ORIGINAL ARTICLES

Comparison of Bacteriostatic Normal Saline and Lidocaine Used as Intradermal Anesthesia for the Placement of Intravenous Lines

Pamela E. Windle, MS, RN, CNA, BC, CPAN, CAPA
Meggie L. Kwan, BSN, RN, CAPA
Honey Warwick, BSN, RN, CAPA
Agnes Sibayan, BSN, RN, CPAN
Charito Espiritu, BSN, RN, CAPA
Jennifer Vergara, BSN, RN, CAPA

Pain with intravenous (IV) insertion is a common fear for preoperative patients. As perianesthesia nurses, we take the necessary measures to minimize the discomfort and anxiety of our patients. Several research studies have found the use of bacteriostatic normal saline (BNS) to produce a less painful, yet equally effective, safer, and less expensive alternative method for intradermal anesthesia. The purpose of this study was to determine whether a difference existed in pain with intradermal injection and pain with venipuncture when intradermal anesthesia was used. Using an experimental design, 221 participants were randomly assigned by lottery convenience sampling into three groups: lidocaine, BNS, and no local anesthesia. Patients were asked to quantify their pain/discomfort level after the intradermal injection and IV insertion using a modified visual analog scale. Significant findings (P = < .05) indicated that BNS was less painful on injection, and both BNS and lidocaine were effective as local anesthetics for IV insertion. This study helped perianesthesia nurses and patients in determining which method of IV insertion is more effective and reasonably acceptable to ensure patient comfort, satisfaction, and positive outcomes.

Pamela E. Windle, MS, RN, CNA, BC, CPAN, CAPA, is the Nurse Manager, Day Surgery Center, PACU, Surgical Observation Unit, St Luke's Episcopal Hospital, Houston, TX; Meggie Kwan, BSN, RN, CAPA, is a Charge Nurse, Day Surgery Center, St Luke's Episcopal Hospital, Houston, TX; Honey Warwick, BSN, RN, CAPA, is a Staff Nurse, Preop/PACU, St Luke's Community Medical Center–The Woodlands, Houston, TX; Agnes Sibayan, BSN, RN, CAPA, is a Staff Nurse, Day Surgery Center, St Luke's Episcopal Hospital, Houston, TX; Charito Espiritu, BSN, RN, CAPA, is a Staff Nurse, Day Surgery Center, St Luke's Episcopal Hospital, Houston, TX; and Jennifer Vergara, BSN, RN, CAPA, is a Staff Nurse, Day Surgery Center, St Luke's Episcopal Hospital, Houston, TX.

Address correspondence to Pamela E. Windle, MS, RN, CNA, BC, CPAN, CAPA, St Luke's Episcopal Hospital, 6720 Bertner Ave, Houston, TX; e-mail address: pwindle@sleh.com.

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MOST PATIENTS undergoing surgery are required to have an intravenous (IV) port inserted before the surgical procedure for the administration of fluids and medication. Pain during venipuncture is a major source of concern and a common source of anxiety for these patients.[1-4] About 20% of adults had mild to intense fear when confronted with injections.[3,4] Approximately 10% of adults have such a profound fear of needles that they have clinical signs and symptoms of "needle phobia," which may include immediate anxiety and a vasovagal response that can lead to bradycardia and hypotension.[3,4] Fear also lead to vasoconstriction, making an IV start more difficult.[5]

Many of these patients had prior encounters with venipuncture and these experiences may have left painful memories because of staff failure to obtund venipuncture pain with analgesics.[6] Therefore, administration of an analgesic agent before venipuncture is useful to prevent pain and optimize patient comfort and satisfaction. Perianesthesia nurses are obligated to take measures to minimize the patient's discomfort and anxiety. At St Luke's Episcopal Hospital in the Texas Medical Center, Houston, Texas, the Day Surgery Center (DSC) nurses follow routine orders from the anesthesia department, which require an intradermal injection of 0.1 mL of 1% lidocaine before the insertion of an IV catheter. This technique provides a local anesthetic effect to ease the pain of the IV line placement. Even a small dose of lidocaine, however, may produce negative effects such as burning at the site of injection, allergic reaction, inadvertent injection into the vascular system, and systemic toxicity.[6-10] The most common complaint of presurgical patients at the DSC was stinging and burning during the lidocaine injection.

