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Clinical Implications of Unmanaged Needle-Insertion Pain and Distress in Children

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ABSTRACT

Increasing evidence has demonstrated that pain from venipuncture and intravenous cannulation is an important source of pediatric pain and has a lasting impact. Ascending sensory neural pain pathways are functioning in preterm and term infants, yet descending inhibitory pathways seem to mature postnatally. Consequently, infants may experience pain from the same stimulus more intensely than older children. In addition, painful perinatal procedures such as heel lancing or circumcision have been found to correlate with stronger negative responses to venipuncture and intramuscular vaccinations weeks to months later. Similarly, older children have reported greater pain during follow-up cancer-related procedures if the pain of the initial procedure was poorly controlled, despite improved analgesia during the subsequent procedures. Fortunately, both pharmacologic and nonpharmacologic techniques have been found to reduce children's acute pain and distress and subsequent negative behaviors during venipuncture and intravenous catheter insertion. This review summarizes the evidence for the importance of managing pediatric procedural pain and methods for reducing venous access pain. *Pediatrics* 2008;122:S130–S133

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Key Words

venipuncture, peripheral cannulation, pain, nociceptors, psychophysiology, developmental biology

Abbreviations

IV—intravenous
ED—emergency department

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ELIMINATION OR RELIEF of pain and suffering, whenever possible, is an important responsibility of physicians caring for children,¹ because unmanaged pain can result in a variety of negative long-term consequences.² This general precept encompasses the management of pain associated with venipuncture and intravenous (IV) cannulation, routine procedures that may be viewed by many health care professionals, erroneously, as having little significance and impact. **Increasing evidence has demonstrated that venous access procedures are an important source of pediatric pain that should be managed proactively.** The purpose of this review is to briefly summarize the data demonstrating the importance of managing pediatric procedural pain in general, and venous access pain in particular.

GENERAL CONSIDERATIONS

Understanding of the ontogeny of the pediatric pain experience has increased significantly over the past 2 decades. Accumulating evidence has indicated that pain is perceived earlier in life than had been previously believed. By the middle of the third trimester of human gestation, ascending pain fibers fully connect to the primary somatosensory cortex of the brain.^{3,4} Anand's landmark article⁵ demonstrated that preterm infants given fentanyl in addition to nitrous oxide had significantly lower hormonal responses to surgery for ligation of the patent ductus arteriosus than did infants who did not receive fentanyl. Neonates who received high-dose sufentanil compared with halothane-morphine had improved survival rates after cardiac surgery,⁶ whereas infants in the NICU have been shown to be able to distinguish real from sham heel sticks.⁷ These results are consistent with the existence of functioning neural pathways for pain sensation at early times. Descending inhibitory pain pathways, on the other hand, seem to require postnatal development; rather than being less sensitive to pain, a misconception widely held until recently, newborn infants may actually experience pain more intensely than older children.⁸

Because the brain rapidly matures during the first weeks to months after birth, recurrent painful stimuli may alter the formation of new neuronal circuits, resulting in children's hypersensitivity and increased behavioral response to noxious stimuli.^{3,9–11} Long-term consequences have been noted in premature infants who have undergone multiple painful events in the NICU. Grunau et al found differences in pain sensitivity on the basis of parental ratings in extremely low birth weight 18-month-olds¹² and differences in pain ratings between extremely low birth weight infants and controls at 8 to 10 years of age.¹³ Fortunately, knowledge that these types of experiences may alter the development of a child's later pain sensation has prompted improved pain management in many patient populations.

