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Abstract

Children endure numerous acute painful events, most of which occur within the medical arena. For instance, by the time a child reaches the age of 6, the child will have experienced approximately 30 immunization injections (Centers for Disease Control and Prevention, 2008). Grounded in the Gate Control Theory (Melzack & Wall, 1965), psychological methods of pain management have focused on anxiety and pain management via behavioral means. In addition, ample research has been devoted to how best to prepare children and their parents for upcoming painful or distress-provoking procedures (e.g., surgery, hospitalization, injection). This paper will review the preparation literature, which details how to inform and arm children and their parents for impending procedures and will highlight the psychological pain management literature which includes distraction, cognitive behavioral therapy, and additional promising interventions.

Psychological Approaches to Acute Pediatric Pain Management

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage (International Association for the Study of Pain Subcommittee on Taxonomy, 1986). Across pediatric and adult populations, pain is the most common reason that people seek medical care (Stewart, Ricci, Chee, Morganstein, & Lipton, 2003). Children endure numerous acute painful events within the medical arena. For instance, by the time a child reaches the age of 6, the child might have undergone approximately 30 routine immunization injections (Centers for Disease Control and Prevention, 2008). Previous research suggests that there can be numerous secondary detrimental effects associated with unmanaged pediatric pain. These consequences include neuro-developmental outcomes (i.e., neuronal plasticity; Woolf & Salter, 2000), future psychological distress (Bjittebier & Vertommen, 1998), and adult medical non-adherence behavior (Pate, Blount, Cohen, & Smith, 1996). Fortunately, there is a rich body of pediatric psychology literature to guide interventions aimed at optimizing pain preparation and management.

Theories of Pain

Gate Control Theory

There are several theories that assist in our conceptualization and understanding of the pain experience. The most notable is the Gate Control Theory of Pain (GCT), which provides a scientific framework for understanding the complex mechanisms associated with the experience of pain (Melzack & Wall, 1965). This theory suggests that pain is a result of the interplay between both physiological and psychological factors. GCT proposes that the transmission of nerve impulses from the brain can inhibit (close the gate) or facilitate (open the gate) spinal cord transmission. Thus, descending psychological processes such as thoughts, beliefs, emotions, and

attention are an integral part of the pain experience through their influence on ascending pain signals. For example, children who are reporting increased anticipatory anxiety might have an amplified pain experience, whereas children attending to pleasant stimuli such as a movie or book may have less pain. The complex coordination and interaction of multiple systems highlighted by GCT supports the potential of psychological methods and interventions for influencing the pain experience. The results achieved through neurological/pharmacological-based approaches can also be achieved through behavioral strategies aimed at psychological factors that influence neuronal output.

Biopsychosocial Model of Pain

Similar to GCT, The Biopsychosocial Model of Pain (BMP) emphasizes a complex interaction among multiple systems. The focus of BMP is the variability of the pain experience that is influenced by biological, psychological, and social factors (for a review, see Asmundson & Wright, 1996). Contributing biological factors include, but are not limited to disease status, tissue/organ damage, and physiological changes. Psychological factors may include an array of subjective experiences or mental states, whereas social factors include cultural contexts or beliefs that influence one's perception of pain. In contrast to the biomedical model, which focuses on the disease or biological condition, BMP's focus is extended to include illness behaviors that are defined as one's perceptions and responses to the biological state (Mechanic, 1962). Additionally, the manner by which these systems interact can vary as a function of individuals, impairment, and time. Thus, the implementation of psychological interventions should also account for the inherent variability of these factors.

Biobehavioral Model of Pediatric Pain.

Another useful framework for conceptualizing pediatric pain is the Biobehavioral Model of Pediatric Pain (BMPP; Varni, 1989). Varni identified four primary categories of pediatric pain, which include pain associated with chronic illness, pain associated with physical injury, pain not associated with a specific cause, and pain associated with acute medical procedures. BMPP suggests that pain perception and behavior is influenced by several risk and resiliency factors. The variables identified through this model include precipitants (e.g., disease, injury, stress, procedures), intervening variables (e.g., biological predispositions, family environment, cognitive appraisal, coping strategies, perceived social support), and functional status (e.g., activities of daily living, school attendance, depressive symptoms, anxious symptoms, behavioral problems, interpersonal relationships). BMPP's multivariate approach to understanding pediatric pain has laid the groundwork for the implementation of behavioral interventions aimed at reducing children's acute pain experiences.