Several investigators have found that the use of bacteriostatic normal saline (BNS) may provide a less painful, equally effective, safer, and less expensive alternative for intradermal anesthesia.[5-9] BNS is already being used at some institutions to help decrease the pain associated with IV insertion. The primary aim of this study was to determine the difference in pain during the three-cannulation techniques: (1) lidocaine, (2) BNS, and (3) no anesthesia. Data obtained from this study will be used to evaluate and possibly change current nursing practice.

Review of the Literature

Several research studies have been published on decreasing pain with venipuncture, perhaps because venipuncture is perceived as a painful and stressful event to an already anxious patient. Pain during venipuncture is a major concern to children and their caretakers, and children view needle sticks as the worst source of pain and fear in the hospital setting. In an effort to minimize the pain of needle sticks, Kleiber et al[11] conducted a comparative study between ELA-Max (Ferndale Laboratories, Ferndale, MI) and eutectic mixture of local anesthetics (EMLA) to investigate their anesthetic equivalence. They reported that there was no significant difference in pain ratings for hands that were treated with either agent.[11] Galinkin et al[1] studied the effect of dermal analgesia provided by lidocaine iontophoresis and EMLA and concluded that lidocaine iontophoresis provides similar pain relief for insertion of IV catheters as EMLA, and is a useful noninvasive alternative to establish dermal analgesia for venous cannulation.[1]

BNS is a widely available physiologic solution containing the preservative benzyl alcohol. It is frequently used in the management of critically ill patients to flush intravenous (IV) catheters after use and is also used to dilute or reconstitute medications for IV use. Its anesthetic properties have been noted in the literature as far back as 1918, and its use as an effective and safe intradermal anesthetic for intravenous line change has been validated in several studies. Both past and present literature suggest that bacteriostatic 0.9% sodium chloride containing the preservative benzyl alcohol provides intra-

dermal anesthesia comparable to that of 1% lidocaine hydrochloride.[5-9]

Patterson et al[6] compared pain on application, pain on venipuncture, cost, and convenience of four analgesic agents used for venipuncture. There was a significant difference in cost and convenience among the four agents, with BNS and lidocaine being the least expensive analgesic agents. Lidocaine had low pain on venipuncture, low cost, and convenience of use, but it was less than ideal in terms of pain on application. They concluded that BNS had all the qualities of an ideal analgesic agent for venipuncture; it had low pain on application and venipuncture and was inexpensive and convenient to use.[6] Brown[12] compared lidocaine hydrochloride 1% with sodium bicarbonate and sodium chloride 0.9% with benzyl alcohol for their anesthetic effect during initiation of peripheral intravenous catheters. No significant difference in pain scores was found between the two groups ($P = .43$).[12] Minogue et al[13] did another interesting study comparing the effects of BNS and lidocaine on pain experienced during propofol injection. They concluded that BNS was an effective and cheap alternative to lidocaine in decreasing pain associated with the IV administration of propofol.

McNelis[9] conducted a study comparing the anesthetic effects of 0.9% bacteriostatic sodium chloride with 1% lidocaine HCL in obtaining IV access. This double-blind study had 40 adult presurgical patient subjects who consented to have two large-bore IV catheters placed: one insertion was pretreated with lidocaine and the other with BNS. A skin wheal was created using a 25-gauge needle to intradermally inject 0.1 mL and 0.4 mL of solution. The cannulation technique, location, and size had to be the same for both extremities, and access must have been achieved on the first attempt to qualify in the study. Pain was rated on a modified visual analog scale after the insertion. The findings showed no significant differences in the perceived pain of IV cannulation pretreated with either lidocaine or BNS ($P = .29$). Therefore, 0.9% sodium chloride containing benzyl alcohol was found to be as effective as 1% lidocaine hydrochloride in providing local anesthesia for intravenous cannulation.

