

Use of local anesthesia for arterial punctures

January 2008



Timothy Hudson
RN, MS, MEd, CCRN

*Reprinted from AMERICAN JOURNAL OF CRITICAL CARE, November 2006, Volume 15, No 6, 595-599
Hudson TL, Dukes SF, Reilly K. Use of local anesthesia for arterial puncture. Copyright with permission from American Journal of Critical Care*

Background

Except for intravenous therapy, arterial access is the most common invasive procedure performed on critically ill patients. Arterial puncture is a source of pain and discomfort. Intradermal injection of lidocaine around the puncture site decreases the incidence and severity of localized pain when used before arterial puncture.

Objective

To review the recommendations and studies related to the use of intradermal lidocaine to decrease pain during arterial punctures.

Methods

Articles were identified by doing a systematic computerized search of MEDLINE (1980 to January 2006) to

evaluate articles and reference lists of articles and a manual search of the references listed in original and review articles.

English-language articles that evaluated any aspect of pain related to arterial puncture and cannulation, pain related to and methods of introducing lidocaine subcutaneously, and perceptions and use of local anesthesia for arterial or intravenous punctures were reviewed.

Results

Except among anesthesia providers, the use of a local anesthetic before arterial puncture is not universal, contrary to the standard of practice. A number of false perceptions may prevent wider use of such anesthetics.

Conclusion

Before a plan for behavior modification or policy change is recommended for use of local anesthesia to decrease pain associated with arterial puncture, further research must be done to determine nurses' perceptions of use, actual practice, and currently established local policies. (American Journal of Critical Care. 2006;15:595-599)

Critically ill patients require quick decision making that can mean the difference between life and death. One laboratory test that enhances such decision making is arterial blood gas (ABG) analysis.

The results of the analysis allow practitioners to immediately assess a patient's oxygenation status, carbon dioxide levels, and acid-base balance. In order to obtain blood samples for ABG analysis from a patient who does not have a central circulatory or arterial access, an arterial puncture must be performed.

An undesirable characteristic of an arterial puncture is the pain experienced by the patient during the procedure [1]. In an attempt to eliminate or at least minimize pain associated with obtaining arterial blood samples, local anesthetization of the puncture site should be performed [2].

In this article we review the recommendations and studies related to the use of intradermal lidocaine to decrease pain during arterial punctures. We also provide a series of questions that may be useful in identifying barriers to the use of this evidence-based practice.

Professional standards

Professional nursing, organizational, and accrediting standards support the use of procedures to decrease pain. Administration of local anesthetic before arterial puncture is recommended in the standards of practice for both critical care and emergency department nurses [2,3].

An example from the American Association of Critical-Care Nurses procedure manual [2] is presented in TABLE 1. A similar procedure is found in Emergency Nursing Procedures [3]. The British Thoracic Society and the Association of Respiratory Technicians and Physiologists also recommend the use of local anesthesia before arterial puncture [4].

Except for intravenous therapy, arterial access is the most common invasive procedure performed on critically ill patients [5]. Arterial puncture is a source of pain and discomfort in critical care [1].

Although pain cannot be completely eliminated during invasive procedures such as obtaining blood from an artery, pain should be minimized. In a study [6] of 100

Step	Rationale	Special considerations
Locally anesthetize the puncture site	Provides local anesthesia for arterial puncture	It has been reported that most patients experience pain during arterial puncture
Use a 1-mL syringe with a 25-gauge needle to draw up 0.5 mL of 1 % lidocaine without epinephrine	Minimizes vessel trauma; absence of epinephrine decreases the risk for peripheral vasoconstriction	Research exploring the efficacy of lidocaine ointment, amethocaine gel, and EMLA cream* as alternatives to intradermal lidocaine for managing the pain associated with arterial puncture has shown mixed results; if they are used, the manufacturer's recommendations should be followed
Aspirate before injecting the local anesthetic	Determines whether or not a blood vessel has been inadvertently entered	
Inject intradermally and then with full infiltration around the artery puncture site; use approximately 0.2 to 0.3 mL for an adult	Decreases the incidence of localized pain while injecting all skin layers; patients have reported reduced pain when a local, intradermal anesthetic agent is used before the arterial puncture	*An emulsion containing lidocaine 2.5 % and prilocaine 2.5 %

TABLE 1: Procedure guidelines for arterial puncture from the American Association of Critical-Care Nurses [2]

intensive care patients, punctures to obtain samples for ABG analysis were the No. 1 factor “that moderately or severely worried patients,” and 48 % of these patients’ unpleasant experiences were associated with arterial blood sampling [6].