Memory of Early Pain is Evident

Studies have demonstrated that even term newborn infants have a memory of painful events. Infants of diabetic mothers, but not matched controls, exhibited increased pain responses when their uninjured skin at the dorsum of the hand was cleansed with alcohol in preparation for venipuncture at 72 hours of age. These infants had experienced multiple heel sticks for blood glucose measurements in the first 24 to 36 hours of life, whereas control infants had had no heel sticks.¹⁴ Boys who had been circumcised at birth without effective anesthesia cried longer and had increased pain reactions at their 4- and 6-month routine vaccinations than uncircumcised controls.¹⁵ Similarly, toddlers who had experienced painful postoperative care during their first 3 months of life demonstrated greater pain responses at their 14-month immunizations compared with controls; this effect was not observed at 45 months.¹⁶

Pain Impacts Future Procedures

Painful cancer-treatment procedures have been associated with negative memory and greater pain during later procedures,¹⁷ even when the later procedures were performed with adequate analgesia.¹⁸ A compelling example of this was demonstrated in young children who, in addition to a local anesthetic, received placebo instead of an oral analgesic agent during initial lumbar puncture and bone marrow aspiration for the evaluation of newly diagnosed cancer.¹⁸ Children who received placebo for the initial procedures reported greater pain and continued to report greater pain and distress during follow-up procedures despite receiving the oral analgesic for the later procedures.¹⁸ Finally, children undergoing dental injections have been found to have increased pain when they feel anxious from previous procedures.^{19,20}

Although the mechanisms underlying these observations have yet to be fully elucidated, these data show that painful episodes can be encoded into children's implicit and explicit memories.²¹ Praising a child after a painful procedure, in an effort to modify negative memories, has been shown to lessen these memories and reduce distress during subsequent procedures.²² Prevention or alteration of negative memories is a crucial part of breaking the negative feedback loop that can then cause greater anxiety and pain during future procedures.^{22,23}

PERIPHERAL VENOUS ACCESS PROCEDURES

Effects on Children

Venipuncture and intravenous (IV) cannula insertions are the 2 most common sources of pain in hospitalized children.²⁴ IV cannula insertions were also found to be the second most common cause of the worst pain experienced during hospitalization (second only to pain related to the patient's underlying disease).²⁵ Observational and self-report studies of children and adolescents undergoing routine venipunctures have consistently demonstrated high levels of pain and distress in adolescents, preadolescents, and toddlers.^{26–29} In 1 study,²⁶ a total of 171 children ranging in age from 3 to 17 years

and requiring venipuncture were included in the survey analysis. Moderate-to-severe levels of pain associated with venipuncture were reported in 36% of children 3 to 6 years of age and 13% in children 7 to 17 years of age. Another study used trained observers to evaluate distress, by using the Groningen Distress Scale,²⁸ in 223 children and adolescents undergoing routine venipuncture. In the absence of premedication or psychological interventions, high levels of distress during venipuncture were reported in 50% of the children. When evaluated according to age group, high levels of distress were reported in 83% of the toddlers (2 1/2–6 years of age), 51% of the preadolescents (7–12 years of age), and 28% of the adolescents (≥ 12 years of age).²⁸

Despite the wealth of information highlighting the importance of pain associated with venous access procedures, management of this pain may often be inadequate.^{30,31} One potential outcome may be needle phobia.³² The development of needle phobia, a true medical condition that is included in the *Diagnostic and Statistical Manual of Mental Disorders* within the diagnostic category of blood-injection-injury phobias,³³ is estimated to be present in up to 10% of the population.³² Needle phobia seems to require both a genetic predilection and negative experiences with needles in childhood.³² Needle-phobic patients exhibit sometimes extreme adverse physiologic responses to needles, including vasovagal responses, changes in heart rate and stress hormone levels, and echocardiogram changes; they also may have increased morbidity and mortality throughout their lives as a result of chronic avoidance of medical care.³²

Studies also suggest a correlation between childhood pain and fear associated with medical procedures and adult pain sensitivity, fear, and avoidance of health care.^{32,34} In a study of 47 children aged 2 to 12 years who were hospitalized for a planned surgical procedure, parents were asked about previous medical experiences and to rate their child's anxiety before a blood draw.³⁵ The authors found no correlation between the number of previous episodes and the parent's rating of the child's anxiety. However, the quality of the previous experience did correlate with anxiety. The results showed that children who had had negative previous venipuncture experiences had higher anxiety ratings than those without previous negative experiences.³⁵

