

Factors Influencing Nurses' Use of Local Anesthetics for Venous and Arterial Access

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ABSTRACT

The use of local anesthetics to relieve pain associated with intravenous cannulation and arterial blood gas sampling is given low priority in many health institutions. This review sought to identify factors influencing nurses' use of local anesthetics for these procedures. The Database Syntax Guide for Systematic Reviewers was used; health-relevant studies were critically assessed with appropriate Critical Appraisal Skills Programme tools. Significant factors influencing the use of local anesthetics for parenteral procedures were identified, including the level of effectiveness among types of local anesthetics, the perceived benefits of facilitating needle insertions and patient satisfaction, the underestimation of pain associated with needle punctures, time concerns, physician authorization, and costs.

Key words: arterial blood gases, catheterization, factors, intravenous cannulation, local anesthesia, nurses, pain reduction

Local anesthesia is used to relieve pain associated with intravenous (IV) cannulation and arterial blood gas (ABG) sampling in various countries. However, the use of pain management for these procedures is given a low priority in many health institutions throughout Saudi Arabia, and there is a significant lack of recommendations regarding local anesthesia for these procedures.^{1,2} Therefore, adults and children are subjected to pain and the associated anxiety, which could otherwise be managed with the use of local anesthesia.

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DEFINITIONS

Local anesthesia refers to the method of eliminating sensations in, or numbing, a specific part of the body for relieving the pain associated with invasive procedures.^{3,4} It is typically administered through 1 of 2 routes: topical and parenteral. Topical local anesthesia is applied to the skin surface as creams, gels, sprays, and patches. Parenteral local anesthesia is administered as injections through intradermal or subcutaneous layers of the skin.⁴

IV cannulation is an invasive procedure used for vascular access that requires the insertion of a catheter containing a needle to administer medications, fluids, and other therapeutic treatment.⁵ *ABG sampling* is a test performed by inserting a needle into an artery to obtain blood samples; this is more painful than a venipuncture because of the need to insert the needle more deeply into highly innervated anatomical locations, such as the wrist, antecubital fossa, or groin.⁶

OBJECTIVE

Pain related to needle punctures is associated with physical and psychosocial complications. Fear of procedures that use needles and the associated pain may lead to patients avoiding preventive health care. This may cause delays in the treatment of illnesses, which poses a long-term burden on the health care system and society.⁷ The use of local anesthesia helps reduce patient distress at the time of the procedure, serves to facilitate needle insertion, and helps

improve patient satisfaction and hospital experience.⁷⁻⁹ This review sought to identify factors influencing nurses' use of local anesthesia for IV cannulation and ABG sampling.

METHODS

Article Search and Selection Process

The search process was performed in accordance with the Database Syntax Guide for Systematic Reviewers,¹⁰ which helped identify relevant articles in health-related databases. The databases searched included the Cumulative Index to Allied and Health Literature (CINAHL), MEDLINE, and PsycINFO. The main search terms were *local anesthesia, pain reduction, intravenous cannulation, arterial blood gases, nurses, factors, and barriers*. The search was limited to the English language and abstracts that contain the keywords *local anesthesia*. Titles and abstracts of articles that resulted from the search strategy were assessed for relevance to the research subject. As a result, 38 of the 54 articles identified did not meet the aforementioned inclusion criteria and were excluded. In addition, the reference lists of the included articles were searched manually to identify additional studies. No studies were found that had been performed in Saudi Arabia regarding the use of local anesthesia for IV cannulation or ABG sampling. Additionally, recent studies related to the use of local anesthesia for invasive procedures rarely involved nursing. Thus, articles published from 2005 onward that contained 2 or more of the search terms and that discussed important aspects relevant to the research topic were included. A total of 16 articles were included in this literature review.

Critical Appraisal of the Studies

Articles that met selection criteria for the literature review were critically assessed with the use of appraisal tools and programs and appropriate checklists. Most studies were trials that examined the effectiveness of local anesthesia for reducing the pain associated with venous and arterial access. All trial studies were critically assessed by using the relevant tool designed by the Critical Appraisal Skills Programme (CASP).¹¹ Survey studies were assessed with the Critical Appraisal of a Survey checklist, produced by the Centre for Evidence-Based Management (CEBMA),¹² and the included studies were evaluated by means of the CASP tool designed for systematic reviews.¹³ Critical appraisal tools were used for the articles, based on the suitability of screening questions and similarity of study approaches. A critical analysis of each study was undertaken to identify and critique their purpose, method, findings, limitations, and significance (Appendix 1).¹⁴⁻²⁷ The rigor of the reviewed studies was assessed through identification of limitations and strengths.

Thematic Analysis

Thematic analysis helped organize and describe the data set of the research topic²⁸ and allowed further scope beyond

evaluation of existing structural data. It enabled exploration of various aspects of the research topic in terms of factors that have an impact on the use of local anesthesia for procedural pain. After individual analyses of the studies, articles were grouped together based on recurrent themes that emerged from the findings (Appendix 2). Findings are presented with themes that were extracted from the reviewed articles.

RESULTS

Effectiveness of Local Anesthetics

Intradermal Injections

The effectiveness of local anesthesia injection types has been studied in terms of the reduction of the pain associated with venipunctures. Matheson et al²¹ aimed to identify an effective method for reducing the pain associated with ABG sampling. The study compared 3 methods of analgesic administration at the site of arterial puncture (0.7 mL 1% lidocaine, 0.7 mL buffered 1% lidocaine, or 0.7 mL bacteriostatic saline) to determine which method was most effective at minimizing the pain associated with arterial needle puncture. The investigation involved a randomized, partially blinded, prospective study convenience sample of 40 hospitalized patients in the United States. The findings suggested that although lidocaine and buffered lidocaine were both effective for reducing pain associated with the ABG sampling procedure ($P = .000$ and $P = .041$, respectively), compared with bacteriostatic saline ($P = .665$), lidocaine alone resulted in the most significant reduction of pain.

Another study by McNaughton et al²² compared pain and anxiety associated with IV cannulation after pretreating patients with 1% subcutaneous buffered lidocaine, 4% lidocaine cream, or no local anesthesia. A randomized cross-over study of 70 participants (medical students or nurses) who participated in hospital workshops for IV insertion in the United States was conducted. Three IV cannulations were performed for each participant; each insertion was pretreated randomly with either no treatment, lidocaine cream, or buffered lidocaine. Participants were asked to report the level of pain, anxiety, and preference for the use of local anesthesia, for themselves and patients, on a 10-point numeric rating scale.