Obtaining samples for ABG analysis was ranked higher than endotracheal suctioning as an unpleasant experience and was identified separately from regular “pain,” which was ranked third. It is noteworthy that the pain related to arterial puncture is of such intensity that patients place it in a separate and higher category of discomfort than other types of pain in the intensive care unit.

The standard of practice for arterial puncture is well established and includes use of a local anesthetic. However, the actual practice of using a local anesthetic is not universal. Intradermal injection of lidocaine before arterial puncture decreases the incidence and severity of localized pain [1,7]. Clinicians’ perceptions of the use of a local anesthetic before arterial punctures, however, can affect whether the clinicians use intradermal lidocaine.

Concerns related to the use of local anesthesia

A number of concerns are expressed when clinicians are asked why they do not administer a local anesthetic before performing an arterial puncture [8,9].

These concerns include the perceptions that pain from the injection of an anesthetic is just as painful as the arterial puncture, that infiltration of an anesthetic hinders the ability to obtain a sample, that it takes too long to inject an anesthetic, and that the pain of an arterial puncture is marginal or no more than a venipuncture [9,10].

In a telephone survey on use of local anesthesia for arterial punctures, Lightowler and Elliot [9] found that 84 % of the junior hospital physicians surveyed never administered a local anesthetic before doing arterial punctures; 47 % of the physicians thought that injecting a patient with a local anesthetic would be just as painful as the arterial puncture itself.

Sado and Deakin [8] surveyed 178 physicians to assess the prevalence of anesthetic use for arterial punctures to obtain samples for ABG analysis. The investigators found an interesting difference between anesthesia providers and non-anesthesia providers. Approximately 60 % of anesthesia providers used local anesthetic for arterial punctures, whereas less than 3 % of non-anesthesia providers did.

Does local anesthesia reduce the pain from arterial puncture?

Giner *et al.* [1] conducted a double-blind study with 270 subjects to compare perceptions of pain during an arterial puncture with and without local anesthesia and to compare that pain with the pain associated with a venous puncture.

Results from the study [1] indicated that subcutaneous infiltration of a local anesthetic (mepivacaine hydrochloride without epinephrine) before arterial puncture reduced pain by more than 50 %, so much so that the arterial puncture was even less painful than venous cannulation.

Lightowler and Elliot [9] evaluated pain levels associated with arterial puncture with and without lidocaine infiltration and noted that the use of a local anesthetic reduced patients’ reported pain levels. On a 4-point pain scale, arterial puncture was less painful with lidocaine infiltration; scores were 1.5 with lidocaine versus 2.2 with placebo ($P < .001$) and 1.5 with lidocaine versus 2.1 with nothing ($P < .001$).

A solid foundation of published work [10-15] is available on using a local anesthetic to reduce the pain associated with intravenous cannulation. Fewer studies, though with no less compelling results, have addressed using a local anesthetic to reduce the pain associated with arterial punctures [1,9].

The arterial wall has many more pain receptors than do venous walls and is therefore more sensitive to pain. However, the greatest benefit of using an anesthetic is the reduction of pain throughout the epidermis, dermis, and subcutaneous tissue.

Does injection of an anesthetic decrease the success rate of obtaining an arterial blood sample?

Giner *et al.* [1] addressed the concerns related to the misconception that the use of an intradermal injection of a local anesthetic would actually decrease the success rate for obtaining an arterial blood sample.

They found that increased levels of pain associated with not using local anesthesia actually decreased success rates for obtaining arterial blood samples because patients could not remain immobile during the procedure. Giner *et al.* [1] recommended administering local anesthesia before obtaining an arterial blood sample because their results showed that mepivacaine not only reduced pain, but did not hinder locating the artery to be punctured.