Behavioral Intervention Considerations

Developmental Level

An important consideration of both preparation and management approaches is the child's developmental level. Cognitive development impacts a child's perception of pain such that as they progress through certain developmental stages, their understanding shifts as well. Piaget's (1954) stages of development suggest that children's reasoning is characterized by four stages, which are qualitatively different from one another. Thus, as children progress from the preoperational stage (approximately 2-6 years) to the concrete operational period (7-12 years) their cognitive abilities come to include abstract thinking, perspective flexibility, and mental operations. Research suggests that, as a result of these different developmental stages, preparation interventions are more efficacious for older than younger children (Vernon &

Thompson, 1993). In addition, more abstract assessment (e.g., visual analog scales) and intervention (e.g., imagery) approaches can be used effectively with older children whereas younger children respond better to approaches that are more concrete. Another important maturational achievement is the ability to form insights into one's physiological and psychological processes (Walsh & Bibace, 1991). Younger children are also less able to encode, store, and retrieve information from memory. Their encoding abilities are largely dependent on verbatim information and knowledge, both of which are uniquely flawed resulting in greater forgetting than older children (Brainerd & Ornstein, 1990). Though young children have the capacity to store as much information as older children, their rate of forgetting is much more rapid (Brainerd & Reyna, 1995). Additionally, the ability to retrieve information and apply it to a medical event is influenced by whether they merely observed or actively participated in the intervention (Gobbo, Mega, and Pipe, 2002). Thus, psychological approaches should take into consideration both the developmental and cognitive appropriateness of the intervention.

Ethnocultural Variables

Bronfenbrenner (1979) described an interaction between several social and cultural contexts that influence psychological functioning in children and adults. Specifically, these layers of context consist of the following levels: microsystem (i.e., immediate social relationships), mesosystem (i.e., medical setting, school, church), exosystem (i.e., medical board, insurance companies), and macrosystem (i.e., cultural practices, values, institutions). Though behavioral intervention research is typically concentrated within the microsystem level, it is imperative to consider the complex relations among all of these variables. Further examination of the exosystem level yielded the Institute of Medicine report, through which Smedley, Stith, and Nelson (2002) noted a failure to both recognize and effectively treat pain in minorities.

Additionally, these reports concluded that racial and ethnic minorities are at risk for undertreatment of pain. Though, the majority of health disparities research is focused on adults, it is likely that parents, who are advocates for their children, will have had experiences with disparate care which may indirectly effect children's acute pain experiences. Greater awareness of the history of inequities in pain care is essential to the development of culturally-appropriate, evidence-based practices in pediatric pain preparation and management.

Behavioral Interventions

Acute medical procedures can be organized into four discreet stages: anticipation, preparation, procedural, and recovery (Fanurik, Koh, Schmitz, & Brown, 1997). During the anticipation phase, medical providers obtain the medical and psychological history in addition to establishing rapport with the family. The preparation phase consists of pre-procedural procedures such as blood draws or other tests (e.g., MRI's), which may lead to increased fear and anxiety in the child. The time period that encompasses the actual medical event is referred to as the procedural phase, which is immediately followed by the recovery phase that provides the child with an opportunity to recover both physically and psychologically from the procedure.

Preparation programs typically occur well in advance up until shortly before the anticipation phase, whereas pain management programs often occur immediately before the anticipation phase and at any subsequent time through all phases including recovery. Behavioral preparation and intervention have been proven to be efficacious clinical interventions for children enduring a range of medical care.