The study showed that pain and anxiety associated with IV cannulation were significantly minimized by using either type of local anesthesia. Buffered lidocaine injection reduced venipuncture pain more than lidocaine cream did, without affecting the success of insertion. There were no significant differences in anxiety scores between the use of lidocaine cream or injected buffered lidocaine. Seventy percent of the participants reported that they would always want buffered lidocaine in the future.

Similarly, Burke et al¹⁴ compared the efficacy of intradermal bacteriostatic normal saline with that of intradermal buffered lidocaine in providing local anesthesia to adult

patients before IV catheterization. A randomized, double-blind, parallel-design, quasi-experimental study was conducted on 148 adult patients from the hospital's same-day surgery unit. The study's strength was that it tested 2 types of local anesthesia using the same route of administration, which eliminated other confounding variables. It was determined that intradermal buffered lidocaine was significantly superior to intradermal bacteriostatic normal saline for reducing IV catheterization pain ($P = .007$).

Hudson et al¹⁸ reviewed studies and recommendations related to the use of intradermal lidocaine to reduce pain during arterial punctures. The findings showed that the use of intradermal lidocaine before arterial puncture clearly decreased pain associated with the procedure and did not interfere with the success rate. Overall, intradermal lidocaine injection was more efficacious for reducing procedural pain among the types of local anesthesia tested in those studies.

Intradermal Needleless Device

A needleless intradermal jet injector (eg, J-Tip; National Medical Products, Irvine, CA) is another type of local anesthesia used to reduce pain associated with cannulation and ABG sampling. Hajiseyedjavady et al⁹ conducted a randomized, controlled clinical trial to compare pain levels from ABG sampling performed with and without application of lidocaine through a jet injector. Forty-two alert and cooperative volunteers who required ABG sampling as part of their pain management were recruited in the emergency department (ED) of the Imam-Reza Hospital in Tabriz, Iran.

Despite the small sample size, the study showed that the visual analog pain scale score during ABG sampling was considerably lower in the treatment group than in the control group. All residents reported ease of use for the lidocaine jet injection procedure ($P < .05$). Another study by Jimenez et al¹⁹ compared the effectiveness of administering 1% buffered lidocaine with a jet injector vs using a topical transdermal agent, such as a eutectic mixture of local anesthetics (eg, EMLA; AstraZeneca, Cambridge, United Kingdom) to facilitate IV cannulation and provide adequate analgesia before catheter placement. The study was a randomized, controlled trial of 116 young patients (7-19 years old) at the Children's Hospital and Regional Medical Centre in Seattle, Washington. The findings showed a statistically significant difference ($P = .0001$) in the pain ratings during IV cannulation between the topical transdermal agent (median = 3) and the jet injector (median = 0), indicating that the jet injector group experienced less pain than the topical transdermal agent group.

Interestingly, the jet injector was well tolerated, and the children were not frightened by the "pop" sound produced by the device, in contrast to the researchers' expectations. It was concluded that applying 1% buffered lidocaine through a jet injector before IV cannulation is not painful and has better anesthetic effectiveness than applying the topical transdermal agent.

In addition, Crowley et al⁸ conducted a comprehensive literature review to provide evidence-based information for

emergency nurses in terms of reducing pain and distress in pediatric patients undergoing minor invasive procedures in the ED. The study classified the outcomes according to levels of recommendation for practice: Level A, High; Level B, Moderate; and Level C, Weak or Not Recommended for Practice. All forms of lidocaine/tetracaine (amethocaine) injections were Level A. The form of lidocaine delivered in the needleless jet injection device was superior to other forms of local anesthesia (Level A).

Topical Local Anesthesia

Topical local anesthesia, such as creams, gels, sprays, and patches, are used to reduce pain associated with needle punctures. Hijazi et al¹⁷ examined the effectiveness and safety of a topical alkane vapocoolant spray in reducing pain associated with venous cannulation in adults in an ED. The study used a randomized, double-blind, placebo-controlled approach that involved 201 adult patients in the ED of a metropolitan hospital in Australia. A visual analog scale was used to assess cannulation pain and discomfort induced by the spray; this is a highly discriminant method of assessing pain.

The study showed that application of topical alkane vapocoolant spray less than 15 seconds before cannulation was successful in numbing the area and reducing pain. Median pain scores for IV cannulation in the control and intervention groups were 36 (19-51) mm and 12 (5-40) mm, respectively ($P < .001$); 59 (60%) and 33 (32%) patients, respectively, reported pain scores ≥ 30 mm ($P < .001$). The vapocoolant intervention was concluded to be effective, safe, and acceptable for reducing pain associated with peripheral cannulation in adults in the ED.

Similarly, Page and Taylor²⁵ compared the efficacy, acceptability, and safety of a topical vapocoolant alkane spray and 1% subcutaneous lidocaine for reducing pain from IV cannulation. They conducted a nonblinded, randomized, controlled trial on a convenience sample of 220 participants (adult and pediatric) from a metropolitan ED. The study findings suggested that although vapocoolant spray was less painful to administer, it was less effective for reducing pain associated with cannulation than lidocaine injection. Vapocoolant spray was associated with greater cannulation success (83.6% vs 67.3%; $P = .005$), required less time to administer (median 9.0 vs 84.5 seconds; $P < .001$), and was more convenient for staff (median 5 vs 4; $P < .001$), although the overall patient satisfaction scores were similar between the groups. They concluded that although lidocaine was superior, vapocoolant spray offered a useful alternative in the ED setting.

Mirzaei et al²³ conducted a quasi-experimental study to compare the effect of transdermal cream, lidocaine spray, and ice packs on the intensity of pain experienced with arteriovenous cannulation in hemodialysis patients. The study involved 40 patients > 18 years old in Shahid Rahneemoon Hospital in Iran. Transdermal cream was found to be highly effective for reducing pain intensity compared with lidocaine spray and ice packs ($P < .001$). Similarly,

findings from Crowley and colleagues' literature review⁸ included classifications of topical anesthesia that were recommended for management of pain and distress associated with venipuncture, in which vapocoolant spray in the form of ethylvinylchloride was Level C, and pentafluoropropane and tetrafluoroethane were Level B.