In the study by Lightowler and Elliot, [9] 0.5 mL of 2 % lidocaine was injected with a 29-gauge needle. The rate of successful arterial punctures was higher in the lidocaine group than in the group that received no local anesthetic. Similar results were also found with respect to venous cannulation [11,12].

Does it matter what size of needle or what local anesthetic is used?

Use of smaller gauge needles for arterial puncture does produce less damage of the arterial wall [16]. In most clinical situations, 22-gauge arterial puncture needles are sufficient in size to allow self-filling of the syringe [17] and may reduce the incidence of arterial vasospasm [2].

No study has been done to compare pain levels associated with use of different sized needles for the actual puncture, though Palmon *et al.* [18] studied the effects of different needle gauges (25 and 30 gauge) on the discomfort related to the actual injection of lidocaine.

They found no significant difference in the report of pain with the different gauge needles. The current AACN Procedure Manual for Critical Care [2] recommends the use of a 25-gauge needle for injection of lidocaine.

Anecdotally, many clinicians use even smaller gauge needles (with tuberculin and insulin syringes) for the injection of a local anesthetic.

Alkalinization (buffering) of lidocaine may decrease discomfort during percutaneous infiltration because of the pH of lidocaine. Hence, consideration has been given to buffering lidocaine with sodium bicarbonate. In 2 studies, [19,20] the addition of sodium bicarbonate decreased the discomfort associated with the injection of lidocaine.

Burgher and McGuirk [21] also studied the use of buffered lidocaine in intravenous cannulation in the emergency department. Although their study focused on intravenous cannulation and not arterial punctures, subcutaneous injection of buffered lidocaine significantly reduced pain while not adversely affecting the success rate of intravenous cannulation in adult patients in the emergency department.

In contrast, Richtsmeier and Hatcher [22] found no significant differences between use of buffered and nonbuffered lidocaine in children during hemodialysis cannulation via arterial and venous access sites.

The generalizability of results from studies of hemodialysis cannulation to arterial punctures is a concern. Additional factors, such as warming the lidocaine solution [23] and altering the speed of injection [24], did not change the perception of pain when either buffered or nonbuffered solution was used.

Won't a topical anesthetic work just as well?

Giner *et al.* [25] compared a eutectic mixture of local anesthetics (EMLA) cream, placebo cream, and mepivacaine for arterial punctures. They concluded that mepivacaine injected subcutaneously was more effective at reducing pain than was EMLA cream applied topically.

Researchers [25-32] also have investigated whether a topical anesthetic would decrease pain experienced by patients during venous cannulation. The results of

the effectiveness of lidocaine ointment, amethocaine gels, and EMLA creams as an alternative to intradermal lidocaine were mixed.

The effectiveness of applying topical anesthetics before performing an arterial puncture is limited in the acute care environment by the extended application time required (30-60 minutes) for a topical anesthetic to penetrate sufficiently to reduce discomfort. Results of ABG analysis are needed in a more timely manner than topical anesthetics will allow.

As a final note, the use of intradermal lidocaine is not cost prohibitive. Fry and Aholt [33] compared the cost of buffered lidocaine and syringe with the cost of EMLA cream patches. The cost of a single application of EMLA cream is \$7, whereas lidocaine and a syringe cost approximately 17 cents. Adding lidocaine and needed supplies to the basic ABG supply requirement would add less than 20 cents per procedure.

Conclusion

Arterial punctures to obtain blood samples for ABG analysis are some of the most painful and worrisome procedures experienced by critically ill patients. The use of intradermal lidocaine before the arterial puncture clearly decreases the pain associated with the procedure and does not interfere with the success rate.

Although researchers in a few studies have noted the perceptions of physicians about the use of local anesthesia before arterial blood sampling, no studies related to nurses' perceptions of and training in the use of local anesthesia in arterial puncture procedures have been done. However, most likely the practice of using local anesthesia among nurses is equal to or less than that among physicians.

Such a finding would be disturbing, because the clear published standard of nursing practice [2] supported through research-based outcomes [1,9] recommends use of local anesthesia for arterial punctures.

Although the lack of use of local anesthetic could

be the same among nurses and other care providers, the barriers would not. Thus, it may be inappropriate to generalize the findings of barriers from other care providers to nurses.