Effects on Parents

The effects of venous access pain may not be limited to children exclusively. From a general perspective, functional imaging studies have shown a partial activation of the pain-response system in persons who observed a loved one receiving a painful stimulus.³⁶ Physiologic and anxiety-related responses have also been measured in caregivers who observed their child receiving a venipuncture while in the emergency department (ED).³⁷ Changes in heart rate, blood pressure, and anxiety were evident in parents during their child's venous cannulation, and these responses were predictive of pain and distress in the child.³⁷ In a prospective survey of parents of children (≤ 8 years of age) presenting to an ED, most parents (89%) indicated that they would choose for

their child's IV catheter placement to be painless; of these, 65% were willing to stay an extra 1 hour, 77% were willing to spend an extra \$15.00, and 37% were willing to pay an extra \$100.00 to ensure that the procedure was painless.³⁸

Effects on Health Care Providers

Health care providers often find performing venous access procedures in fearful and anxious children to be challenging. A recent survey of 2188 pediatric, emergency, and infusion nurses reported that children are physically restrained by another nurse and/or their parent/caregiver during IV cannula insertions 74% of the time.³⁹ The morale of nurses working on a burn unit has been linked to perceived challenges to their image of themselves as alleviators of pain.⁴⁰

In a study of 40 nurses in a pediatric ED, beliefs about pediatric IV catheter insertion were evaluated before and after an educational intervention that aimed to improve the understanding and use of local anesthetics and comfort techniques during such procedures.⁴¹ Nurses reported a reduction in their distress associated with IV cannula insertions after the educational intervention, compared with before the intervention, when local anesthesia was used ($P < .0001$). Moreover, 76% of the nurses reported that IV cannula insertion was easier when local anesthesia was used. Improving peripheral venous access pain management correlates with enhanced job performance and job satisfaction among nurses.³⁹

In another study, Taddio et al⁴² compared the duration and success of IV cannulation procedures in children 1 month to 17 years of age by using liposomal lidocaine 4% (LMX4 topical anesthetic cream [Ferndale Laboratories, Inc, Ferndale, MI]; previously known as ELA-Max) or placebo. A total of 142 children completed the trial. The cannulation success rate on the first attempt was significantly higher in the children who received liposomal lidocaine 4% compared with those treated with placebo (74% vs 55%, respectively; $P = .03$). A reduction in total procedure time was also noted for those who were treated with the topical anesthetic (6.7 vs 8.5 minutes with placebo; $P = .04$). Venipuncture success rates after application of topical lidocaine and prilocaine cream, 2.5%/2.5% (EMLA cream [eutectic mixture of local anesthetics] [AstraZeneca LP, Wilmington, DE]) were evaluated in a study conducted in the ED setting.⁴³ Patients with a high likelihood of requiring a venipuncture, as assessed by a triage nurse, were identified and randomly assigned to receive either lidocaine and prilocaine cream, 2.5%/2.5% or no intervention. Successful venipunctures with use of the topical anesthetic were reported for 84% (51 of 61) of the patients versus 65% (58 of 89) for those with untreated skin ($P = .01$).

These studies demonstrate the significant impact of venous access procedures on health care providers and argue persuasively that better management of the associated pain improves practical aspects of the procedure (overall time, success rates). Additional study will be necessary to determine if these effects translate into

significant job-satisfaction improvements on the part of nurses and other health care providers.

CONCLUSIONS

Routine inpatient and outpatient medical care frequently involves needle-insertion procedures for peripheral venous access. These procedures are among the most frightening aspects of the health care experience for children. In contrast to long-held beliefs, research now supports the existence of a pain response early in life. Even such seemingly minor medical procedures as needle insertions for vascular access can create significant pain and distress for a child, cause anxiety in adult caregivers, and be challenging events for nurses. In addition, negative memories of distressing and painful needle-based procedures in childhood may result in exaggerated memories of the pain and heightened distress during subsequent procedures. Reduction of pain and distress associated with these types of procedures may help to reduce long-term negative consequences and improve procedural outcomes.

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