Papa and Zempsky²⁴ surveyed 2187 nurses from 3 nursing societies in the United States to examine nurses' attitudes and experiences regarding techniques used to manage venous access pain in pediatric patients. Although the study did not specify which types of topical anesthesia were used in those settings, the findings suggested that topical local anesthesia was considered more effective than nonpharmacological techniques, but was used less often because of concerns about its slow-acting nature. Most nurses (92%) agreed that an effective, fast-acting topical local anesthetic would benefit pediatric patients, their families, and the nurses who treat them.

This review has presented common types of local anesthesia that have been studied for their effectiveness in reducing pain associated with venous and arterial punctures. Evidence and recommendations presented in the reviewed studies show the efficacy of local anesthesia for minimizing procedural pain at different levels. Table 1 shows the levels of recommendations for those methods of local anesthesia, as well as some of their characteristics, according to the reviewed literature. Notably, the levels of effectiveness of those methods of local anesthesia in pain reduction, as well as their positive and negative characteristics, are important factors that can influence the use of local anesthesia by nurses.

Additional Strategies for Procedural Pain Management

Application of Ice

Application of ice is another technique that can be used by nurses as an alternative method for reducing pain associated with needle-related procedures. Haynes¹⁶ conducted a study that investigated whether precooling a puncture site with ice could reduce the pain associated with arterial puncture. A convenience sample of 80 adult outpatients

with a physician's order for ABG sampling was obtained. The study used a prospective, stratified, randomized, controlled trial approach and showed significant reductions in pain in the treatment group (ice application) compared with the control group. This suggested that the application of ice is an effective alternative option for reducing pain associated with arterial puncture because it is noninvasive, nonpharmacologic, inexpensive, and readily available.

Similarly, a previous quasi-experimental study by Rostami et al²⁶ was conducted with 80 children (6-12 years old) in an ED of a pediatric center in Ahwaz, Iran. The study aimed to determine the effect of local application of ice for 3 minutes before venipuncture on pain-related responses in school-aged children. They tested this hypothesis in relation to physiological and psychological variables and found no significant differences in physiological responses before and after procedures between the 2 groups ($P = .07$). However, behavioral and subjective responses before and after the procedure were lower in the test group ($P = .0011$ and $P = .0097$, respectively). The study concluded that the application of ice to the skin before venipuncture can be an effective and safe intervention for reducing puncture-related pain.

In addition, Mirzaei et al²³ showed that the ice method was effective in reducing pain intensity associated with arteriovenous cannulation in hemodialysis patients; however, it was inferior to transdermal agents. Those previous findings are consistent with the classifications of pain management by Crowley et al⁸ regarding needle-related procedures recommended for practice, in which the local application of ice for reducing the pain and distress associated with venipuncture was classified as Level B.

Behavioral Intervention

Behavioral intervention is an area in nursing care that can be used effectively for pain management in needle-related procedures. Crowley et al⁸ reported classifications of pain management for needle-related procedures that were recommended for practice. The level of recommendation for a behavioral intervention to reduce the pain and distress associated with venipuncture was classified as Level A because of sufficient evidence-based information

TABLE 1

Effectiveness of Local Anesthesia for Reducing Pain Associated With Venipuncture According to Reviewed Literature

Local Anesthetics	Level of Recommendation	Onset of Effect	Disadvantages
Lidocaine jet injector (needleless)	High	Fast	Makes "pop" sound
Intradermal lidocaine	High	Fast	Additional needlestick needed
Intradermal buffered lidocaine	High	Fast	Additional needlestick needed
Vapocoolant alkane spray	Moderate	Fast	Inferior to lidocaine for pain reduction
Transdermal agent (topical mixture of lidocaine and prilocaine)	Moderate	Slow acting	Long wait time required to produce effect

supporting the efficacy of cognitive behavioral therapy, breathing exercises, appropriate distractions, and hypnosis. However, Papa and Zempsky²⁴ found that nonpharmacological techniques, although frequently used by nurses, were perceived by nurses as insufficient in alleviating procedural pain when used alone.

Other Benefits of Local Anesthesia

Facilitation of Successful Needle Insertions

The use of local anesthesia facilitates successful IV cannulation and ABG sampling because of the reduction of associated pain and anxiety, which helps patients remain still during the procedure. According to Hudson et al,¹⁸ the administration of local anesthesia for ABG sampling was helpful in increasing the success rates of gaining arterial access because it minimizes patient movement during the procedure. Similarly, Crowley et al⁸ evaluated the success rate of injection and topical anesthetics; all reviewed studies indicated that the success rates were enhanced by the administration of local anesthesia. Furthermore, the administration of topical anesthetics was associated with increased success rates of catheter insertions. Likewise, Hajiseyedjavady et al⁹ found that the use of jet injectors resulted in a marked reduction of the pain of arterial puncture and contributed to a greater success rate of ABG sampling. They stated that the ABG procedure frequently fails because of the deeper anatomical location of the artery, which causes more pain. This makes it difficult for the patient to hold still during the procedure, which complicates the performance of the practitioner. Therefore, Hajiseyedjavady et al⁹ believed that greater pain relief would lead to more successful sampling.

Improved Satisfaction

The use of local anesthesia for invasive procedures by nurses provides patients with optimal pain management, thus improving patients' satisfaction and hospital experience. This can have a positive impact on patients' future well-being. Papa and Zempsky²⁴ examined the impact of managing venous access pain in pediatric patients, according to the nurses' perceptions. Ninety-six percent of nurses acknowledged that performing IV cannulation in a fearful and anxious child was challenging. Thus, most nurses (91%) agreed that better-quality pain control improved their satisfaction with their job performance, increased their overall job satisfaction (81%), increased positive relationships with patients and families (91%), and had a positive impact on the hospital experience of children and their families (97%).

Furthermore, McNaughton et al²² conducted a study on health care providers (ie, medical students and nurses). The researchers investigated whether participants would want local anesthesia for IV insertion for themselves and their patients. The study showed interesting outcomes, in that many participants were more influenced by personal experience to use local anesthesia for themselves and their patients in the future. In addition, an exploratory study

by Levitt and Ziemba-Davis²⁰ explored the knowledge of patient preferences for pain control during IV cannulation. One aim was to measure patients' rates of satisfaction with the treatments they chose. Only 4 patients chose the traditional strategy of no pain management. In contrast, 86.6% of participants preferred pain control. All participants in all groups reported that patient involvement in decision making regarding pain management was very important. Patient satisfaction and staff convenience, including the convenience of nurses, regarding the use of local anesthesia for invasive procedures were measured in some reviewed studies, and the outcomes were satisfactory.^{9,17,25}

Factors Leading to the Low Use Rate of Local Anesthesia

Staff Members' Underestimation of Procedural Pain

Pain associated with a needle puncture can be perceived as insignificant by health care practitioners, which can hinder the use of local anesthetics by nurses and other health professionals. Sado and Deakin²⁷ measured the prevalence of local anesthetic use for IV cannulation and ABG sampling by physicians. The authors stated that although many studies recommended the use of local anesthesia for these procedures, previous surveys indicated that ward physicians were more likely than anesthetists to ignore such advice.