For example, physicians do not need an order to use lidocaine, whereas nurses may need a physician's order to incorporate lidocaine into the procedure. We highly recommended that nurse managers coordinate with their medical directors a standing order whereby the use of lidocaine is a standard protocol for obtaining all blood samples for ABG analysis. Still, we can only speculate about why nurses are not using local anesthetics for arterial punctures.

If standards are not being met, what are the barriers? Managers should first determine the use of local anesthesia and then identify the barriers to use.

A series of questions (TABLE 2) may be useful in identifying factors that may inhibit or enhance the use of intradermal lidocaine for arterial punctures, including perceptions of critical care nurses (in intensive care units and emergency departments) of use of local anesthesia, local procedures and policies, and practice standards and current practice related to management of pain during arterial puncture.

This information could then be used to identify areas of potential education and training and interventions to eliminate barriers and increase uptake of this evidence-based practice.

Acknowledgments

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Air Force, Department of the Army, Department of the Navy, or Department of Defense.

How often have you performed an arterial puncture in the past 30 days? In the past year?

What type of training did you receive in performing arterial punctures?

What is your organization/unit's procedure or policy regarding arterial puncture (who is authorized, what type of needle/syringe is used, is anesthetic used)?

Does your organization have a standing order for lidocaine use with arterial punctures, or does the physician have to write the order for each episode?

How often do you use local anesthetic for arterial punctures?

If you do not use local anesthetic for arterial punctures, why not (list the main reasons)?

TABLE 2: Questions to identify barriers to the use of local anesthesia for arterial punctures