Fein et al[10] studied the effects of intradermal anesthesia for IV placement in children. They performed a prospective randomized clinical trial of 99 children ages 6 to 19 years old, presenting to the emergency department and requiring nonemergent IV placement. The children were divided into three groups receiving intradermal BNS, intradermal lidocaine, or no anesthesia before attempting IV access. In the lidocaine and BNS groups, a 27-gauge needle was used to inject 0.1 to 0.2 mL of the compound. The nurse determined what gauge needle was appropriate for the vein and one minute after the injection of the compound, inserted the catheter into the vein. A modified visual analog scale was used for the children to rate their preprocedural anxiety, pain with intradermal injection, and pain with cannulation. The results indicated that saline with benzyl alcohol and 1% lidocaine were equally effective as intradermal anesthetics for IV line placement in children ($P = .08$). However, unlike previous adult studies, this study of children found both solutions to be equally painful on injection ($P < .01$).

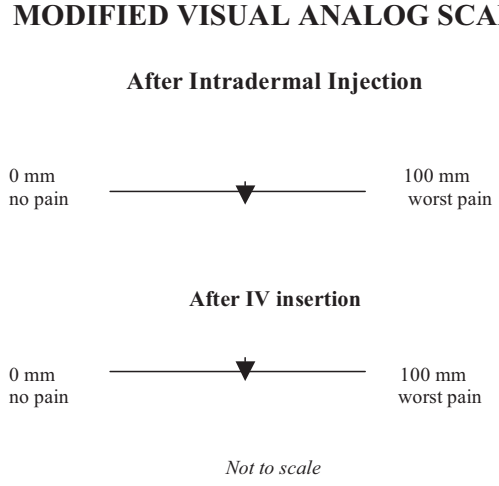

Fig 1. Modified visual analog scale (MVAS).

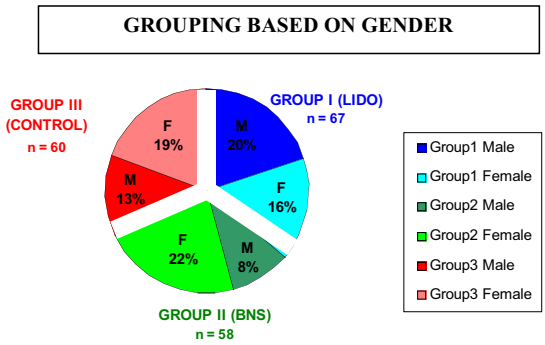

Fig 2. Grouping based on gender.

Few nurses outside the preoperative department use venipuncture analgesia. Perhaps this is because nurses view venipuncture analgesia as requiring too much time or ineffective, or they believe one needle stick is better than two. Brown[14] studied registered nurses' (RNs') choices regarding the use of intradermal lidocaine for IV insertions and the challenge of changing practice. She concluded that the reasons for not offering lidocaine included the following: (1) perception that it made the procedure more difficult, (2) acknowledgment that it was not part of their routine, or (3) they did not think of it. The RNs who used the lidocaine and the RNs who did not stated that poor staff knowledge and skill contributed to lack of use of intradermal lidocaine.[14] Venipuncture analgesia is also a consumer issue. Patients want the best care with the least amount of pain and cost. Providing quality care is a nursing goal, and venipuncture analgesia is a part of quality care.

Sample

After the approval of the Nursing Research Council and the Institutional Review Board, the researchers reviewed and discussed the specific technique for data collection to assure consistency. Random sampling by lottery method was used to select participants from the surgery schedule, which included outpatients and same-day admit patients. Study inclusion criteria included the following: (1) adult participants who were 18 years and older, (2) patients who were able to read and write English, and (3) patients whose IV insertion was performed on an upper extremity. Exclusion criteria included (1) participants with neuropathy and/or needle phobias, (2) renal patients, and (3) patients whose IV insertions were not achieved on the first attempt.