Preparation

The use of preparative interventions as a way to decease children's medical distress has been proven effective in a range of stressful pediatric procedures including anesthesia and

surgery (Kain & Caldwell-Andrews, 2005; Margolis et al., 1998), venous access (Cohen, in press), dental procedures (Melamed, Yurcheson, Fleece, Hutcherson, & Hawes, 1978), imaging (Pressdee, May, Eastman, & Grier, 1997), hospitalization (Gross, 1986; Melamed, Meyer, Gee, & Soule, 1976; Nelson, & Allen, 1999), and ear piercing (Spafford, von Baeyer, & Hicks, 2002). Several important features of preparation programs have been identified including timing, format, content, coping skills, and parents (Jaaniste, Hayes, & von Bayer, 2007).

Timing. Children who have relatively accurate expectations and are equipped with adequate coping behaviors typically report lower levels of distress during medical procedures and better adjustment post-procedure (Melamed & Ridley-Johnson, 1988). Effective preparatory interventions utilize timely and developmentally-appropriate methods, which lead to increases in children's knowledge coupled with decreases in anxiety and distress. Information should be provided sufficiently in advance of the event so that the child has time to process it (Kain, Mayes, & Caramico, 1996). Information provided too far in advance of the medical procedure could lead to increases in anticipatory anxiety and forgetting of pertinent information (Eiser & Patterson, 1983; Melamed & Ridley-Johnson, 1988). Timing is also related to whether the particular procedure is major or minor. Less invasive procedures, such as immunizations or blood draws may be well-suited to same-day information provisions, whereas major surgeries might require advanced delivery of information (Kain, et al., 1996). However, children's perception might help determine whether or not a procedure is deemed "minor" or "significant" (Cohen, in press).

Format. Format is an important aspect of pediatric pain preparation. A variety of information-providing formats have been examined in the literature including computer programs (Franck & Jones, 2003; Rassin, Gutman, & Silner, 2004), videos (Melamed & Siegel,

1975; Peterson & Shigetomi, 1981), puppets (Cassell, 1965) written summaries (Felder-Puig, et al. 2003), live modeling (Klingman, Melamed, Cuthbert, & Hermecz, 1984), and hospital tours (Gross, 1986; Peterson, Ridley-Johnson, Tracy, & Mullins, 1984). The approach of each format varies in terms of its emphasis on didactics and experiential learning with a combination of some aspect of diversion. Additionally, different behavioral approaches may be useful for children of different ages. Younger children may not have the cognitive capacity to understand that puppets or dolls represent him or herself, suggesting that modeling (in person, video, or computer) may be more developmentally appropriate (Salmon, 2006). Modeling may be especially useful for children with limited experience with the medical procedure or environment. Research suggests that the addition of visual illustrations to written or verbally presented material may optimize memory in children of all ages (McGuigan & Salmon, 2005).

Sociocultural theories emphasize social practice as an integral part of children's learning (Vygotsky, 1978), and research has found that by approximately two months of age, children are able to engage in active interaction (Bateson, 1979). Thus, the format of the preparation intervention should construct an environment where the child is not merely a passive observer or recipient of information. The child should be encouraged to participate in an interactive dialogue where they can ask questions and be fully engaged. In addition to explicit learning, children also engage in implicit learning. Children observe the medical environment, which includes a range of potentially anxiety-provoking visual and auditory stimuli. They may view other children crying, children being pushed in wheel chairs, or healthcare providers with wary expressions and they may hear other children screaming, medical providers speaking amongst themselves in terms they do not understand, or parents attempting to comfort their children. Thus it is critically important to encourage children to actively engage and ask questions as they arise.

Content. One of the most important considerations for a preparation program is the content. Given that children's attention may be divided, and younger children do not have the cognitive capacity to anticipate future physical and emotional states, the content and language must be clear, concrete, and developmentally-appropriate. Whereas sensory information in isolation was found to be useful in the reduction of pain and distress, integration of both sensory and procedural information has been shown to be optimally efficacious (Sokolov, 1963; Spafford, et al., 2002; Suls & Wan, 1989; Tak, & van Bon, 2006). Children should be able to predict what will take place during the procedure as well as what they will feel. Thus, the information should be concrete and specific and the language used to convey the information should be developmentally-appropriate because the terminology children often use to describe pain, discomfort, or fear varies as a function of age (Stanford, Chambers, & Craig, 2005). Providing specific sensory and procedural information allows the child to both develop a sense of mastery over the information and an ability to apply the information to their experience. During the medical procedure, the medical provider should continue to guide the child through the steps by outlining the procedural and sensory information in a calm voice with age-appropriate language.

