Use of Buffered Lidocaine in Bone Marrow Biopsies: A Randomized, Controlled Trial

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Patients with cancer require numerous invasive procedures throughout their disease process, including bone marrow biopsies, lumbar punctures, and aspiration of fluid from organ cavities. The procedures generally cause discomfort. One of the biggest concerns for healthcare providers is keeping patients comfortable. Lessening the pain that patients experience during invasive procedures is one way to improve patient comfort.

Purpose/Objectives: To determine whether a difference exists in perceived pain during preprocedure anesthetic injection for bone marrow biopsy between buffered and unbuffered lidocaine, to determine whether pain levels change over time, and to investigate relationships between perceived pain scores and other variables.

Design: A double-blind, randomized, experimental, crossover design.

Setting: A large hospital in the midwestern region of the United States.

Sample: 48 patients undergoing bone marrow biopsy.

Methods: The patients served as their own controls for the bilateral procedure. A 100 mm visual analog scale measured pain. A demographic questionnaire gathered the between-subjects exploratory variables.

Main Research Variables: Perceived pain scores and type of lidocaine anesthetic solution (buffered versus unbuffered).

Findings: Participants reported significantly lower pain scores on the side anesthetized with buffered lidocaine compared with the side anesthetized with unbuffered lidocaine. Higher pain scores were reported on the treatment side for participants who had received more than two surgical procedures. Patients who were members of a minority group had higher mean pain scores than Caucasians on the control side.

Conclusions: Buffered lidocaine is superior to unbuffered lidocaine as an anesthetic for bone marrow biopsy procedures.

Implications for Nursing: Advanced practice nurses perform a significant number of bone marrow biopsies and aim to improve patient comfort during invasive procedures. Use of unbuffered lidocaine should be questioned.

Background

Of the 1.3 million newly diagnosed cancer cases per year, about 8% are hematologic malignancies; this translates to more than 114,460 new cases per year (Leukemia & Lymphoma Society, 2008). Patients diagnosed with hematologic malignancies require bone marrow biopsy procedures at the time of diagnosis, and many patients require several during the treatment process. Patients should experience as little discomfort with bone marrow biopsy procedures as possible (Hyun, Stevenson, & Hanau, 1994).

Bone marrow biopsies are invasive procedures that cause a considerable amount of discomfort and often pain. Because pain is a subjective symptom and because healthcare professionals aim to deliver patient-centered care, anything that helps to reduce patients' perceptions of pain is beneficial. Patients with cancer may encounter more peripheral pain than patients with other diagnoses because of physical changes from the disease itself or from side effects of chemotherapy (Matutes, 2007; Wood & Phillips, 2003). The chemotherapy that patients receive makes their skin, tissue, and bones more sensitive to any type of manipulation. This, in turn, adds to the pain that patients experience (Kannarkat, Lasher, & Schiff, 2007; Polomano & Bennett, 2001). To decrease the amount of discomfort and pain that patients experience, and to promote smooth procedures, local anesthesia is used for bone marrow extraction. The local anesthetic used most often is lidocaine (Hyun et al., 1994).

Lidocaine, as injected, causes a painful burning sensation that continues with injection into the bone marrow. The pain associated with lidocaine can be partially correlated to the actual acidity of the available solution (Milner, Guard, & Allen., 2000; Richtsmeier & Hatcher, 1995; Ririe, Walker, James, & Butterworth, 2000; Xia, Chen, Tibbits, Reilley, & McSweeney, 2002). Lidocaine is an amino amide that can cause precipitation if left in its

base form; therefore, it is mixed with an acidic medium that significantly lowers its pH. The lower pH allows for enhanced solubility of the commercially available anesthetic and a longer shelf life (Milner et al.). The pain patients experience upon infiltration of the skin with lidocaine causes them to be anxious, stressful, and tense (Trewhitt, 2001).