Methodology

Subjects meeting the inclusion criteria were counseled regarding the study. Informed consent was obtained and participants were randomly assigned to three groups: (1) 1% lidocaine, (2) 0.9% BNS with benzyl alcohol, and (3)

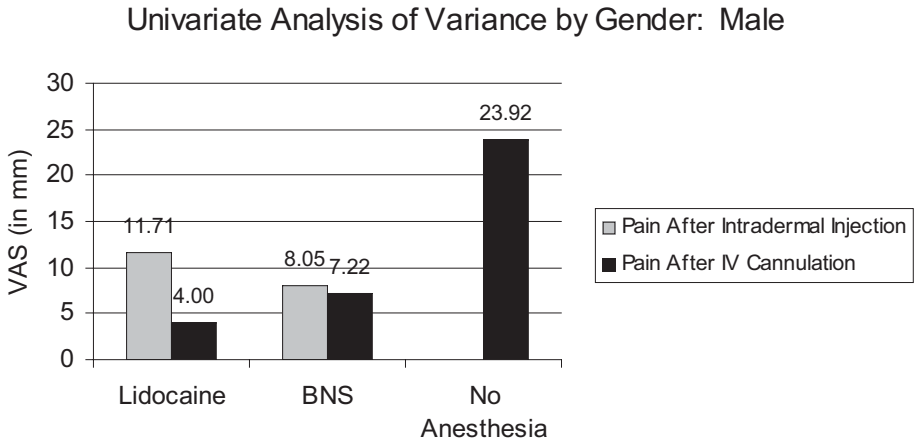

Fig 3. Univariate analysis of variance by male gender.

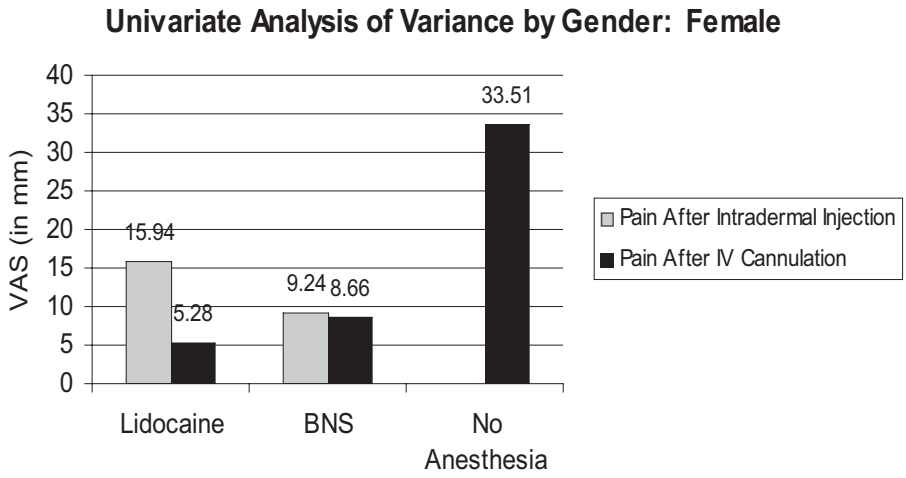

Fig 4. Univariate analysis of variance by female gender.

no intradermal anesthesia. Subjects' questions and concerns were also addressed at this time. All the participants were assured that they would be given the same standard of care whether they participated in the study or not. The RN performing the IV cannulation also obtained demographic information from the subject. A 0- to 100-mm modified visual analog scale[15] (MVAS) (Fig 1) was used to evaluate the pain associated with the local anesthetic at two points: (1) immediately after intradermal injection and (2) after IV cannulation. The investigators were trained on how to educate the subjects on the MVAS, and a script was prepared. The MVAS was explained to each subject before IV cannulation.

A 29-gauge needle was used to inject 0.05 to 0.1 mL of either 1% lidocaine or 0.9% BNS with benzyl alcohol solution to the back of the hand or forearm to produce a wheal, followed by the insertion of a 20-gauge or an 18-gauge IV cath-