The authors sought to determine whether these differences persist. A questionnaire was given to 178 anesthetists, physicians, and surgeons in 8 hospitals in the United Kingdom. Although the study was conducted 10 years ago, interestingly, the findings were consistent with the hypothesis of that study, in which 60% of anesthetists used local anesthesia for these procedures compared with 2% of ward physicians. Similarly, Hudson et al¹⁸ reviewed the literature and recommendations related to the use of intradermal lidocaine to decrease pain during arterial punctures. Although some articles reviewed in their study were old, they showed that, except among anesthesia providers, the use of a local anesthetic before arterial puncture was not universal. This is contrary to the standard of practice, which supports the use of local anesthetic to minimize arterial puncture pain. A number of false perceptions may hinder wider use of such anesthetics. Despite differences between physicians and nurses, certain beliefs and attitudes can contribute to a similar practice of disregarding the use of local anesthesia for invasive procedures. IV cannulation and ABG sampling, in particular, are performed by nurses in Saudi Arabia, and there is a lack of recommendations for using local anesthesia for these procedures in local practice.^{1,2}

Staff Concerns About Time Taken in Administering Local Anesthesia

Time is a critical factor that can have an impact on nurses' use of local anesthesia for invasive procedures. Nurses surveyed in a study by Papa and Zempsky²⁴ reported that they used topical local anesthesia in only 29% of cases.

One of the reasons most frequently identified was the slow onset of topical anesthetics, which is associated with treatment delays. Likewise, the findings of Czarnecki et al¹⁵ showed that the majority of nurses identified insufficient time to premedicate patients before procedures as one of the most common barriers to pediatric pain management. Furthermore, Hijazi et al¹⁷ and Page and Taylor²⁵ stated that the application time of topical anesthesia, such as a transdermal agent (45 minutes), is often unacceptable in an acute care environment, where immediate cannulation is required. They studied the practicality of using vapocoolant spray as a fast-acting topical anesthetic in the ED and found that this spray could produce the desired effect within less than 15 seconds after application.^{17,25} In their literature review, Hudson et al¹⁸ suggested that the effectiveness of lidocaine ointment, amethocaine gels, and transdermal creams, as alternatives to intradermal lidocaine, is limited in critical settings because of the lengthy application time required (30-60 minutes) to produce a sufficient effect. The findings concluded that ABG analysis was required in less time than allowed by use of topical anesthetics. As a concern related to this issue, Hajiseyedjavady et al⁹ tested the efficacy of jet injectors for ABG sampling. The findings suggested that the jet injector was effective and beneficial in providing rapid anesthesia in less than 6 minutes. Similarly, Jimenez et al¹⁹ measured the time from application to cannulation for both transdermal agents and the jet injector and found that transdermal agents required 69 minutes compared with 1.8 minutes for the jet injector group. Using the jet injector was recommended, especially in emergency or busy situations, when there is insufficient time for the transdermal agents to take effect.

Lack of Physician Authorization

Physicians' orders regarding local anesthesia are an important factor that can hinder use by nurses. A cross-sectional study conducted by Czarnecki et al¹⁵ identified barriers that were perceived to interfere with nurses' abilities to provide optimal pain management in pediatric patients. A survey study was conducted on 272 nurses from the Children's Hospital of Wisconsin. The most significant barriers identified for optimal pediatric pain management included insufficient physicians' orders for local anesthesia before procedures (mean 4.98, standard deviation [SD] 2.67; and mean 4.92, SD 2.81, respectively). Furthermore, Papa and Zempsky²⁴ explored nurses' perceptions of the impact of pain management in pediatric patients. ED nurses were most challenged in terms of pain control and most often resorted to nonpharmacological management. Papa and Zempsky²⁴ stated that because of the rapid responses required in the ED, nurses working in the ED might be less likely to order pain control measures, which requires a physician's authorization, because of concerns regarding the consequent delay in treatment. Hudson et al¹⁸ agreed that the need for a physician's order to administer local anesthesia before arterial access is a barrier that limits the use of

local anesthesia by nurses. Therefore, it was recommended that nurse managers establish standing orders to incorporate the use of local anesthesia (subcutaneous lidocaine) as a standard protocol for obtaining blood samples for ABG analysis.¹⁸

The Cost of Local Anesthesia

Cost is another factor that contributes to the availability of local anesthesia for nurses. In their review, Hudson et al¹⁸ compared the cost of local anesthesia methods and suggested that intradermal lidocaine is inexpensive compared with transdermal agents. Transdermal agent patches cost \$7 per application, and lidocaine and syringes cost approximately 17 cents, so the additional lidocaine needed for basic ABG sampling requirements would cost less than 20 cents per procedure.¹⁸

In addition, Page and Taylor²⁵ calculated the cost of vapocoolant spray and lidocaine subcutaneous injection per patient (in Australian dollars) from the vapocoolant spray retailer and hospital pharmacy department. The cost of 1 can of vapocoolant spray (250 g) was approximately \$16.12 AU and provided 70 administrations. Notably, the authors did not state the price of lidocaine. However, although vapocoolant spray was less expensive than lidocaine, it was concluded that both agents were considered inexpensive.

Jimenez et al¹⁹ also compared the cost of the jet injector vs transdermal agent per IV insertion in their institution. The cost of the jet injector was \$2.10 compared with \$2.80 for a transdermal agent. That study recommended the implementation of jet injector local anesthetic as a cost-effective alternative. In addition, Burke et al¹⁴ reported that use of a transdermal agent as a topical local anesthesia was inappropriate because of the cost.

