Interventions for paediatric procedure-related pain in primary care

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As a part of routine and specialized health care, children are subjected to a number of invasive medical procedures (eg, immunizations, venipunctures). These events are anxiety provoking and painful, and can have detrimental short-term and long-term effects. The present paper provides an overview of pharmacological and nonpharmacological techniques for the management of procedure-related pain in children, with a focus on clinically relevant information. Sufficient detail is provided to facilitate the translation of reviewed strategies into standard practice.

Key Words: *Nonpharmacological; Pain; Pharmacological; Procedure; Treatment*

La prise en charge de la douleur reliée à des interventions pédiatriques en soins primaires

Dans le cadre des soins systématiques et spécialisés, les enfants sont soumis à un certain nombre d'interventions médicales effractives (p. ex., vaccins, ponctions veineuses). Ces interventions provoquent de l'anxiété et de la douleur, et elles peuvent avoir des effets néfastes à court et à long terme. Le présent article contient un aperçu des techniques pharmacologiques et non pharmacologiques pour prendre en charge la douleur reliée à des interventions chez les enfants, et s'intéresse surtout à l'information pertinente d'un point de vue clinique. Il contient assez de détails pour faciliter le passage des stratégies évaluées à la pratique standard.

ASSESSMENT AND TREATMENT OF PROCEDURAL PAIN IN CHILDREN

As a part of routine and specialized health care, children are subjected to a number of invasive medical procedures (eg, immunizations and venipunctures). According to guidelines published by the United States Centers for Disease Control and Prevention in 2005, children are to receive roughly 29 intramuscular immunization injections by six years of age. These events are anxiety provoking and painful, especially for younger children, who exhibit higher distress than older children (1-3). In fact, Jacobsen et al (2) report that as many as 45% of four- to six-year-old children experience 'serious or severe distress' during immunization procedures. In many cases, procedure-related distress is so severe that it results in escape behaviour (eg, kicking) and a need for child restraint (4).

In addition to the unnecessary short-term suffering, paediatric procedural distress can have long-term detrimental effects on the patient. For instance, Bijttebier and Vertommen (5) found that children with a history of negative medical experiences showed higher levels of anxiety before a venipuncture procedure, and were more distressed and less cooperative during the procedure. Childhood medical distress has also been linked to adults' reports of pain and fear regarding medical events, and negative experiences with early medical procedures have even been linked to the avoidance of future health care (6). In addition, early painful procedures have been associated with increased behavioural sensitivity to later medical insults (7), a finding that is supported by recent physiological evidence indicating that activation of the nociceptive system can alter neuropathways, resulting in increased sensitivity to later stimulation (8).

Given the evidence for short- and long-term impacts of procedure-related pain, there has been a recent surge in research into factors that are associated with increased pain and the development of pain management interventions. Unfortunately, much of this research has been published in specialty psychology and anesthesiology journals and has not been widely disseminated into primary care. Hence, the purpose of the present article is to provide a brief review of research on paediatric procedural pain management and to provide specific practice recommendations. Rather than providing an exhaustive review of all interventions available

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for numerous types of procedure-related pain, we focus in more detail on several evidence-based interventions that are applicable to the most common types of procedures in typical paediatric practices (eg, immunizations and venipunctures). It is important to note that the present article is not meant to be a systematic review of the literature, but, rather, is designed to be a succinct presentation of literature on strategies for pain management that have demonstrated efficacy in primary care. Where possible, we include only those studies that meet the highest scientific standards (eg, randomized controlled trials meeting Consolidated Standards of Reporting Trials [CONSORT] guidelines [9]). For those cases in which such studies are not available, we review the studies that are the most methodologically sound (eg, having the largest sample sizes and multimethod means of evaluating outcomes).

INTERVENTIONS FOR PROCEDURAL PAIN

A great deal of recent research has been dedicated to the development of interventions for paediatric procedure-related pain. Both pharmacological and nonpharmacological interventions have received empirical attention. Pharmacological interventions are generally topical formulas that reduce pain by providing local anesthesia to the procedure site. Taking a slightly different approach, behavioural interventions target pain by providing coping skills and interventions to modify pain signals via cognitive and affective pathways.

PHARMACOLOGICAL INTERVENTIONS

It is beyond the scope of the present paper to review all of the pharmacological methods of procedural pain control, particularly those that are required for specialty procedures (eg, conscious sedation protocols for bone marrow aspirations or lumbar punctures). Instead, we focus more closely on those pharmacological interventions that are widely available and are appropriate for many in-office paediatric procedures (eg, immunizations).