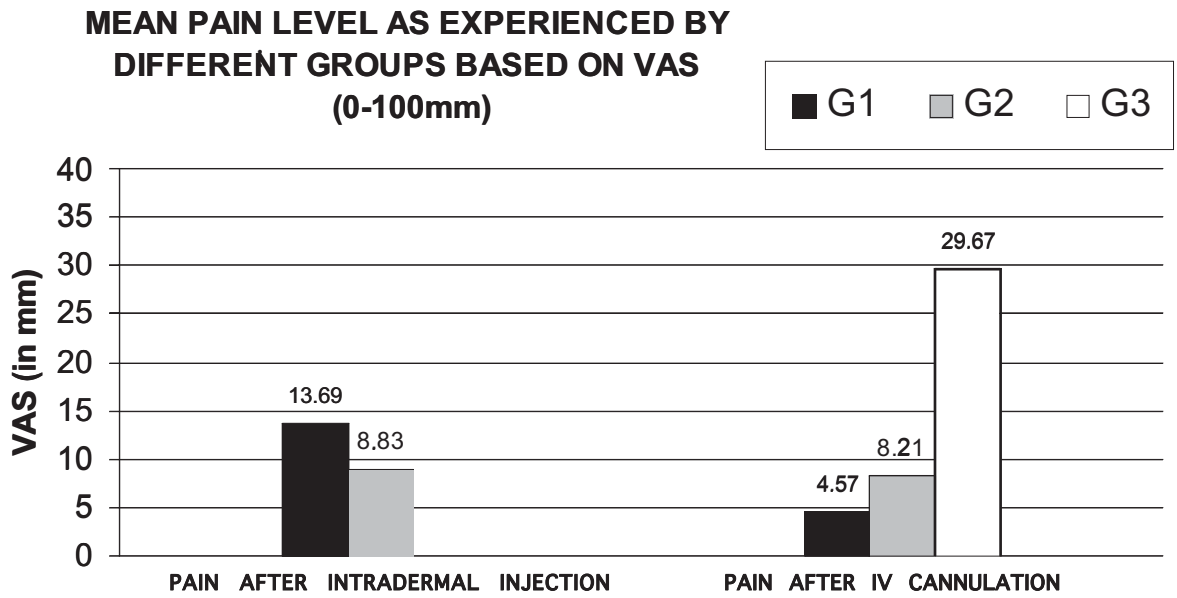

Fig 5. Mean pain level as experience by different groups based on VAS.

Table 1. Demographic Characteristics

Intradermal Injection	Women (N = 77)	Men (N = 62)
Age		
Mean (SD)	47.40 (14.60)	48.081 (12.42)
Range	19–78	19–74
Race (%)		
White	62.3	64.5
Black	19.5	12.9
Asian	1.3	1.6
White Hispanic	7.8	11.3
Native American	0	3.2
Other	9.1	6.5

IV Insertion	Women (N = 112)	Men (N = 85)
Age		
Mean (SD)	47.94 (14.12)	50.55 (13.041)
Range	19–78	19–81
Race (%)		
White	58.3	65.9
Black	24.3	12.9
Asian	0.9	2.4
White Hispanic	7.1	10.6
Native American	0	2.4
Pacific Islander	0	0
Other	8.9	5.8

eter directly over the wheal, then waiting 30 seconds to 1 minute before IV cannulation. Participants were blinded as to what solution was being used. Subjects receiving intradermal injection (Groups 1 and 2) (Figs 2-5) were then asked to draw a vertical line on the first line on the MVAS best representing the pain they experienced. Approximately one minute after cannulation, participants in all groups were asked to rate the pain they had during the IV cannulation by drawing a vertical line on the second line on the scale.

Results

Demographic characteristics for the subjects appear in Table 1. The intradermal injection arm of the study consisted of 139 subjects (44.6% male and 55.4% female). The impact of gender and type of anesthesia used for the intradermal injection on levels of reported pain as measured by the pain scale was also analyzed in this subset. Two-way analysis of variance resulted in a nonsignificant interaction of anesthesia group by gender, F (1139) = 0.886, P =.35. There was also no significant main effect for gender, F (1139) = 0.060, P = .81. There was a significant main effect for type of anesthesia, F (1139) = 4.30, $P < .05$), with the subjects receiving lidocaine reporting a higher pain score (M = 16.94, SD = 16.58) than those receiving BNS (M = 11.15, SD = 14.36). These results are noted in Table 2.

The second component of the study analyzed pain during IV cannulation and consisted of 197 subjects, 43.1% of which were males and 56.9% females. Pain levels during IV cannulation after an intradermal injection of lidocaine or BNS were recorded, and a group of patients who did not receive any intradermal anesthesia served as the control.