DISCUSSION

As illustrated by this review, different forms of local anesthesia exhibit different levels of effectiveness for reducing the pain associated with IV cannulation and ABG sampling. The level of efficacy of the medication is an important factor to consider when using local anesthesia to provide effective pain management for needle punctures. Other factors can influence nurses' decisions regarding local anesthesia use, such as the age of the patient, its practicality in specific clinical settings (critical or noncritical), and type of procedure performed (eg, gaining venous or arterial access). For example, topical anesthetics are commonly used for pediatric patients because children are more anxious and less tolerant of needle insertions compared with adult patients.⁷

According to studies included in this review, jet injection is highly recommended compared with other forms of local anesthesia because it is needleless and penetrates intradermally to produce fast-acting pain relief. It is also deemed

safe and effective. This device works effectively in ABG sampling because the arterial access required is more invasive than gaining venous access, and the associated pain is greater. Furthermore, its cost is reasonable. Although McSwain and Yeager²⁹ argued that the concept of this device has gained popularity, it is not yet broadly available.

Transdermal cream is effective for reducing procedural pain. However, it may not be practical in nursing practice because of its slow-acting effect, especially in situations where time is critical. Because of this, the use of fast-acting local anesthetic alternatives can influence nurses' use of local anesthesia. This would help to eliminate barriers related to time concerns associated with treatment delay.

In addition, ice can be used by nurses as an alternative method to reduce procedural pain effectively (because it is noninvasive, nonpharmacological, inexpensive, and readily available) and when local anesthesia is not available or is not offered to patients in some settings. Behavioral interventions, which can be partially effective, are often used by nurses to lessen pain associated with needle-related procedures. However, reliance on behavioral interventions alone to relieve pain associated with invasive procedures is insufficient. The use of local anesthesia should be incorporated into these interventions to provide patients with optimal pain management.

Individuals who have experienced better pain management with local anesthesia for invasive procedures prefer to have local anesthesia in the future. This observation is important because it can affect future emotional and physical well-being. Despite physicians' orders that may limit the use of local anesthesia, nurses should take the initiative to help eliminate such barriers by negotiating with medical and nursing directors to establish standing orders or to develop appropriate protocols. Cost was also identified as an important factor that may encourage or hinder the use of local anesthesia.

A concern that may be perceived as a barrier to using local anesthesia injection by nurses is that its administration can affect successful insertion because it causes subcutaneous wheal formation, obscuring visibility of the blood vessel and subsequently increasing the difficulty of venipuncture. However, evidence from the reviewed studies disproved this. The rates of successful insertions with injectable local anesthesia were satisfactory in those studies. Another potential concern for nurses regarding the use of local anesthesia injections could be the exposure of patients to additional pain as a result of 2 needlesticks. The local anesthetic needlestick is less painful because of the small size of the needle used compared with the procedural needle insertion.²⁷ Alternative modes of local anesthesia, which can be used according to their appropriateness for the situation, such as transdermal agents, vapocoolant sprays, and jet injectors, have been suggested.

Anecdotal evidence suggests that the lack of hospital policies or guidelines can be barriers to the use of local anesthesia for IV cannulation and ABG sampling. This is

the case in the largest tertiary care center in Riyadh, Saudi Arabia. In addition, lack of education or training in nursing education in Saudi Arabia hinders the use of local anesthesia for needlesticks. As a consequence, nursing practice is shaped by these factors. Pain relief for needle-related procedures is underestimated in health care in Saudi Arabia, which affects the quality of care available to patients.

Implications for Nursing Practice

No studies have been conducted in Saudi Arabia that support the use of local anesthesia for venous and arterial needle punctures to date. The research findings presented in this article add to knowledge regarding factors that have an impact on the use of local anesthesia for vascular access. Identifying these factors from an international perspective provides a valuable understanding of the issue at a local level, which may help policy makers develop strategies to improve the quality of nursing practice. This review was undertaken to benefit society to improve the quality of health care and enhance patients' satisfaction and hospital experience, as well as prevent physical, psychological, and economic concerns.

CONCLUSION

Factors that can have an impact on the use and availability of local anesthesia by nurses were identified in this review. These include (1) the level of effectiveness among types of local anesthesia; (2) underestimating pain associated with catheter insertion, time for administration, and onset of action, especially in critical settings; (3) lack of provider authorization; and (4) cost. The absence of hospital policies and a lack of education or training also influence the use of local anesthesia because nursing practice is shaped by these organizational guidelines. A core responsibility of nursing is to alleviate pain and advocate for patients' best interests. This review informs stakeholders about the gap in nursing practice in Saudi Arabia as substantiated by the recommendations and evidence in the literature.

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Literature Review

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
<p>Burke et al, 2011¹⁴</p>	<p>The purpose of the study was to compare the efficacy of intradermal bacteriostatic normal saline with that of intradermal buffered lidocaine in providing local anesthesia to adult patients before IV catheterization.</p>	<p>148 adults (M = 26, F = 48 each group) from the researcher's hospital same-day surgery unit</p>	<p>Quantitative Randomized, double-blind, parallel-design, quasi-experimental study</p>	<p>Intradermal buffered lidocaine was demonstrated to be significantly superior to intradermal bacteriostatic normal saline in reducing the pain of IV catheterization ($P = .007$).</p>	<p>Large sample. Practice setting was not identified. A skilled infusion nurse performed the procedure, which could lead to a missing confounding variable of different skills and experience of a group of professionals. Two types of local anesthesia were tested using the same route of administration, which eliminated other variables that could affect the outcomes.</p>	<p>Two types of local anesthesia were tested, which provided a useful comparison among other types used for the same purpose of reducing procedural pain. This can help determine their practicality and convenience in nursing practice.</p>
<p>Crowley et al, 2011⁸</p>	<p>The purpose of the study was to add to the development of emergency nursing resources evidence-based information regarding pain and distress reduction in pediatric patients during minor invasive procedures in the ED.</p>	<p>Comprehensive literature review</p>	<p>The authors used standardized worksheets, including the Evidence-Appraisal Table Template, Critique Worksheet, and the Agree Worksheet to prepare tables of evidence ranking each article in terms of the level of evidence, the quality of evidence, and its relevance and applicability to practice.</p>	<p>Categories of effectiveness for pain relief are ranked as follows: 1. Biobehavioral interventions. (Level A: High). 2. Dermal anesthetic: Vapocoolant spray. i. Ethyl vinyl chloride (Level C: Weak). ii. Pentafluoropropane and tetrafluoroethane (Level B: Moderate). iii. All transdermal forms of lidocaine/tetracaine (amethocaine) (Level B: Moderate). 3. Subdermal local anesthetic with needleless delivery (eg, jet injection device) as a delivery method for lidocaine is superior to other forms of preparation (Level A: High). 4. Local application of ice (Level B: Moderate). 5. Pacifiers and sucrose for infants 0-3 months: i. Pacifiers (Level B: Moderate). ii. Sucrose (Level C: Weak).</p>	<p>Secondary source. Practice setting was not identified.</p>	<p>Provided levels of recommendations for different types of pain management for needle-related procedures in children based on evidence ranking, which can help support the study of their effectiveness. Factors that contributed to such conclusions in this study are important to research because they can influence the use of local anesthetics by nurses.</p>