Sodium bicarbonate is a buffering additive that increases the pH of the solution, allowing for a decrease in pain upon infiltration (Richtsmeier & Hatcher, 1995; Xia et al., 2002). It also has been shown that increasing the pH by adding sodium bicarbonate can minimize the painful sensation during intradermal injection of lidocaine without interrupting the effects of the anesthetic (Milner et al., 2000; Richtsmeier & Hatcher; Xia et al.). Richtsmeier and Hatcher further reported that no evidence of precipitate formation was detected by the naked eye or microscopy in any of the local anesthetic solutions buffered with sodium bicarbonate; therefore, safety to patients was maintained with the buffered additive. Ririe et al. (2000) measured the onset of nerve block of the median nerve with lidocaine to test the hypothesis that the addition of bicarbonate uniformly speeds the onset of anesthesia in motor and sensory modalities. The study indicated that adding 8.4% of sodium bicarbonate to plain lidocaine hydrochloride 1% produced no significant difference in the sensory nerve action potentials compared to lidocaine alone; therefore, patients do not have to receive twice as much medication to obtain the same effect. Patient comfort was not studied.

Limited research has compared unbuffered and buffered lidocaine. In one early study, McKay, Morris, and Mushlin (1987) conducted a double-blind, randomized trial to determine the relationship between pH of anesthetic solutions and production of pain associated with intracutaneous injection of lidocaine. Twenty-four volunteers received an intradermal injection of normal saline and five other preparations. The preparations studied were 1% lidocaine, 1% lidocaine with epinephrine (investigator added), 1% lidocaine with epinephrine (commercially added), sodium bicarbonate added to commercially prepared 1% lidocaine with epinephrine, and sodium bicarbonate added to plain 1% lidocaine (1:10 ml concentration). The results demonsrated that pain resulting from skin infiltration of lidocaine solutions with or without epinephrine can be decreased by the addition of sodium bicarbonate.

More recently, several studies have compared unbuffered and buffered lidocaine in adult patients prior to IV insertion and in adult patients comparing several solutions administered as intradermal injections. Xia et al. (2002) evaluated pain and the spread of analgesia from lidocaine, buffered lidocaine (addition of 8.4% of sodium bicarbonate to lidocaine at a 1:9 ratio), diphenhydramine, and normal saline when given as intradermal injections into the dorsal aspect of the hand. Forty adult participants were randomly assigned to receive either a 0.25 ml injection of 1% lidocaine, buffered lidocaine, diphenhydramine 1%, or 0.9% sodium chloride solution (used as placebo). A visual analog scale (VAS) compared the pain of needle insertion with the pain of solution infiltration. The study concluded that buffered lidocaine reduced infiltration pain as opposed to lidocaine or diphenhydramine. Buffered lidocaine also was equivalent to lidocaine in terms of spread of analgesic and efficacy. Although buffered lidocaine VAS pain intensity scores were slightly lower than the placebo scores, the difference was not statistically significant.

Vossinakis, Stavroulaki, Paleochorlidis, and Badras (2004) compared buffered lidocaine with epinephrine to lidocaine with epinephrine alone during bilateral open carpal tunnel compression surgery. Twenty-one patients served as their own controls. VAS scores showed that patients experienced less pain during the local anesthetic process with the buffered solution.

Younis and Bhutiani (2004) studied 85 patients undergoing bilateral vasectomy and compared buffered 1% lidoocaine (with 1:200,000 epinephrine) to unbuffered xylocaine (with 1:200,000 epinephrine). Patients who served as their own controls had lower linear analog pain scores with the buffered lidocaine than the unbuffered solution. Pain scores demonstrated significance during infiltration and the procedure.

Finally, Yiannakopoulos (2004) studied the effects of alkalinization and warming of 1% lidocaine in 65 patients undergoing carpal tunnel decompression. Each patient was randomized to one of three groups: Group A received plain lidocaine, group B received alkalinized lidocaine, and group C received warmed and alkalinized lidocaine. VAS scores were collected from subjects during needle insertion and solution infiltration. Significant differences were found during infiltration; however, no differences were found during needle insertion. Group C VAS scores were lowest among all groups; however, group B VAS scores were lower than those of group A, demonstrating that buffered lidocaine was less painful to patients than unbuffered lidocaine (Yiannakopoulos).

