (Bergomi et al., 2018). This phenomenon also occurs when testing for hematocrit and erythrocyte count (Bergomi et al.,

2018). This information makes the Buzzy® device have limited use during venipuncture and would require additional operator education regarding appropriate use. This information was only disclosed in a single study but is crucial information to relay as laboratory tests, particularly a complete blood count, are one of the main reasons for venipuncture.

Another gap in the literature was the inconsistency in implementing multiple distraction techniques simultaneously during the needle-based procedures. Bergomi et al. (2018) and Susam et al. (2018) identified that using the Buzzy® device, in addition to animations and distraction cards respectively, yielded enhanced results in comparison to the methods used alone. This outcome was not mentioned in the other studies nor was the combination of distraction techniques discussed. Virtual reality, albeit a new technology, was found to impact the perspective of pain. This technology influences multiple sensations and perhaps could prevail over the other distraction techniques if more readily used. It would be compelling if there were studies involving a combination of virtual reality in addition to other distraction techniques, such as the Buzzy® device.

Conclusion

Immunizations are the single most common painful procedure that a pediatric patient will experience during their lifetime (McMurtry, 2015). Longitudinal studies have found that the repetitive pain experienced during these procedures influence structures in the brain. These changes correlate to post traumatic stress disorder in later years as evidenced by avoidance behaviors, hypersensitivity to stress and anxiety, and needle phobias (Hamm, 2020). Despite the knowledge that exists surrounding the long-term sequelae occurring from immunizations, there is no standard of care to decrease pain for pediatric patients. Distraction techniques are cost-effective strategies that have been found to be effective in reducing pain. Various methods, such

as the Buzzy® device, virtual reality, and animations, can be used alone and/or in conjunction with one another to reduce pain in both inpatient and outpatient settings, and during most needle-based medical procedures. The use of distraction techniques has the added benefit of decreasing anxiety and distress in not only the patient, but also the patient's caregiver and the healthcare staff involved in performing the painful procedure. Adopting the use of distraction techniques as the standard of care during immunizations can be a considerable start in the right direction to reducing pain for pediatric patients and, in effect, reducing the potential for long-term negative sequelae because of the procedure.

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