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
Czarnecki et al, 2011 ¹⁵	The study aimed to identify barriers perceived as interfering with RNs' ability to provide optimal pediatric pain management.	272 of 970 surveys were returned from RNs (F = 226, M = 6) Children's Hospital of Wisconsin is a pediatric teaching hospital in southeastern Wisconsin.	Quantitative, cross-sectional design	The 5 most significant barriers identified were insufficient orders, insufficient physician orders before procedures, insufficient time to premedicate patients before procedures, the perception that pain management by medical staff is a low priority, and parents' reluctance to have patients receive pain medication. Additional barriers were identified through narrative comments.	Large sample size. Nurses were from a single setting. The study provided detailed description of data. The majority of participants were female, which could show bias responses; however, this may reflect the reality of the nursing population, in which the majority often are female.	Although this study is limited to pediatrics and is not specifically about local anesthetic, it identified important factors from nurses' perspectives that are barriers to optimal pain management, which are useful to the research. In addition, the use of topical analgesics for procedural pain was involved as part of this study, which is relevant to the research.
Haynes, 2015 ¹⁶	The study investigated whether application of ice to the puncture site could reduce the pain associated with arterial puncture.	Convenience sample of 80 adult outpatients with a physician order for an ABG test	Quantitative, prospective, stratified, randomized, controlled trial	Significant reduction of pain in the treatment group compared with the control group. (Mean visual analog scale 13.8 ± 16.9 vs 25 ± 23 mm, $P = .01$; median visual analog scale 7 mm, IQR 1.5–19 vs 20 mm; IQR 4.5–38.5 mm, $P = .01$). Only 3 subjects were unable to tolerate 3-min ice application.	Recent study. Practice setting was not identified. A single phlebotomist drew all ABGs, so there might be a missing confounding variable because a group of professionals with various skills and experience was not involved.	Application of ice is another technique that can be used by RNs as an alternative for procedural pain reduction because it is noninvasive, non-pharmacologic, inexpensive, and readily available, especially when local anesthesia is not available or is not offered to patients in some settings.

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
Hajisevedjavadly et al, 2012 ⁹	The aim of the study was to compare pain levels from ABG sampling performed with or without application of lidocaine through an intradermal jet injector.	42 alert and cooperative volunteers requiring ABG sampling as part of their management in the ED Group A vs Group B (M = 15 and F = 6 vs M = 10 and F = 11) Imam-Reza Hospital in Tabriz, Iran	Quantitative, randomized, controlled clinical trial	The pain visual analog scale score during ABG sampling was considerably lower in group A compared with group B (1.29 ± 0.90 vs 4.19 ± 1.43; <i>P</i> < .001). The number of attempts required for ABG was significantly lower in group A compared with group B (1.29 ± 0.46 vs 2.1 ± 0.12; <i>P</i> = .009). All residents reported ease of use with the lidocaine jet injection procedure (<i>P</i> < .05).	Small sample. The control group received a conventional method of mild local anesthesia; however, it was not explained why this was done. Contradictory information provided in the abstract about the method (application of local anesthesia 5 min before the procedure).	Although there was no nursing involvement in this study in which ED residents performed the procedure, the study compared the use of a jet injector device with other types of local anesthesia. This study has relevant aspects that may influence the use of this device by nurses, such as administration time, successful insertion, and convenience.
Hijazi et al, 2009 ¹⁷	The authors examined the effectiveness and safety of using a topical alkane vapocoolant spray in reducing pain associated with venous cannulation in adults in EDs.	201 adult patients in the ED of a metropolitan teaching hospital in Australia	Quantitative approach Randomized double-blind, placebo-controlled trial	Median pain scores for cannulation in the control and intervention groups were 36 (19-51) and 12 (5-40) mm, respectively (<i>P</i> < .001), and 59 (60%) and 33 (32%) reported pain scores ≥ 30 mm (<i>P</i> < .001). Success rates for first cannulation attempt did not differ between groups (<i>P</i> = .39). 39% and 62% patients said they would choose the spray they received for analgesia in the future (<i>P</i> = .002). Topical alkane vapocoolant spray is effective, safe, and acceptable in reducing cannulation pain (less than 15 s of application) in adults in ED.	Large sample size. Potential confounders were measured to ensure accurate outcomes. Visual analog scale was used, which is a highly discriminant method of assessing pain. Clear and detailed information was provided that expresses reliability of the study.	Although it was exclusive to only 1 type of local anesthesia, this study helps support the evidence of vapocoolant spray effectiveness in reducing pain associated with venous cannulation. It is also beneficial to compare with other types of local anesthesia that are used for the same purpose to examine aspects that can influence nurses' use, such as level of effectiveness and onset of action.

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
Hudson et al, 2006 ¹⁸	The purpose of the study was to review recommendations and studies related to the use of intradermal lidocaine to decrease pain during arterial punctures.	Literature review	A systematic computerized search of MEDLINE (1980-January 2006)	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.	Secondary source. Practice setting was not identified.	Although the review specified 1 type of local anesthetic and some reviewed articles are considered old, it explored many factors that can influence the use of local anesthesia by nurses, such as standard of practice, effectiveness of intradermal lidocaine, topical anesthesia, barriers of use, effect on successful insertion, and cost.
Jimenez et al, 2006 ¹⁹	The study aimed to compare the effectiveness of 1% buffered lidocaine with an intradermal jet injector vs a topical transdermal agent, (eg, EMLA) to facilitate IV cannulation and provide adequate analgesia before IV placement.	116 young patients (7-19 y old) Topical transdermal agent group = 59 Intradermal jet injector group = 57 Children's Hospital and Regional Medical Center in Seattle, Washington	Quantitative Randomized, controlled trial	There was a significant difference in pain ratings ($P = .0001$) during IV cannulation between the topical transdermal agent (median = 3) and the intradermal jet injector (median = 0). 84% of patients reported no pain at the time of the intradermal jet injector lidocaine application compared with 61% in the topical transdermal agent group at the time of dressing removal ($P = .004$). No differences were found in the number of attempts for IV cannulation. Intradermal jet injector application of 1% buffered lidocaine before IV cannulation is not painful and has better anesthetic effectiveness compared with a topical transdermal agent.	Large sample. Lack of control group was not explained in the study. Blinding of study personnel was not provided.	This study is useful to the research topic because it tested an intradermal jet injector local anesthetic against a topical transdermal agent to measure the effectiveness between both, and it measured relevant aspects, such as successful insertion rate, time, and convenience. It also tested the hypothesis that children would be frightened by the pop sound, yet the opposite was proven. All of these results are factors that could influence the use of local anesthetics by nurses.