Based on the research, buffered lidocaine produces less discomfort than unbuffered lidocaine regardless of the site of use. Despite the evidence that buffered lidocaine helps to decrease pain experienced with local anesthetic, most national Comprehensive Cancer Centers do not use buffered anesthetic solutions during bone marrow biopsy procedures. Anecdotal research collected by the author also revealed that some providers sometimes resort to using conscious sedation when performing bone marrow biopsies. Because of the physical risks and monitoring needs that conscious sedation poses, less dangerous solutions should be sought for less painful bone marrow biopsy procedures. This is an

important area of research because patients deserve to experience as little discomfort as possible with invasive procedures such as bone marrow biopsies. The use of buffered lidocaine has been documented to decrease patient discomfort, but no studies have been conducted in patients receiving bone marrow biopsies. Therefore, the specific aims of the current study were to determine whether a difference exists in patients' perceived pain during injection of the preprocedure anesthetic when buffered versus unbuffered lidocaine is administered, to determine whether pain levels change over time after the anesthetic is administered, and to investigate relationships between patients' perceived pain scores and variables such as gender, ethnicity, stage and extent of disease, body mass index, history of pain tolerance, and perceived emotional support.

Theoretical Framework

The theoretical framework used in this study is the Symptom Management Model (SMM) (Dodd et al., 2001). The SMM is a broadly based model built on the premise that to effectively manage any symptom, researchers must consider the symptom experience, symptom management strategies, and outcomes. The three major variables are placed in the context of person, health and illness, and environment, which are known to influence the symptom experience. The focus of the SMM is the person experiencing the symptom, and self-report is viewed as the gold standard for the study of the symptom(s) (Dodd et al.).

Methods

Design

A double-blind experimental crossover design was used to examine the difference in pain levels with buffered versus unbuffered lidocaine prior to a bilateral bone marrow biopsy procedure. The patients served as their own controls. Both the site of the first biopsy procedure and the initial type of lidocaine solution administered were chosen randomly.

Sample and Setting

A convenience sample of 48 participants was recruited from inpatient and outpatient hematology and oncology service units of a large Comprehensive Cancer Center in the midwestern region of the United States. The sample size was based on a power analysis using 80% power, an alpha of 0.05, and a medium effect size for a paired *t* of 0.5. Any newly diagnosed patient older than 18 years whose hematologist or oncologist ordered him or her to undergo a bilateral bone marrow biopsy for diagnostic or treatment purposes was eligible to participate. Patients were excluded from participating if they (a) were pregnant or lactating; (b) were allergic to local anesthetics; (c) required a unilateral bone marrow biopsy; (d) could not lie flat in either the supine or prone position; (e) had used a narcotic, non-narcotic analgesia, or anxiolytic medication on the same calendar day as the scheduled procedure; (f) were taking long-acting narcotic medication; (g) had neuropathy in the posterior iliac crest area; (h) had a platelet count less than 20,000; (i) were cognitively impaired or unable to self-report pain using the VAS; or (j) had known bone metastasis.

Instruments

Pain was measured with a **100 mm VAS** for pain intensity. Scores on the VAS ranged from 0–100, with higher scores indicating more pain. Participants were instructed to place a mark on the 100 mm line to indicate how much pain they were experiencing at designated times during the procedure. Pain scores were assessed at baseline, after interdermal injection, after interosseal injection, and at completion of each bone marrow biopsy. VAS pain rating scales have established concurrent validity (Bird & Dickson, 2001; Gift, 1989; Li, Liu, & Herr, 2007) and discriminate validity (Joyce, Zutshi, Hrubes, & Mason, 1975; Lingjaerde & Foreland, 1998; Price, McGrath, Rafii, & Buckingham, 1983). Test-retest reliability has been reported as $r = 0.95$, $p < 0.001$ (Li et al.; Reville, Robinson, Rosen, & Hogg, 1976), and between-session reliability has been reported as $r = 0.97$ (Li et al.; Price et al.; Reville et al.).

The second instrument was a 16-item **demographic data collection form**. Twelve items were completed by participants, and four items were completed by the research team. Self-reported variables were age, sex, race or ethnicity, method of payment for healthcare services, height, weight, medical and surgical histories, stage and extent of disease, perceived emotional support (two items), and history of pain tolerance. Exploratory variables were selected based on their potential to directly or indirectly (e.g., anxiety producing) influence a patient's perception of pain. The research team recorded body mass index and three items related to observed emotional support.