Because Levene's Test of Equality of Error Variances was significant ($P < .0001$), a higher α level for the test of the F ratio was set at 0.01 for this arm of the study. At this α level, the interaction was not significant F (2197) = 1.33, P = .05, and there was no main effect for gender, F (2197) = 1.614, P = .21. There was a significant

Table 2. Intradermal Injection Phase: Two-Way ANOVA Summary Table for the Relationship Between Type of Pain Medication and Gender on Reported Pain Level

Source	df	SS	MS	F
Anesthesia Type	1	1045.94	1045.94	4.30*
Gender	1	14.68	14.68	0.060
Interaction†	1	215.41	215.41	0.886
Within (error)	135	32,836.09	243.23	
Total	138	34,238.52		

*$P < .05$; †Interaction means that the effect of one of the variables (gender) on the outcome is dependent on the other variable (type of medication). Depending on the gender, there may have been a different reaction to the type of pain medication the patient received or the level of pain they perceived.

main effect for type of intradermal injection, F (2197) = 19.76, $P < .0001$. Patients who received no pain medication reported significantly higher pain levels (M = 27.47) than those who received either BNS (M = 13.62) or lidocaine (M = 8.16). However, the mean difference on reported pain level between the lidocaine and BNS groups was not significant ($P = .21$). These results are noted in Table 3.

Overall results, as reflected in Table 4, indicated that BNS is less painful than lidocaine when used during intradermal injection, as reported by study participants on the MVAS. The pain experienced during IV cannulation was reported as less with either the use of lidocaine or BNS compared with the pain perceived by the participants who received no anesthesia. The difference in reported pain between lidocaine and BNS was not statistically significant.

Limitations

The results of the study may have been affected by certain variables that were not controlled. Because there were five researchers involved in the study, the interrater reliability was lower than if there had been fewer researchers. One or two researchers collecting the data will show consistency with the technique in IV insertion. The use of both 18- and 20-gauge IV catheters may have directly affected the amount of pain felt by the patient. Conversation was not controlled before, during, or after the IV insertion and may have unknowingly acted as a distractor to the patients. The patients were not uniform in their previous IV experience, and this may have affected their pain rating on the MVAS.

Table 3. After IV Insertion Phase: Two-Way ANOVA Summary Table for the Relationship Between Anesthesia Type and Gender on Reported Pain Level

Source	df	SS	MS	F
Anesthesia Type	2	11,194.24	5597.12	19.76*
Gender	1	457.09	457.09	1.614
Interaction	2	1735.48	867.74	3.065
Within (error)	191	54,081.13	283.147	
Total	197	117,345.25		

*$P < .0001$.

Table 4. Means and Standard Deviations for Perceived Pain as a Function of Type of Anesthesia for Both Parts of the Study

Anesthesia Type	During Intradermal Wheal		During IV Insertion	
	Mean	SD	Mean	SD
Lido	16.94	16.58	8.16	14.86
Saline	11.15	14.36	13.61	15.67
None			27.47	20.71

Discussion and Nursing Implications

Pain management is one of the top priorities for nurses, especially in the perianesthesia setting. The main goal is to provide positive patient outcomes, and patient comfort has proven to be directly related to patient outcomes. One of the most common patient anxieties when entering the hospital for surgery is the IV insertion; so preoperative nurses try to alleviate patients' fear and anxiety. Most hospital facilities do not include the use of local anesthesia before IV cannulation in their policy and procedures; they use other "distracting" methods to decrease pain during IV insertion. Although the lidocaine group reported the least pain after the IV insertion, the BNS group also experienced significantly less pain than the no anesthetic group. In addition, the BNS group reported less pain on injection than lidocaine. These results, combined with the fact that BNS is less expensive and carries a lower risk of adverse effects, should be considered as an option for local anesthetic for IV insertion hospital-wide, particularly in the perianesthesia setting.

Conclusion

Applying the results of this study and changing how IVs are started in the preoperative area will

be beneficial to the hospital and patient. The low cost of BNS, along with its low risks and side effects, can make it a safe and cost-effective intradermal medication for IV line insertion. Use of this technique should improve overall satisfaction and cost-effective quality of care for all our patients. Therefore, a change in our current practice is warranted to improve both patient and hospital outcomes.

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