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
Levitt and Ziemba-Davis, 2013 ²⁰	The purpose of this study was to explore knowledge about patient preferences for pain control during peripheral venous cannulation. Specific aims were to (1) elucidate patients' desire to be involved in decisions about pain management; (2) determine whether patients have a preference for different pain management strategies; (3) determine patient satisfaction with the pain management choice; and (4) record pain ratings and satisfaction with IV insertion.	30 patients recruited from a referral hospital in the United States	Quantitative approach. Exploratory study. Patients were asked to answer some questions before and after the procedure. Three groups: intradermal lidocaine, guided imagery, and no intervention.	Four patients chose the traditional strategy of no pain control. In contrast, 86.6% of participants preferred to have pain control. The study found that pain in the intradermal lidocaine group was significantly lower. All participants in the 3 groups reported that the patient's involvement in decision making regarding pain management is very important.	Recent study. Small sample size. Study methodology was unclear. Lack of blinding and equal treatment limit its reliability. Randomization to groups was not possible because participant choices about pain management strategies were a key study outcome.	Despite limitations, this study is useful because it explored the importance of pain management strategies for IV insertion from patients' perspectives. In addition, its implications for nursing practice are particularly relevant to the concerns outlined in this article.
Matheson et al, 2014 ²¹	The study aimed to compare standard practice and 3 methods of analgesic infiltration (0.7 mL 1% lidocaine, 0.7 mL buffered 1% lidocaine, or 0.7 mL bacteriostatic saline to determine if 1 method was more successful than the others at reducing pain associated with ABG sampling.	Convenience sample of 40 hospitalized patients at OSF Saint Anthony Medical Center, in Rockford, Illinois	Quantitative, randomized, partially blinded, prospective design	Comparing the nonintervention group with the 3 interventions showed that the buffered ($P = .041$) and plain lidocaine ($P = .000$) induced significantly less arterial puncture pain than the nonintervention group, but there was no statistical significance with the use of bacteriostatic saline ($P = .665$). Overall, plain lidocaine was the intervention that resulted in significant reduction of pain.	Recent study. Small sample size and partial randomization. Patients were treated equally. All ABGs were drawn by 1 researcher; outcomes could be affected if different levels of skill and experience of a group of health professionals were involved. Based on patients from a single setting.	The study is useful to support effectiveness of local anesthesia for procedural pain. It is also relevant to the study topic, as the researcher is a nurse who has also experimented with ways to reduce pain associated with arterial puncture for ABG sampling.

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
McNaughton et al, 2009 ²²	The study aimed to compare pain and anxiety associated with IV cannulation after pretreating patients with 1% subcutaneous buffered lidocaine, 4% lidocaine cream, or no application of local anesthesia.	70 medical student and nurse volunteers who participated in hospital workshops for IV insertion in the United States	Quantitative, randomized, crossover	Pain and anxiety associated with IV cannulation was significantly minimized by the use of lidocaine cream or injected buffered lidocaine. There was no significant difference in anxiety scores in patients receiving lidocaine cream and those injected with buffered lidocaine. 70% of subjects reported that they would always request buffered lidocaine in the future. Many participants were influenced by their positive personal experiences in receiving local anesthesia as a reason to administer it to their patients.	The sample was biased to health professionals, which might affect the validity of the findings in terms of their knowledge about local anesthesia. They were not blinded, and a placebo was not used because of the claim of ethical consideration.	The study is relevant to the research topic, in which it supports the effectiveness of local anesthesia for reducing pain and anxiety associated with IV cannulation. Interestingly, the study shows that personal experiences of participants have influenced their perception toward using local anesthesia in the future for themselves and their patients. Therefore, personal experience could be a factor that influences nurses' use of local anesthesia.
Mirzaei et al, 2018 ²³	The aim of the study was to investigate the effect of topical transdermal cream, lidocaine spray, and ice on arteriovenous cannulation pain intensity in hemodialysis patients.	40 hemodialysis patients > 18 y old with arteriovenous fistula Shahid Rahmehoon Hospital in Yazd, Iran	Quantitative, quasi-experimental	The reduction in mean pain intensity was significantly greater with topical transdermal cream compared with lidocaine spray and ice ($P < .001$). The pain score was also significantly different before intervention and after application of the 3 interventions ($P < .001$). The study concluded that all 3 methods of intervention were effective in reducing pain intensity, with topical transdermal cream exerting the greatest effect in decreasing the puncture-related mean pain intensity of arteriovenous fistula cannulation.	Current study Small sample size Lack of randomization	This is a recent study comparing 3 types of local anesthesia—a topical transdermal agent, lidocaine spray, and ice—tested on arteriovenous cannulation for hemodialysis. The study provided a useful comparison of different types of local anesthesia used for the same purpose of reducing procedural pain. This can help determine their practicality and convenience within nursing practice.