Coping style and skills. An additional factor that is integral to a preparation program is the patient's coping style. Lazarus and Folkman (1984) defined stress as the relation between life events and one's responses to those events. This model may be applied to pediatric pain such that pain only becomes a stressor when the child's ability to manage or cope with the stressor, is either insufficient or overwhelmed. Depending on the outcome, coping strategies can either be adaptive or maladaptive. Thus, assessing the utility of the strategy is based on the mechanism by which pain relief is appropriately managed. Common features of coping skills training include

instructing the child to engage in active relaxation (e.g., diaphragmatic breathing, imagery, progressive relaxation) or distraction techniques (e.g., counting backwards, imagery, repeating a mantra, solving problems).

Parent behavior. Parents' behaviors during children's medical procedures have been shown to account for a large amount of the variability in children's coping and distress (Cohen, Bernard, Greco, & McClellan, 2002). Whereas parents' presence alone has not been shown to be instrumental in decreasing children's pre-surgical anxiety (Piira, Sugiura, Champion, Donnelly, & Cole, 2005), parents' behavior was found to be an important factor (Caldwell-Andrews, Blount, Mayes, & Kain, 2005). Thus, many preparation programs seek to engage the parents directly through targeting their anxiety (Jay & Elliott, 1990) or indirectly through teaching them to be coaches for the pediatric patient (Cohen, Blount, & Panopoulos, 1997). Though there appears to be no research evaluating whether variability in the quality of information provision provided by different sources is associated with child outcomes, adult modeling of distraction and appropriate coping behaviors have been shown to be associated with decreases in child distress. In contrast, specific parent behaviors have been identified that are positively correlated with child distress include criticizing, apologizing, and providing excessive reassurance (McMurtry, McGrath, & Chambers, 2006).

Interventions

Whereas preparation programs are conducted in advance of the medical procedure, many pain management approaches are implemented during the actual procedure. Specifically, behavioral interventions such as relaxation training (Jay, Elliott, Katz, & Siegel, 1987), breathing exercises (Kazak, Penati, Boyer, Himelstein, Brophy, Waibel, et al., 1996), rehearsal (Powers, Blount, Bachanas, Cotter, & Swan, 1993), positive reinforcement (Jay, et al., 1987), and imagery

(Jay, Elliott, Fitzgibbons, Woody, & Siegel, 1995) have met criteria for "empirically-supported treatments" (Powers, 1999). Distraction, an integral component of the aforementioned interventions, has been supported through a meta-analysis (Kleiber & Harper, 1999). Sucrose administration has been shown to be an effective pain management intervention for neonates and young infants (Barr et al., 1995). In addition to these behavioral approaches, positioning has also been proven beneficial to the pediatric patient, especially for infants and toddlers (Halimaa, 2003; Stephens, Barkey, & Hall, 1999).

Distraction. The mechanism by which distraction has been found most effective is through the manipulation of attention. McCaul and Mallott (1984) hypothesized that the brain has a limited capacity to focus attention on stimuli. Once this system is depleted by focusing on an engaging task, there are few resources left for the child to devote to attending to a painful stimuli. In addition to the diversion of attention framework, Cohen (2002) suggests that distracters interfere with the classical condition pathway, whereby attention is diverted away from pain-inducing stimuli in the environment. Distraction has been shown to minimize children's fear, anxiety, and pain while simultaneously maximizing their coping. Many different forms of distraction stimuli have been researched including movies (Cohen, 2002), interactive toy robots (Pringle et al., 2001), virtual reality goggles (Hoffman et al., 2004), music (Fowler-Kerry & Lander, 1987), bubble-blowing (Sparks, 2001), and short stories (Mason, Johnson, & Wooley, 1999). Regardless of the theoretical explanation or type of strategy, distraction appears to be an effective intervention for pediatric pain management.

