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Local Anesthesia for Vein Cannulation

A Comparison of Two Solutions

Abstract

This randomized, double-blinded study prospectively compared two solutions for their anesthetic effect during initiation of peripheral intravenous catheters. Each subject received an intradermal injection of one solution at the intended venipuncture site immediately before vein cannulation. After catheter placement, the subjects rated their discomfort associated with this procedure using the Wong-Baker FACES Pain Rating Scale. Of the 47 subjects included in this study, 21 received lidocaine hydrochloride 1% with sodium bicarbonate and 26 received sodium chloride 0.9% with benzyl alcohol. No statistically significant difference in pain scores was found between the two groups (P = .429).

Patient satisfaction scores and cost containment are major considerations in the current healthcare environment. Patient satisfaction scores, based on surveys completed by patients discharged from healthcare facilities, provide information to healthcare providers about how patients view the care they received.

Care for up to 90% of inpatient hospital populations includes intravenous (IV) therapy. Patients have rated IV therapy as highly stressful and uncomfortable.[1] The discomfort a patient feels during IV catheter insertion can create a mood of dissatisfaction. Patient satisfaction with IV therapy might be improved by implementing a practice that decreases the discomfort of vein cannulation. Before implementing a change in practice, cost efficiency should be evaluated by weighing increased expenses against benefits to be gained.

• INTRADERMAL ANESTHESIA

Intradermal injection of lidocaine hydrochloride, a local anesthetic agent, before vein cannulation is a widely accepted practice intended to decrease patient discomfort during IV catheter placement. Sodium bicarbonate ($NaHCO_3$) can be added to buffer the acidic lidocaine, resulting in less discomfort at injection.[2] Risks associated

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with the use of lidocaine include allergic reactions, systemic toxicity, and altered cardiac rhythms. A review of the 450 adverse reactions reported to manufacturers over a 15-year period identified only 41 of the incidences as possible allergic reactions.[3] The occurrence rate for allergic reactions to lidocaine, even when used in large doses, is reportedly less than 0.05%.[4] Although many patients report an allergy to local anesthetics, true allergies comprise less than 1% of all adverse local anesthetic reactions. Adverse experiences can be attributed to vasovagal response, hyperventilation, or inadvertent intravascular administration.[5] According to the manufacturer, adverse experiences are dose related and may result from high plasma levels caused by excessive dosage.[6] Plasma concentrations of 5 to 10 μ/mL are required to produce symptoms of systemic toxicity. A bolus of 50 to 100 mg given twice within 10 minutes is necessary for antiarrhythmic plasma concentrations of 1.5 to 5.0 μg/mL. The 1- to 3-mg dose used for intradermal injection is highly unlikely to cause toxicity or alter cardiac rhythms.[7]

Bacteriostatic 0.9% sodium chloride (NaCl) is another solution used as an intradermal numbing agent before catheter insertion. Benzyl alcohol, added to NaCl as a preservative, has been documented to have an off-label benefit of being an effective local anesthetic with relatively no risks.[8-11] The hemodynamic status of human subjects is reportedly unaffected by the IV administration of 1.0 mg benzyl alcohol per kilogram of body weight.[12] Sodium chloride without benzyl alcohol may have a mild, short-lived local anesthetic effect because of skin distention at injection.

A common concern of those not familiar with local anesthesia is that the intradermal injection is as uncomfortable as vein cannulation, and that an extra needlestick is therefore causing the patient more pain. The 30-gauge needles commonly used for lidocaine injection are much smaller than the needles used for catheter insertion. According to previous studies, the insertion of 18-, 20-, and 22-gauge catheters is significantly more painful than an intradermal injection,[13] and local anesthesia significantly reduces the pain of vein cannulation.[14-17] Because nursing policies vary from institution to institution, many patients have had catheters started with and without intradermal injections. Nurses often hear these patients voice a preference for receiving a pre-insertion injection for numbing.

• LITERATURE REVIEW

Few studies have compared buffered lidocaine with bacteriostatic NaCl for local anesthetic effect during vein cannulation, and the available results do not concur. A study comparing lidocaine 1% with $NaHCO_3$, NaCl 0.9% with benzyl alcohol, plain NaCl 0.9%, and no pretreatment showed that lidocaine produced the lowest mean pain score. Benzyl alcohol in 0.9% NaCl was also effective. No pretreatment and plain NaCl resulted in the highest mean pain scores.[18] Similar results were found when lidocaine, benzyl alcohol, and NaCl 0.9% were compared. Benzyl alcohol provided significantly better anesthesia than NaCl, but was less effective than lidocaine.[19] Conflicting results were found in a study that compared NaCl 0.9% with benzyl alcohol and lidocaine 1% with $NaHCO_3$. No significant difference between the reports of perceived pain with IV cannulation was found.[20]

• PURPOSE

Due to the conflicting results from previous research, the current study was conducted to identify which solution, lidocaine hydrochloride 1% or bacteriostatic 0.9% NaCl, has the best local anesthetic effect for vein cannulation.

• DESIGN

Formal applications were submitted to and approved by the institutional review boards of the hospital at which the study was conducted and a local university. Approval was granted after protection of the subjects had been thoroughly considered.