Topical anesthetics have received a great deal of empirical study in the management of paediatric procedural pain. The application of eutectic mixtures of local anesthetics (EMLA, AstraZeneca, USA), such as lidocaine and prilocaine, to the skin inhibits ionic fluxes that initiate and conduct pain receptor neuronal impulses, thereby resulting in local anesthesia. Topical anesthetics have been shown to be effective in relieving pain during various medical procedures, including skin grafts and circumcision (10,11). However, some studies suggest that it is not as effective for deep tissue pain, such as intramuscular injections (12). Unfortunately, the widespread use of topical mixtures such as these is limited by the time requirements necessary for optimal performance. EMLA, for example, requires at least 1 h to provide sufficient epidermal and dermal anesthesia. However, newer preparations using liposomal lidocaine (eg, ELA-Max, Ferndale Laboratories, USA) or amethocaine gel allow for shorter application time (30 min), with no apparent differences in efficacy from traditional eutectic mixtures (13,14). Administration time has been further reduced by the use of iontophoresis (15), but the use of this strategy necessitates an initial investment in the apparatus. Although there was some initial concern about local anesthetics interfering with antibody response to immunizations, these concerns have been unfounded in later studies (16).

Further addressing the drawbacks of administration time requirements, preparations such as ethyl chloride and vapocoolant sprays have been used to provide immediate-onset but brief-duration (approximately 20 s) dermal and epidermal anesthesia. Ethyl chloride has a distinct advantage over EMLA in that it has a much lower cost (approximately $0.50 per patient with vapocoolant versus approximately $15.00 per patient with EMLA) and requires less time to reach maximal effectiveness (approximately 20 s with vapocoolant versus at least 1 h with EMLA). Although there is a fair amount of evidence supporting the efficacy of vapocoolant for medical procedures in adults (17), results in children have been mixed. For example, a recent comparison of vapocoolant and placebo sprays for intravenous cannula insertion in children revealed no significant benefit of vapocoolant on self-reported pain (18). Alternatively, Cohen Reis and Holubkov (19) found positive effects of vapocoolant; specifically, it was as effective as topical creams. Cost, inconvenience and delayed onset of action continue to be drawbacks to pharmacological interventions for brief acute pain (20).

Developmental considerations

Of note, most of the research conducted on various preparations of topical anesthetics has been used in older children and adults. However, according to manufacturer's instructions, EMLA can be used for infants as young as 37 weeks' gestational age. Notably, there have been several randomized, controlled trials conducted that have demonstrated the efficacy of eutectic mixtures for infant venipuncture (21) and circumcision (22). Notably, evidence for the efficacy of topical anesthetics for heel lance is still equivocal (23). Unfortunately, little is known about the efficacy of vapocoolant or ethyl chloride in infants.

One intervention that is particularly relevant to the discussion of developmental considerations in the management of procedural pain is sucrose, which is often used as an alternative to pharmacological methods in infants. A recent Cochrane Collaboration review (24) that included over 20 randomized, controlled trials evaluating sucrose for heel stick or venipuncture in neonates up to 28 days of age indicated that sucrose was safe and effective in the management of pain from single procedures. Unfortunately, the optimal dose of sucrose has not yet been identified, with doses ranging from 0.012 g to 0.12 g demonstrating efficacy. Furthermore, definite age cut-offs for the efficacy of sucrose are unknown (24).

SUMMARY OF PHARMACOLOGICAL STRATEGIES

A variety of pharmacological strategies are available for the management of paediatric procedural pain in primary care.

EMLA is effective for venipunctures, but its efficacy in intramuscular immunization is limited. Traditional preparations such as EMLA are limited by their requirement of 1 h preprocedure administration. Alternatives, such as liposomal lidocaine or iontophoresis, help to reduce administration time, without any apparent effects on efficacy. Immediate-effect preparations, such as ethyl chloride and vapocoolant, are time and cost effective, but have equivocal efficacy and are limited by their short duration of anesthetic effect.

NONPHARMACOLOGICAL STRATEGIES

Physical interventions

Approaching paediatric procedural distress from another perspective, several nonpharmacological techniques have been evaluated for paediatric procedural pain. Nonpharmacological techniques are generally divided into physical and behavioural techniques. Physical techniques include, but are not limited to, injection technique, massage and counter-stimulation. Despite the anecdotal evidence and intuitive appeal of these strategies, there has been very limited evaluation of physical interventions for procedural pain in children. Studies in adults have demonstrated the efficacy of counter-stimulation, such as pinching (25) and pressure (26), but these strategies have not been evaluated in children.

