

3. Yourc'h G, Tannieres ML, Freche G: Anaesthesia for microsurgery of the larynx using a carbon dioxide laser. *Anaesthesia* 34:53-57, 1979
4. Hirshman CA, Smith J: Indirect ignition of the endotracheal tube during carbon dioxide laser surgery. *Arch Otolaryngol* 106:639-641, 1980
5. Pashayan AG, Gravenstein JS: Helium retards endotracheal tube fires from carbon dioxide lasers. *ANESTHESIOLOGY* 62:274-277, 1985
6. Norton ML, De Vos P: New endotracheal tube for laser surgery of the larynx. *Ann Otolaryngol* 87:554-557, 1978
7. Wolf GL, Simpson JI: Flammability of endotracheal tubes in oxygen and nitrous oxide enriched atmosphere. *ANESTHESIOLOGY* 67:236-239, 1987
8. Lu T, Ohmura A, Wong KC, Hodges MR: Helium-oxygen in treatment of upper airway obstruction. *ANESTHESIOLOGY* 45:678-680, 1976

Anesthesiology  
68:804-806, 1988

## Comparison of the Analgesic Effects of EMLA (Eutectic Mixture of Local Anesthetics) to Intradermal Lidocaine Infiltration Prior to Venous Cannulation in Unpremedicated Children

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Fear of needles and the pain associated with venipuncture often makes iv cannulation prior to the induction of general anesthesia a traumatic experience for awake children. Many attempts have been made to obtain a suitable formulation of topically applied local anesthetics that can produce adequate skin anesthesia to allow painless venipuncture. Recently, a eutectic§ mixture of the local anesthetics (EMLA) lidocaine and prilocaine, which can penetrate the intact skin, has become available (table 1). This mixture has been shown to be effective in preventing pain associated with venipuncture in studies that compared EMLA to either a placebo or nothing at all.<sup>1-4</sup> This study compares prospectively the analgesic efficacy and acceptability of EMLA *versus* the current practice of intradermal infiltration with lidocaine (skin wheal) prior to venous cannulation in awake unpremedicated children.

### MATERIALS AND METHODS

The study was approved by the Institutional Review Board, and informed consent was obtained in every case. Forty-two ASA Physical Status I unpremedicated children, ages 7-12 yr, scheduled for minor ambulatory

surgical procedures were studied. Younger children were not included, because we found from previous studies that they have difficulty using analogue pain scales. Children who had a history of allergy or hypersensitivity to the amide type of local anesthetics were excluded from the study. To avoid possible bias resulting from the selection of children who prefer or have already accepted an intravenous induction of anesthesia, participation in the study was offered as an alternative to undergoing phlebotomy for preoperative laboratory testing; a procedure that is required of all children in our institution.

Patients were randomly assigned to one of two groups. Children in group I had 2.5 g of 5% EMLA cream applied over the anticipated venipuncture site on the dorsum of the nondominant hand. The cream was covered with an occlusive dressing for 60 min, the recommended optimal application time for EMLA to be fully effective.<sup>2</sup> After the 60 min, the occlusive dressing was removed and the skin was wiped dry and inspected for local reaction. The skin was then cleaned with 70% isopropyl alcohol and allowed to dry prior to iv cannulation. Children in group II had the corresponding skin area infiltrated with 0.2 ml of 1% lidocaine using a 30-gauge needle. All venipunctures were performed by the same investigator. The patient's response was assessed first during the performance of a skin "nick" using the bevel of a 19-gauge needle, and again during the actual iv cannulation, which was accomplished by using a 20-gauge catheter in all cases. Blood for routine laboratory testing was withdrawn from the iv cannula. The cannula was then flushed with a dilute heparin solution, taped and secured on an armboard for use during induction of anesthesia.

The patient's response to venipuncture was scored by the anesthesiologist performing the venipuncture, an

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Received from the Departments of Anesthesiology, Child Health and Development, Children's Hospital National Medical Center and George Washington University, Washington, DC. Accepted for publication December 21, 1987. Presented in part at the Annual Meeting of the American Society of Anesthesiologists, Atlanta, Georgia, October, 1987.

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Key words: Anesthesia; pediatric. Anesthetics, local: lidocaine; prilocaine. Anesthetic techniques: topical.

§ A eutectic "mixture" is the liquid formed from specific solid constituents at the lowest possible temperature.