Virtual reality distraction, which typically consists of a head mounted display with interactive auditory and visual input has been proven to be an effective behavioral intervention for pediatric burn debridement (Das, 2005), burn rehabilitation (Hoffman, et al., 2001), and

cancer-related procedural pain (Gershon, Zimand, Pickering, Rothbaum, & Hodges, 2004; Wint, Eshelman, Steele, & Gizzetta, 2002). The bulk of the research in virtual reality has been with patients being treated for burn injuries (Lange, Williams, & Fulton, 2006). A variety of virtual reality stimuli have been utilized including videogames, interactive toys, and environmental manipulations such as "Snow World" (Hoffman, Doctor, Patterson, Carrougher, & Furness, 2000). Of note however, there are several drawbacks to the implementation of virtual reality as a behavioral intervention including its high cost and necessity of technical expertise.

Optimal distraction stimuli typically take into account multiple sensory modalities such as vision, hearing, and touch in addition to consideration of both timing and individual factors. A key component is that they promote positive emotional states that are incompatible with pain and distress (Demore & Cohen, 2005). A meta-analysis found distraction to be an equally effective intervention for pediatric pain management across gender and ethnic groups with increased success in children less than 7 years of age (Kleiber, et al., 1999). For older children, there are mixed results regarding the effectiveness of sensory focusing, which involves directing one's attention toward the sensations of the medical procedure instead of away from it (Fanurik, Zeltzer, Roberts, & Blount, 1993; Piira, Hayes, Goodenough, & von Bayer, 2006). Children who engage in an approach coping style may be able to decrease their own pain and distress by being actively involved in the procedure. Although more research in this area is warranted, the utility of sensory focusing as a form of distraction appears to be closely associated with the child's particular coping style (Christiano & Russ, 1998). More detailed analyses, examining specific procedural phases suggests that the introduction of distraction stimuli is dependent on the child's affective state. Distraction interventions implemented prior to the medical procedure reduce

anticipatory anxiety whereas interventions implemented during or after the procedure enhance recovery (Blount, Piira, & Cohen, 2003).

Cognitive-behavioral treatments (CBTs). The central tenet of the cognitive-behavioral model is that patients' beliefs and schemas interact with emotional factors and behavioral responses to reinforce adaptive and maladaptive ways of thinking, feeling, and behaving (Turk, 2002). McGrath (1990) noted that the instability of situational factors (cognitive, behavioral, and emotional) interact with the child's individual factors to create a situation where pain is experienced. Cognitive factors include children and parent's knowledge/understanding, behavioral factors encompass children and parent behavioral responses, and emotional factors refer to their feelings about the painful experience. In conjunction with the Society of Pediatric Psychology (SPP) Empirically Supported Treatment Task Force, Powers (1999) concluded that CBT was a well-established intervention for pediatric procedural pain. Powers (1999) outlined several empirically-supported CBT approaches including behavioral rehearsal, breathing exercises, emotive imagery, and positive reinforcement. When compared with pharmacological agents such as valium (Jay, et al., 1987) or EMLA cream (Cohen, et al., 1999), CBT was found to be as effective or superior in decreasing children's pain and distress. CBT approaches have been utilized with several pediatric pain populations including children undergoing bone marrow aspirations (BMAs) or lumbar punctures (LPs; Blount, Powers, Cotter, Swan, & Free, 1994; Kazak, et al., 1996;), injections and venipuncture procedures (Dahlquist, Gil, Armstrong, Ginsberg, & Jones, 1985; Manne, et al., 1990), and routine immunizations (Gonzalez, Routh, & Armstrong, 1993).