Behavioural interventions

Early studies of behavioural interventions evaluated multicomponent interventions and found that these combined interventions proved to be effective in decreasing pain during various procedures, including burn debridements (27) and lumbar punctures (28). Typical protocols involved combinations of strategies, such as distraction, relaxation breathing, emotive imagery and reinterpretation of pain. For example, Elliot and Olson (27) used distraction strategies, such as having children look for something hidden in the room or complete mathematical problems in their heads. Slowed breathing was included as a part of another multicomponent intervention (29). Specifically, children engaged in paced breathing by blowing into a party blower slowly while the caregiver counted out loud. Tangible reinforcers (eg, stickers) were offered to the child contingent on their use of the party blower. Children who received this intervention displayed fewer distress behaviours and were rated as being less distressed than children in the control group.

Although multicomponent procedural interventions showed efficacy in research studies, their clinical feasibility was limited by additional staff requirements (eg, a trained therapist to administer the intervention). Furthermore, the fast-paced nature of paediatric offices precluded the time-consuming preparation of children for routine procedures. As such, researchers began to develop more streamlined interventions that required fewer resources and could be implemented in a relatively short period of time.

Distraction

The most thoroughly evaluated single component strategy is distraction. The theoretical explanation for the effectiveness of distraction lies in its ability to divert attention away from the painful stimulus. McCaul and Malott (30) hypothesized that the brain has a limited capacity to focus attention on stimuli. Therefore, using up attentional resources while engaging in a distracting task leaves little capacity for attending to painful stimuli.

A variety of distraction strategies have received empirical attention (eg, party blowers, cartoon movies and music), and outcomes have been assessed in multiple dimensions (eg, parent-report, self-report and observational distress). Despite the variability in strategies, the results of most studies demonstrate the efficacy of distraction as an intervention for paediatric pain and distress. Distraction is particularly appealing because it can be easily administered in a time- and cost-efficient manner. For example, adult nonprocedural talk requires no equipment and is always available to practitioners. Gonzales et al (31) manipulated mothers' verbalizations during preschoolers' routine immunizations to examine the relative effects of nonprocedural talk (distraction) and reassurance. Consistent with other studies (4), children whose mothers used nonprocedural talk as distraction displayed less distress than those who used reassurance.

In terms of distraction interventions that require equipment, Cohen et al (32) examined cartoon movies as a distractor for preschool immunizations. The results of the study indicated that children who were distracted by a movie displayed fewer distress and more coping behaviours than children in the control environment. Adding to the applicability of these findings, Cohen et al conducted a cost-effectiveness analysis on their cartoon distraction intervention. They noted that the cost of training nurses to administer distraction, as well as the initial investment in the equipment, would be approximately $454, with no additional costs over subsequent years. A later study (12) using similar methodology found that cartoon distraction was more effective in reducing observed distress in children undergoing immunization than EMLA, again demonstrating the cost effectiveness of distraction.

Demore and Cohen (33) conducted a comprehensive review of distraction strategies for immunization pain, and evaluated these strategies on the basis of clinical and statistical significance, cost efficacy and time requirements. Most of the distraction interventions demonstrated both statistical and clinical significance (as judged by effect size) and were time and cost efficient to implement. Those strategies that required an overt response from the child and that involved multiple sensory modalities were most effective.

Procedural preparation

Preparing children for upcoming painful procedures also falls under the category of a behavioural intervention. In this case, information about what will happen during the procedure is provided to the child. Traditionally, preparation

for hospitalization and surgery have received more empirical attention than preparation for shorter, primary care procedures such as immunizations. In the hospitalization literature, preparation programs have used combinations of play modelling, tours and instruction in coping strategies. Studies suggest that these programs are most effective when administered five to seven days before the procedure and for older children (older than six years of age [34]). Unfortunately, meeting these demands (particularly preparation one week before the procedure) in primary care is difficult. Although intuitively appealing, preparation delivered too close to the procedure (eg, in the waiting room before the procedure) may increase children's distress.

Developmental issues: Behavioural strategies

Most of the literature on behavioural pain management for paediatric procedures has been conducted in children who are preschool aged and older. Only a few studies have evaluated interventions for infants. Cohen et al (35) examined nurse-directed movie distraction in infants receiving immunizations. Distraction was found to lower children's behavioural distress during both the anticipatory and postinjection recovery phase, but not during the procedural phase. Cramer-Berness and Friedman (36) compared parent-directed toy distraction with a supportive care condition and a control group for infants. Parents in the supportive care condition group were encouraged to use techniques that were commonly effective at comforting their infants. Study results indicated that infants in the supportive care condition recovered more quickly from the immunization than infants in the control group, but there were no differences between the distraction and control groups with respect to infant distress. Inconsistent results with regard to the effectiveness of distraction for infants suggest that continuing examination of this intervention is warranted.

CONSIDERATIONS IN BEHAVIOURAL INTERVENTIONS

There is strong evidence for the use of cognitive-behavioural techniques (particularly distraction) in the management of paediatric procedure-related pain. There are a few key points for paediatricians to note, however, that may ensure that behavioural strategies are implemented in the most effective way.