TABLE 1. Composition of EMLA Cream (5%)

Lidocaine (base)	2.5 g
Prilocaine (base)	2.5 g
Arlatone® 289	1.9 g
Carbopol® 934	1.0 g
Sodium hydroxide solution 2M	7.2 g
Water purified to	100.0 g

independent observer, and the child using a 0-10 visual analogue pain scale (fig. 1). The degree of cooperation exhibited by the child during the procedure was recorded by the observer using a five-point scale (table 2).<sup>5</sup> The data were analyzed using Spearman's rank correlation to compare agreement between pain scores by the patient, anesthesiologist, and observer, as well as to examine differences in the response of the two groups to venipuncture and in the degree of cooperation during the procedure. A *P* value < .05 was considered significant in all cases.

RESULTS

The two groups did not differ with regard to age (mean = 9.7 yr), and there was no statistically significant association between age and pain scores. Two patients who initially agreed to participate in the study were later excluded. The first was a 9-yr-old child who became agitated and diaphoretic immediately following the application of the EMLA cream. This same child experienced a similar episode in the laboratory during routine phlebotomy. A second child was excluded following application of the cream because the scheduled time of surgery was moved up due to cancellation of a previous case, thus not allowing sufficient time for the mandatory 60-min EMLA contact period.

Thirty-nine of the remaining 40 children had satisfactory analgesia for iv cannulation. One child in the EMLA group had inadequate analgesia by all three assessments. Children in group I, scoring their own pain, chose a median of 3, while group II scores were 3.5, range 0-10 in both groups (table 3). These differences were not statistically significant. The children in both groups I and II rated their pain and discomfort significantly higher than did either the anesthesiologist or the observer (*P* < .05) (table 3). Spearman's rank correlation showed a significant agreement in pain scores

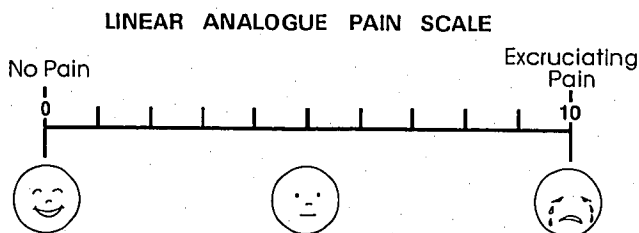


FIG. 1. Linear analogue pain scale.

TABLE 2. Cooperation Scale Rating\*

1	2	3	4	5
Requires no restraint	Requires verbal restraint		Strongly resists procedures, pulls hand	
No verbal protest	Mild protest		Required continuous, firm restraint	
No crying, no restraint needed.	Verbal protest or whimpering. Crying, but comforted with verbal support.		Continued crying	
Shows interest in the procedures and surroundings.	Begins to show interest in the surroundings after verbal comfort.		Screaming or loud crying. Not comforted by verbal or physical contact.	
			Does not show interest in the surroundings.	

\* The table shows behaviors that were used to determine the extent of the child's cooperation on the 1-5 scale.

awarded by the anesthesiologist and observer (*r* = 0.81 ± .1) and, to a lesser degree, those awarded by the anesthesiologist/observer and the children (*r* = 0.61 ± .14). However, the degree of cooperation with the procedure as recorded by the observer showed a poor correlation with the degree of pain perceived by the child (*r* = .43 ± .11). Cooperation did not improve with lower pain scores.

The skin reactions observed following EMLA application included itching, which one child found to be particularly bothersome, and transient blanching in seven patients. Both these reactions resolved spontaneously without treatment. A greasy quality was retained by the skin following removal of the EMLA cream. That greasiness made it slightly difficult to apply adhesive tape to the skin, and required special care in securing the iv catheter.

DISCUSSION

Intravenous induction of anesthesia is often chosen by older children and teenagers, who prefer the rapid

TABLE 3. Pain Scale Readings

	EMLA (n = 20)	Skin Wheal (n = 20)
Child		
Median	3.0	3.5
Range	(0-10)	(0-10)
Anesthesiologist		
Median	0.5	1.0
Range	(0-8)	(0-3)
Observer		
Median	0.5	0.5
Range	(0-8)	(0-8)

Anesth/observer vs. child: *P* < .0003. EMLA vs. skin wheal: NS.

onset of sleep to the slower induction provided by inhaled anesthetics. Moreover, there are certain clinical situations in which an iv induction is preferable, even in younger patients. For example, in children who are in need of emergency surgery in the presence of a full stomach, the procedure of choice may be a rapid sequence induction using the intravenous route, which can best be provided through an intravenous cannula. Any method that allows painless intravenous cannulation in awake children is, therefore, highly desirable.