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
<p>Papa and Zempsky, 2010²⁴</p>	<p>The purpose of the study was to examine nurses' attitudes toward and experience with venous access pain in pediatric patients, and their perceptions of the value of current techniques used for managing such pain.</p>	<p>2187 nurses who were members of 3 nursing societies based in the United States: the Emergency Nurses Association, the Infusion Nurses Society, and the Society of Pediatric Nurses</p>	<p>Quantitative Web-based survey</p>	<p>Respondents indicated that inserting an IV catheter in a fearful, anxious child was challenging (96%). Nonpharmacologic techniques were frequently used but were perceived as insufficient for alleviating pain when used alone. Topical local anesthetics were deemed more effective, but are used less often. Most respondents agreed that improved pain management enhances their satisfaction with their job performance (91%), increases job satisfaction (81%), increases positive relationship with patients and families (91%), and positively impacts the hospital experience for children and their families (97%). Most nurses (92%) agreed that an effective, fast-acting, topical local anesthetic would benefit pediatric patients, their families, and the nurses who treat them.</p>	<p>Large, representative sample. Written language is very clear. Detailed provision of data. It did not specify which types of topical anesthesia are used in those settings.</p>	<p>Although it only focused on pediatric settings, the study identified some important factors that can hinder the use of topical local anesthetics for IV cannulation from the perspectives of the nurses who performed these procedures, which supports the research topic.</p>
<p>Page and Taylor, 2010²⁵</p>	<p>The study's aim was to compare the efficacy, acceptability, and safety of a topical vapocoolant alkane spray and 1% plain subcutaneous lidocaine in reducing pain from IV cannulation.</p>	<p>Convenience sample of 220 adult and pediatric participants in a metropolitan ED</p>	<p>Quantitative, nonblinded, randomized controlled trial</p>	<p>Overall, vapocoolant spray was less painful to administer but less effective in decreasing cannulation pain than lidocaine. Vapocoolant spray was associated with greater cannulation success (83.6% vs 67.3%; $P = .005$), less time to administer (median 9.0 vs 84.5 s; $P < .001$), and more staff convenience (median 5 vs 4; $P < .001$) than lidocaine. Overall patient satisfaction scores were similar. Vapocoolant spray offers a useful alternative in the ED setting.</p>	<p>Large, mixed sample of adults and children. Equal allocation of 110 participants for each group for a total of 220 participants. Provided clear and rich details of information. Practice location was not identified. Lack of control group was not explained. Study was not blinded.</p>	<p>Two types of local anesthesia were studied, which provided a useful comparison among other types of local anesthesia used for the same purposes as this study. Most important, it pointed at contributing factors that can influence the use of local anesthesia by nurses, such as successful IV insertion, administration time, and satisfaction, which helps support this research study.</p>

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APPENDIX 1

Literature Review (Continued)

Author and Date	Aim/Objective	Sample and Setting	Methods and Methodology	Major Findings	Limitations and Rigor/Validity	Significance to the Issue
Rostami et al, 2006 ²⁶	The aim of the study was to determine the effect of local application of ice for 3 min prior to venipuncture on pain-related responses in school-aged children.	80 children (6-12 y old) in a pediatric emergency department of a pediatric center, in Ahwaz, Iran	Quantitative Quasi-experimental	No significant difference in physiological responses before and after the procedure between the 2 groups ($P = .07$). However, behavioral and subjective responses before and after the procedure were lower in the test group ($P = .0011$ and $P = .0097$, respectively). The study concluded that the application of ice to skin prior to venous puncture can be an effective and safe intervention for reducing related pain.	Clear and accurate measurements provided Lack of randomization and blinding	Application of ice is another technique that can be used by nurses as an alternative for procedural pain reduction because it is noninvasive, nonpharmacologic, inexpensive, and readily available, especially when local anesthesia is not available or not offered to patients in some settings. This study is also beneficial to compare with similar studies conducted on adults for the same purpose.
Sado and Deakin, 2005 ²⁷	This study measured the prevalence of the use of local anesthesia for venous cannulation and ABG sampling by physicians.	178 anesthetists, and medical and surgical physicians in 8 hospitals in the United Kingdom	Quantitative Data collected through a printed questionnaire	60% of anesthetists were using local anesthesia for these procedures compared with 2% of ward physicians.	Large sample. The study was conducted 10 y ago. The study has been cited multiple times. Brief description provided in the study. Factors relevant to the issue were discussed based on observing and talking to doctors, but they were not supported with evidence.	This study is useful because the main concept is relevant to the research topic of this article. While nurses in Saudi Arabia are performing these procedures, this article in particular may assist in identifying some factors that lead to similar practice of local anesthesia by physicians for these procedures.

Abbreviations: ABG, arterial blood gas; ED, emergency department; F, female; IQR, interquartile range; IV, intravenous; M, male; RN, registered nurse.

APPENDIX 2

Themes From the Literature

Themes	Element	Sources
Effectiveness of local anesthesia; total articles = 11	Intradermal injections	Matheson et al, 2014 ²¹
		McNaughton et al, 2009 ²²
		Burke et al, 2011 ¹⁴
		Hudson et al, 2006 ¹⁸
	Intradermal needleless device	Crowley et al, 2011 ⁸
		Hajiseyedjavady et al, 2012 ⁹
		Jimenez et al, 2006 ¹⁹
	Topical anesthetics	Hijazi et al, 2009 ¹⁷
		Papa and Zempsky, 2010 ²⁴
		Crowley et al, 2011 ⁸
		Page and Taylor, 2010 ²⁵
Mirzaei et al, 2018 ²³		
Other strategies for procedural pain management; total articles = 5	Application of ice	Haynes, 2015 ¹⁶
		Crowley et al, 2011 ⁸
		Rostami et al, 2006 ²⁶
		Mirzaei et al, 2018 ²³
	Behavioral intervention	Papa and Zempsky, 2010 ²⁴
		Crowley et al, 2011 ⁸
Other benefits of local anesthesia; total articles = 9	Successful insertion	Hudson et al, 2006 ¹⁸
		Crowley et al, 2011 ⁸
		Hajiseyedjavady et al, 2012 ⁹
		Jimenez et al, 2006 ¹⁹
	Improve satisfaction	Hijazi et al, 2009 ¹⁷
		Papa and Zempsky, 2010 ²⁴
		Page and Taylor, 2010 ²⁵
		Hajiseyedjavady et al, 2012 ⁹
		Levitt and Ziemba-Davis, 2013 ²⁰
		McNaughton et al, 2009 ²²
Barriers of low use of local anesthesia; total articles = 9	Underestimation of procedural pain	Sado and Deakin, 2005 ²⁷
		Czarnecki et al, 2011 ¹⁵
	Time concerns	Hijazi et al, 2009 ¹⁷
		Page and Taylor, 2010 ²⁵
		Papa and Zempsky, 2010 ²⁴
		Hudson et al, 2006 ¹⁸
		Czarnecki et al, 2011 ¹⁵
		Hajiseyedjavady et al, 2012 ⁹
	Jimenez et al, 2006 ¹⁹	
	Drug preorder	Hudson et al, 2006 ¹⁸
		Papa and Zempsky, 2010 ²⁴
		Czarnecki et al, 2011 ¹⁵
	Cost	Hudson et al, 2006 ¹⁸
		Page and Taylor, 2010 ²⁵
		Burke et al, 2011 ¹⁴
		Jimenez et al, 2006 ¹⁹