Procedure

Following institutional review board approval, the site of the first biopsy for each participant was randomized (right or left posterior iliac crest) with a computer-based randomization software program. An investigational pharmacist (who was not blinded to the study) provided the advanced practice nurse (APN) with 10 ml of lidocaine containing either 1 ml of 8.4% sodium bicarbonate or 1 ml of normal saline. The pharmacist was given a list of participant names scheduled for the procedure in advance, and the drugs arrived labeled with the participant's name,

medical record number, the name of the study, and which syringe was to be administered to which side first. The pharmacist was responsible for drawing up both the treatment and control solutions daily as well as for discarding unused syringes at the end of each day (and documenting this information). Data were maintained on a password-protected spreadsheet by the investigational pharmacist until all participants were enrolled. When all patients completed the study, the principal investigator was sent the drug data for inclusion in the analysis.

After providing written informed consent, the participants completed the demographic questionnaire. Participants then were given a VAS consisting of a 100 mm line, with 0 labeled "no pain" and 100 labeled "the most severe pain experienced." Each participant recorded a baseline pain score before the procedure began (time 1). The participant's iliac crest then was prepped in a sterile fashion. The APN injected 1 ml of the solution contents intradermally to side 1, forming a small skin wheal within 10 seconds. Immediately after intradermal injection, the participant again recorded a pain score on the VAS (time 2). The APN then injected the subcutaneous tissue and iliac crest periosteum with a total of 7 ml of the same anesthetic over 30 seconds. The participant again recorded a pain score on the VAS (time 3). The APN waited for a total of two minutes before retrieving the bone marrow samples from the participant's side 1. After side 1 was completed, the participant recorded a final pain score on the VAS (time 4). The APN held pressure to the puncture site for at least one minute before beginning the procedure on the participant's other iliac crest (side 2). The procedure and data collection for the participant's second iliac crest were the same as described for side 1.

Data Analysis

Repeated-measures analysis of variance (ANOVA) was planned. The average mean pain scores for treatment and control side were plotted at each of four points in time to examine trends. Separate repeated-measures analyses were performed for each between-variable specified. The within-variables for each analysis were side (treatment versus control) and time (pain scored at baseline, skin injection, bone injection, and end).

Results

Sample

Fifty-two participants expressed interest and met the inclusion criteria. However, four had exclusion criteria and could not be enrolled in the study. Thus, 48 participants were enrolled. The average age of the participants was 54 years; 67% were male, and 85% were Caucasian. Seven subjects were from minority ethnic groups. All but one participant had healthcare insurance. Fifty-four percent of the participants were clinically overweight (body mass index of 27 or greater), and 73% had a self-described high level of pain tolerance (6 or greater on a 1 to 10 scale). Thirty-three percent of the participants reported having more than two previous surgeries. Eighty-three percent of participants were without chronic disease influence; specifically, no participants reported peripheral neuropathic disease. Ninety-nine percent of the subjects reported at least one support person in their lives, with 71% having received active support from the person(s) at the bedside during the bone marrow biopsy procedure. Table 1 displays characteristics of the sample.

Pain Scores

Pain scores were recorded at four points in time: preprocedure (baseline), at intradermal injection (skin), at injection of the iliac crest periosteum (bone), and upon completion of the procedure (final) for the right and left

Table 1. Sample Characteristics

Characteristic	n	%
Age (years)		
$\bar{X}$ = 53.9	–	–
SD = 16.9	–	–
Range = 19–86	–	–
Body mass index		
$\bar{X}$ = 28.1	–	–
SD = 5.6	–	–
Range = 17.4–44.3	–	–
Number of past surgeries		
$\bar{X}$ = 2.2	–	–
SD = 1.8	–	–
Range = 0–10	–	–
Pain tolerance[a]		
$\bar{X}$ = 6.6	–	–
SD = 1.8	–	–
Range = 3–10	–	–
Gender		
Male	32	67
Female	16	33
Ethnicity		
Caucasian	41	85
African American	4	8
Hispanic	1	2
Asian or Pacific Islander	1	2
Other	1	2
Support systems[b]		
Help from spouse	33	69
Help from mother	4	8
Help from father	2	4
Help from sibling	5	10
Help from child	9	19
Help from friend	3	6
Support present on day of biopsy		
Yes	42	88
No	6	13

N = 48

[a] Scale of 1 (no tolerance to pain) to 10 (high tolerance to pain)

[b] Participants could choose multiple responses.