Hypnosis. Though the mechanism by which hypnosis operates is still unclear, it has been hypothesized that pain reduction occurs indirectly through attention control and dissociation

(Hilgard & Hilgard, 1983; Spiegel & Spiegel, 1978). More recently however, advances in neuroscience have found that during hypnotic states, changes in blood flow and electrical activity have been observed in multiple cerebral regions and in descending pathways of the spine (Danzinger et al., 1998; Rainville e al, 1999). Research has supported the use of hypnosis as a behavioral intervention in the treatment of BMAs (Liossi & Hatira, 2003), fracture pain (Iserson, 1999), unspecified pain (Uman, Chambers, McGrath, & Kisely, 2006), and postoperative pain (Lambert, 1996). Though the limitations of hypnosis include the lack of a clear operational definition and a minimal understanding of its functional mechanisms, hypnosis appears to be a promising intervention that warrants further research.

Biofeedback. Olton & Noonberg (1980) define biofeedback as "any technique which increases the ability of a person to control voluntarily physiological activities by providing information about those activities". In the pediatric psychology literature, biofeedback has received empirical support in the treatment of acute and chronic pain (Allen, Elliott, & Arndorfer, 2002; Arndorfer & Allen, 2001; Spirito & Kazak, 2006). A meta-analysis revealed that thermal biofeedback in combination with propranolol (a beta-blocker commonly used in the treatment of migraine headaches) yielded an average symptom improvement of 70% in pediatric migraine patients, which is much higher than is typically found in adult patients (Hermann, Kim, & Blanchard, 1993). Additionally, significant decreases in anxiety, analgesic use, headaches, pain intensity and number of pain episodes were found in children with sickle cell disease who participated in six biofeedback sessions (Cozzi, Tryon, & Sedlacek, 1987). Despite the fact that much of the research is confounded by small sample sizes and other treatment confounds, biofeedback appears to be a promising intervention for pediatric acute and chronic pain which requires further investigation.

Conclusions

In sum, given the increasing amount of acute painful procedures that children experience, pediatric pain preparation and management is an area that warrants continued attention. Various theories have guided our understanding of pain and thus informed research, providing strong evidence that children's acute pain can be managed through the implementation of psychological approaches. Developmental and ethnocultural considerations have been proven as important factors that should be taken into account in the management of children's pain. Behavioral approaches, broadly defined in terms of preparation and intervention programs have been proved useful in decreasing children's acute pain. Specifically, preparation programs, with integral features including timing, format, content, individual coping style, and parent behavior, have received support as effective tools in decreasing child distress either directly or indirectly. In tandem, distraction and CBT have been proven as empirically-supported interventions and the clinical utility of hypnosis and biofeedback is encouraging.

There are several future directions for clinical research into pediatric pain management; most importantly, a shift of focus from the microsystem (e.g., parent, child, healthcare providers) to the largely ignored but influential macrosystem (e.g., cultural practices, values, and institutions; Bronfenbrenner, 1979). It is important to recognize that in order to bring about long-term change in the way pediatric pain is both conceptualized and treated, integration of factors outside of the realm of the medical environment are needed. Parents, children, and healthcare providers come together with a prescribed set of values and beliefs, which need to be taken into consideration when developing future behavioral interventions. Second, a more encompassing view of the "patient" is in order; treatments targeting other important individuals such as siblings will ensure optimal pain management. Third, the downward extensions of adult-based

interventions to children should be carefully considered given the unique developmental characteristics of children (McGrath, 2005). Variability in children's cognitive, emotional, and developmental functioning needs to be addressed throughout the intervention approach. Fourth, the link between clinical research and clinical practice needs to be strengthened. As it is the responsibility of the researcher to assure that their interventions are practical and feasible in terms of cost, time, and expertise, clinical practitioners should remain knowledgeable of advances in their field. Fifth, given that much of the research has successfully proven the efficacy of short-term pain relief, investigation into the long-term benefits of pediatric pain management is necessary. Lastly, integration of multiple disciplines such as medicine, nursing, pharmacology, social work, physical therapy, and other health related fields would continue to strengthen the body of literature aimed at alleviating child physical pain and psychological suffering. As science continues to advance, psychology in conjunction with many other disciplines will continue to need to work towards relieving unnecessary child pain through the implementation of evidence-based interventions and treatments.

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