Choice of distractors

Distraction is an effective intervention, but its efficacy depends on the distraction stimulus being sufficiently engaging to capture a child's attention. This is especially difficult during procedures because the pain stimulus and stimuli surrounding the procedure are very powerful. As such, the choice of distractor is important. Theoretically, those distractors that require more of a child's attention should be more effective (30), but applied research has suggested that putting too many demands on a child's attention during a procedure may be counterproductive. MacLaren and Cohen (37) addressed this question by comparing two types of commonly used distraction strategies. One strategy required an active, overt response from the child (toy robot), whereas the other was more passive in nature and did not require such a response (cartoon movie). It was hypothesized that children using the more interactive distraction strategy would be more distracted and, therefore, less distressed. Results were contrary to hypotheses, however, and indicated that those children who received a more passive distraction strategy were less distressed. The investigators suggested that children's anticipatory distress may have interfered with their ability to interact with a distractor, highlighting the importance of considering children's previous experience and preprocedural distress when selecting a distraction strategy.

Need for coaching

It is also important to note that children do not have as many coping resources as adults and, as such, benefit from adult instruction and encouragement to engage in coping. However, it is important to note that in many cases, simple instruction is not adequate. Even when training in coping strategies is provided to children, they do not engage in these strategies unless prompted by adults (38). Research indicates that this prompting or 'coaching' by adults can be assured by providing training in behavioural strategies. Parents have been one source of coaches for paediatric procedures. Kleiber et al (39) evaluated the effects of a 7 min video training in distraction and positive reinforcement for parents of children undergoing intravenous tube insertion. Parents who watched the training video showed significantly more distracting behaviour than parents who did not watch the video. Training parents in behavioural techniques is especially appealing because it provides them with a skill that can be used for subsequent procedures. However, training individual parents can be time consuming, leading some researchers to use health care personnel as coaches. For example, Cohen et al (32) trained nurses to coach children in distraction during immunizations. Results indicated that children coached by nurses engaged in more coping behaviour and had less distress than children who were not coached. Furthermore, children who were coached by nurses engaged in as much coping as children who were trained in coping themselves and had both a parent and nurse trained in distraction. This study indicated that training nurses to engage children in distraction is a cost-effective coaching technique.

Parental factors

Whether or not parents are trained as coaches, it is important to consider parental factors in paediatric procedural pain. McCarthy and Kleiber (40) provide a good review of parental factors that impact children's responses to medical procedures. For example, they note that the parents' perception of nonpharmacological strategies is an important consideration in their likelihood to administer such strategies. Parental variables, such as parent anxiety and parenting

styles, have received little empirical study. Alternatively, the impact of discrete parental behaviours on children's procedural pain has been extensively studied. Not surprisingly, the efficacy of distraction is evident in this context, with a great deal of research indicating that children with parents who provide more distraction are less distressed. One parental behaviour that has received some attention for its possible detrimental impact during paediatric procedures is reassurance. In a recent commentary, McMurtry et al (41) hypothesized on potential mechanisms for this potential counterintuitive relation. They suggested that reassurance may be a warning signal to the child that there is something wrong, thus creating more distress. They also suggested that reassurance may inadvertently reinforce pain behaviour or may provide permission for the child to display pain behaviour (both mechanisms would result in increased distress).

SUMMARY OF NONPHARMACOLOGICAL STRATEGIES

Nonpharmacological strategies are effective in the management of children's procedural pain and can be used to address the limitation of pharmacological strategies. Physical interventions, such as counter-stimulation and injection technique, have received support in adults, but have yet to be well validated in children. Behavioural techniques, particularly distraction, are well supported, and their efficacy can be optimized by choosing the distractor carefully and attending to parental factors. Procedural preparation can be effective, but ideally should be delivered at least a few days before the procedure and should include training in coping strategies.

CONCLUSIONS

Painful medical procedures are a component of routine and specialized health care in children, and cannot be avoided. Recent evidence of the potential detrimental short-term and long-term effects of untreated procedural pain has led to a surge in research developing and evaluating interventions. Pharmacological interventions exert their effects by locally blocking nociception. Treatments such as EMLA and ethyl chloride spray have become more common in standard paediatric practices, but they have limitations. In addition to pharmacological techniques, cognitive-behavioural techniques have been shown to be effective in reducing procedure-related pain. The most time and cost efficient of these interventions is distraction, with coaching by an adult. Unfortunately, many intervention strategies (eg, counter-stimulation, injection technique and preparation) have anecdotal and intuitive value, but require additional research before specific recommendations can be provided regarding their application in paediatric procedural pain.

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