References

- Giner J, Casan P, Belda J, Gonzalez M, Miralda RM, Sanchis J. Pain during arterial puncture. *Chest*. 1996; 110: 1443-45.
- Lynn-McHale Wiegand DJ, Carlson KK, eds. AACN Procedure Manual for Critical Care. 5th ed. Philadelphia, Pa: WB Saunders Co; 2005.
- Proehl JA, ed. Emergency Nursing Procedures. 3rd ed. Philadelphia, Pa: WB Saunders Co; 2004.
- Guidelines for the measurements of respiratory function: recommendations of the British Thoracic Society and the Association of Respiratory Technicians and Physiologists. *Respir Med*. 1994; 88: 165-94.
- Rowley DD, Mayo DF, Durbin CG Jr. Initial experience with a respiratory therapist arterial line placement service. *Respir Care*. 2000; 45: 482-85.
- Turner JS, Briggs SJ, Springhorn HE, Potgieter PD. Patients' recollection of intensive care unit experience. *Crit Care Med*. 1990; 18: 966-68.
- Le May A, Mulhall A, Alexander C. Bridging the research-practice gap: exploring the research cultures of practitioners and managers. *J Adv Nurs*. 1998; 28: 428-37.
- Sado DM, Deakin CD. Local anaesthesia for venous cannulation and arterial blood gas sampling: are doctors using it? *J R Soc Med*. 2005; 98: 158-60.
- Lightowler JV, Elliott MW. Local anaesthetic infiltration prior to arterial puncture for blood gas analysis: a survey of current practice and a randomised double blind placebo controlled trial. *J R Coll Physicians Lond*. 1997; 31: 645-46.
- Harrison N, Langham BT, Bogod DG. Appropriate use of local anaesthetic for venous cannulation. *Anaesthesia*. 1992; 47: 210-12.
- Holdgate A, Wong G. Does local anaesthetic affect the success rate of intravenous cannulation? *Anaesth Intensive Care*. 1999; 27: 257-59.
- Langham BT, Harrison DA. Local anaesthetic: does it really reduce the pain of insertion of all sizes of venous cannula? *Anaesthesia*. 1992; 47: 890-91.
- Ong EL, Lim NL, Koay CK. Towards a pain-free venepuncture. *Anaesthesia*. 2000; 55: 260-62.
- Paton RH. Local anaesthesia and venous cannulation. *Anaesthesia*. 1995; 50: 1005-06.
- Van den Berg AA, Abeysekera RM. Rationalising venous cannulation: patient factors and lignocaine efficacy. *Anaesthesia*. 1993; 48: 84.
- Smith DC, Hamlin JA, Jensen DA, Pappas JM, Westengard JC, Saukel GW. Effects of angiographic needle size and subsequent catheter insertion on arterial walls: an in vitro experiment in human cadavers. *Invest Radiol*. 1992; 27: 763-67.
- Ansel GM, Douce FH. Effects of syringe material and needle size on the minimum plunger displacement pressure of arterial blood gas syringes. *Respir Care*. 1982; 27: 147-51.
- Palmon SC, Lloyd AT, Kirsch JR. The effect of needle gauge and lidocaine pH on pain during intradermal injection. *Anesth Analg*. 1998; 86: 379-81.
- Steinbrook RA, Hughes N, Fanciullo G, Manzi D, Ferrante FM. Effects of alkalization of lidocaine on the pain of skin infiltration and intravenous catheterization. *J Clin Anesth*. 1993; 5: 456-58.
- Koscielniak-Nielsen ZJ, Stens-Pedersen HL, Kjaerbo EJ. Intra-arterial regional anaesthesia for hand surgery with alkalized 0.5 % lignocaine. *Acta Anaesthesiol Scand*. 1995; 39: 1048-52.
- Burgher SW, McGuirk TD. Subcutaneous buffered lidocaine for intravenous cannulation: is there a role in emergency medicine? *Acad Emerg Med*. 1998; 5: 1057-63.
- Richtsmeier AJ, Hatcher JW. Buffered lidocaine for skin infiltration prior to hemodialysis. *J Pain Symptom Manage*. 1995; 10: 198-203.
- Bartfield JM, Crisafulli KM, Raccio-Robak N, Salluzzo RF. The effects of warming and buffering on pain of infiltration of lidocaine. *Acad Emerg Med*. 1995; 2: 254-58.
- Krause RS, Moscati R, Filice M, Lerner EB, Hughes D. The effect of injection speed on the pain of lidocaine infiltration. *Acad Emerg Med*. 1997; 4: 1032-35.
- Giner J, Casan P, Belda J, Litvan H, Sanchis J. Use of the anesthetic cream EMLA in arterial puncture [in Spanish]. *Rev Esp Anesthesiol Reanim*. 2000; 47: 63-66.
- Ernst AA, Marvez-Valls E, Nick TG, Mills T, Minvielle L, Houry D. Topical lidocaine adrenaline tetracaine (LAT gel) versus injectable buffered lidocaine for local anesthesia in laceration repair. *West J Med*. 1997; 167: 79-81.
- Hallen B, Olsson GL, Uppfeldt A. Pain-free venipuncture: effect of timing of application of local anesthetic cream. *Anesthesia*. 1984; 39: 969-72.
- Joly LM, Spaulding C, Monchi M, Ali OS, Weber S, Benhamou D. Topical lidocaine-prilocaine cream (EMLA) versus local infiltration anesthesia for radial artery cannulation. *Anesth Analg*. 1998; 87: 403-06.
- Koscielniak-Nielsen Z, Hesselbjerg L, Brushøj J, Jensen MB, Pedersen HS. EMLA patch for spinal puncture: a comparison of EMLA patch with lignocaine infiltration and placebo patch. *Anaesthesia*. 1998; 53: 1218-22.
- Molodecka J, Stenhouse C, Jones JM, Tomlinson A. Comparison of percutaneous anaesthesia for venous cannulation after topical application of either amethocaine or EMLA cream. *Br J Anaesth*. 1994; 72: 174-76.
- O'Connor B, Tomlinson AA. Evaluation of the efficacy and safety of amethocaine gel applied topically before venous cannulation in adults. *Br J Anaesth*. 1995; 74: 706-08.
- Speirs AF, Taylor KH, Joanes DN, Girdler NM. A randomised, doubleblind, placebo-controlled, comparative study of topical skin analgesics and the anxiety and discomfort associated with venous cannulation. *Br Dent J*. 2001; 190: 444-49.
- Fry C, Aholt D. Local anesthesia prior to the insertion of peripherally inserted central catheters. *J Infusion Nurs*. 2001; 24: 404-08.