Pain from intravenous cannulation is mainly mediated *via* nerve endings in the epidermis. Although this pain can be alleviated by a topically applied local anesthetic with good skin penetration, all currently available local anesthetics have poor skin penetration when applied topically. Effective tissue penetration, however, can be achieved by using oil in water emulsions<sup>2</sup> that combine a higher concentration of local anesthetic base with a high water content. Although the cationic form of a local anesthetic agent is the active form which blocks the transmission of impulses within the nerve,<sup>6</sup> it is the uncharged base form which penetrates and diffuses into the tissues after topical or parenteral administration. Emulsification of lidocaine produces only 20% active substance in each emulsion droplet. Mixing lidocaine and prilocaine crystals, however, will form a eutectic mixture that produces an emulsion droplet with approximately 80% active local anesthetic substance. This composition of EMLA does not require any oil, and gives a high local anesthetic concentration compared with previously available compositions for topical anesthesia.

Previous studies<sup>1,3,4,7</sup> have examined the analgesic effects of EMLA for pain-free venipuncture in both premedicated and unpremedicated children. However, premedication might have affected the pain perception and cooperation of the children during venipuncture. Moreover, the preparation was compared to either a placebo or no skin analgesia whatsoever, situations that are not generally encountered in the clinical practice of pediatric anesthesia. Under the conditions of our study, EMLA was found to be effective; but it was no more so than the traditional skin wheal infiltration. Of particular interest was the fact that children uniformly rated the pain and discomfort with venipuncture higher than did either the anesthesiologist or the observer. Another interesting observation in these unpremedicated children was that cooperation during venipuncture did not improve with pain-free conditions. The lack of cooperation in the absence of pain seemed to emphasize the significance of the emotional component of anticipating pain<sup>5</sup> that children associate with needles and venipuncture. The transient skin reactions seen in our patients

were similar in character and incidence to those previously reported by Maunuksela *et al.*<sup>1</sup> and Hallen *et al.*<sup>3</sup>

While the use of EMLA precludes the need of a needle to produce skin analgesia, its major inconvenience is the 60-min period of skin contact required for the cream to achieve full efficacy.<sup>3</sup> A previous study<sup>3</sup> showed that it was not possible to reduce this application time if good relief of venepuncture pain was to be obtained. Also, because of that requirement, the re-use of EMLA becomes impractical in the event of an unsuccessful iv cannulation at a prepared site. The potential application of EMLA for analgesia of skin incisions and/or application to lacerations for suturing warrants further investigations.

In summary, this study compared two different methods of providing skin analgesia for venipuncture; namely, the topical application of EMLA cream *versus* intradermal lidocaine infiltration with a 30-gauge needle. Both methods were equally effective in producing analgesia. The absence of pain, however, does not necessarily improve a child's cooperation with these procedures. The EMLA cream seems to be an appropriate means of providing analgesia for iv cannulation in children who are scheduled for elective surgery. The prerequisites for the use of EMLA cream are careful site selection; application under an occlusive dressing, allowing a 60-min contact time; and careful taping of the iv cannula to an armboard to prevent dislodgement.

The authors would like to thank Urs. E. Ruttimann, Ph.D., for performing the statistical analysis in this study. EMLA cream was supplied by Astra Pharmaceutical Products, Inc., Westborough, Massachusetts.

#### REFERENCES

1. Maunuksela E-L, Korpela R: Double-blind evaluation of a Lignocaine-Prilocaine cream (EMLA) in children. Effect on the pain associated with venous cannulation. *Br J Anaesth* 58:1242-1245, 1986
2. Evers H, Von Dardel O, Juhlin L, Ohlsen L, Vinnars E: Dermal effects of compositions based on the eutectic mixture of lignocaine and prilocaine (EMLA)—Studies in volunteers. *Br J Anaesth* 57:997-1005, 1985
3. Hallen B, Olsson GL, Uppfeldt A: Pain-free venepuncture—Effect of timing of application of local anaesthetic cream. *Anaesthesia* 39:969-972, 1984
4. Hallen B, Uppfeldt A: Does Lidocaine-Prilocaine cream permit pain free insertion of iv catheters in children? *ANESTHESIOLOGY* 57:340-342, 1982
5. Visintainer MA, Wolfer JA: Psychological preparation for surgical pediatric patients: The effect on children's and parents' stress responses and adjustments. *Pediatrics* 56:187-202, 1975
6. Covino BG, Vassallo H: Local anesthetics. Mechanisms of action and clinical use. New York, Grune and Stratton, 1976, pp 29-33
7. Ehrenström Reiz GME, Reiz SLA: EMLA—A eutectic mixture of local anaesthetics for topical anaesthesia. *Acta Anaesthesiol Scand* 26:596-598, 1982