In preparation for data collection, the pharmacy department staff filled tuberculin syringes with 0.4 mL of solution. The lidocaine solution comprised 20 mL of lidocaine 1% and 2 mL of $NaHCO_3$ 8.4%. Every milliliter of NaCl prepared by the manufacturer contained 9 mg each of NaCl and benzyl alcohol. Half of the syringes contained the lidocaine solution and half contained the NaCl solution.

Immediately after each syringe had been filled, it was placed in an envelope with a numbered evaluation form. This number also was placed on a list that identified the solution in the syringe. One list contained numbers matching the numbers on the evaluation forms for lidocaine use, and another list contained numbers matching the numbers on the evaluation forms for NaCl use.

The identification lists were kept in the pharmacy until all the data had been collected. The primary researcher was not present when the syringes were prepared, and the pharmacy staff was not present when the syringes were used. This design maintained patient confidentiality and blinded the primary researcher and patient to the solution used. Unused solution was discarded, and new solution was prepared weekly.

The primary investigator, a registered nurse, and a vascular access educator performed all the intradermal injections and catheter placements. Established policies and procedures were followed.

• SAMPLES

Male and female patients admitted to a surgical admissions unit were invited to participate if they had a physician's order for a peripheral catheter, were at least 18 years of age, had the ability to rate and express their level of pain, had not taken medication to relieve pain, and did not have a known allergy to "caine" medications. The primary investigator informed each subject of the procedure, benefits, and risks. The participants gave written consent and were provided with a copy of the consent. Subjects were excluded if more than one attempt was necessary to initiate their catheter. Of the 47 subjects who completed all the study requirements, 21 were in the lidocaine group and 26 were in the NaCl group. This number met the requirements established by a power analysis determining that 17 subjects were needed in each group to show any statistical differences.

• METHODS

A diagram of the Wong-Baker FACES Pain Rating Scale was shown and explained to the participants. This scale consists of a numeric scale ranging from 0 to 10 with a drawing of a face corresponding to each number. A smiling face corresponding to 0 represents no pain, and a crying face corresponding to 10 represents the worst pain imaginable.

A 0.5-cm intradermal wheal was formed by injecting 0.1 to 0.3 mL of solution through a 30-gauge needle. The IV catheter was inserted immediately through the wheal into the vein. Once the catheter was in place, the participant was asked to rate his or her level of pain using the pain rating scale. The pain rating, the other sensations felt, the insertion site, the catheter size and type, and the patient's age and gender were documented on the evaluation form.

Data Analysis

Differences between study groups based on age and catheter location were assessed to determine whether variables other than the intradermal solution could account for any difference found in pain scores. The Student's *t* test was used to assess for differences between the study groups based on the age of the subjects. The Pearson chi-square was used to assess differences between the study groups based on the catheter location. The difference in median pain scores between those receiving lidocaine and those receiving NaCl was assessed using the Mann-Whitney test. The Kruskal-Wallis test was used to determine whether pain scores differed with catheter location.

• FINDINGS

The ages of the participants ranged from 22 to 87 years. The average ages between the two groups were not statistically different. The average participant age in the lidocaine group was 61 years, and the average participant age in the NaCl group was 56 years ($P > .05$). Catheter locations were divided into three groups: hand (n = 23), wrist (n = 10), and forearm (n = 13) locations. There was no significant difference in catheter locations between the study groups ($P = .540$). The pain scores ranged from 0 to 8. In the group receiving lidocaine, the mean pain score was 1.31 (median, 1.0). In the group receiving normal saline, the mean pain score was 1.88 (median, 1.75). The median pain scores were not statistically different between the two groups ($P = .429$). The median pain scores were significantly higher for the participants whose catheter was placed in the forearm than for those whose catheter was placed in the hand or wrist ($P = .036$).

• DISCUSSION

This study showed that there is no significant difference between the anesthetic effect of lidocaine 1% with $NaHCO_3$ and that of NaCl 0.9% with benzyl alcohol. In addition to effectiveness, patient safety, and independence in nursing practice, expense should be considered in determining the best solution for intradermal anesthesia. Although lidocaine is used routinely by physicians and nurses, allergic reaction and systemic toxicity are possible. There are no reported risks associated with NaCl and benzyl alcohol when given in the minute dose required for pre-IV intradermal anesthesia. A physician's order is required for the nursing use of lidocaine. Although physicians should be informed of any nursing protocol for numbing venipuncture sites, a physician's medication order is not necessary for bacteriostatic NaCl.

Sodium chloride is more cost efficient than lidocaine. Each dose of lidocaine costs approximately $0.04, whereas the cost for one dose of NaCl is less than $0.005. Any expense associated with complications from lidocaine use could dramatically increase costs.

Replication of this study is suggested to verify that lidocaine and NaCl provide equal anesthetic effects. The inclusion of a control group in a repeat study could verify that an anesthetic effect is provided by lidocaine and NaCl, as compared with no pretreatment. Although many variables should be considered in the choice of a catheter insertion site, further examination of how catheter location affects patient discomfort could be beneficial. Once confidence in bacteriostatic NaCl as a local anesthetic has been established, the practice of numbing catheter sites with intradermal injections of this solution could be implemented. During this process, continuous monitoring of patient satisfaction scores would be necessary. Scores for infusion therapy should improve as the use of NaCl with benzyl alcohol is implemented.

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