Note. Because of rounding, percentages may not total 100.

Table 2. Mean Pain Scores by Time and Group

Pain Score by Time	Treatment		Control	
	$\bar{X}$	SD	$\bar{X}$	SD
At baseline	1.2	2.5	1.1	2.7
For skin	15.1	19.7	22.9	21.9
For bone	16.8	19.4	26.6	22.9
Final	38.5	27.1	42.1	29.7

Note. Scores on visual analog scale (a 100 mm line with 0 = no pain and 100 = the most severe pain experienced)

sides. Table 2 displays the overall mean pain scores for the treatment (buffered lidocaine) and control (unbuffered lidocaine) sides for the participant group. Other than at baseline, the mean pain scores for the group who received the buffered lidocaine were consistently lower than the scores for those who received nonbuffered lidocaine.

To determine whether a significant difference existed between the buffered (treatment) and unbuffered (control) pain scores, the researchers performed repeated-measures ANOVA. They examined data to ensure that assumptions for the statistics being used were met. Because the sphericity assumption was not met, all results are reported using the Greenhouse-Geisser correction. Table 3 displays the repeated-measures ANOVA for the primary aim of the study.

A significant difference was found for side ($p = 0.002$) and time ($p < 0.001$). However, because the interaction of side by time ($p = 0.046$) also was significant, it will be interpreted first. Using partial eta^2, the portion of variance explained by the interaction of side by time is only 5.8%. Time explained 58% of the variance, and side accounted for 19%. The participants' self-reported pain scores increased as the procedure progressed. However, pain scores on the treatment side were significantly lower than those on the control side for the same patients for all scores except the baseline measure (see Figure 1).

Exploratory Analyses

Exploratory analyses were run on the demographic variables collected. Repeated-measure analyses were done for each between-variable separately with side (treatment versus control) and time (pain scores at the four points in time) as the two within-variables. Between-variables were gender, ethnicity, body mass index, history of pain tolerance, surgical history (number of previous surgeries), medical history (presence or absence of neuropathy), and observed emotional support. Stage and extent of disease could not be examined because the data were not known by the participants.

None of the exploratory between-variables was significant. However, three interactions yielded significant findings: side by surgical history ($p = 0.025$), side by ethnicity ($p = 0.015$), and side by time by ethnicity ($p = 0.014$). Participants were grouped into those with more than two surgical procedures in the past and those with two or fewer. The thought was that participants who had experienced pain related to numerous invasive procedures in the past might have a preconditioned expectation of considerable pain with the current procedure. The mean pain scores for each group are displayed in Table 4.

The main effect of surgical history was not significant. However, side (treatment versus control) by surgical history was significant ($p = 0.025$). The portion of the variance explained by side by surgical history was 10.5% (partial eta^2). The graphs for each group are displayed in Figures 2 and 3.

Higher pain scores were seen on the treatment side for those participants who had received more than two surgical procedures when compared with those who had two or fewer surgical procedures; the phenomenon was not seen on the control side of the same patients. Given that the main effect was not significant and that the treatment side produced significantly lower pain scores than the control side in the overall group (see Table 4), the finding might suggest that the participants with higher numbers of past painful surgical events anticipated more pain and, thus, gave higher self-reported pain scores than those with fewer prior surgical events.

Because of the small sample size of minority participants ($n = 7$), ethnicity was analyzed in two groups, Causasian and minority. The mean pain scores for each group are displayed in Table 5.

In the repeated-measures analysis, the between-subjects effect of ethnicity was not significant. However, side by ethnicity ($p = 0.015$) and side by time by ethnicity ($p = 0.014$) were significant. The partial eta^2 for side

Table 3. Repeated-Measures Analysis of Variance for Pain Scores

Source	SS	df	MS	F	p
Side (treatment/ control)	2,261.77	1.0	2,661.77	10.7	0.002
Time (pain score at four times)	74,034.63	2.1	34,573.22	65.1	0.000
Side by time	1,394.76	2.5	551.94	2.9	0.046
Error (side)	11,647.10	47.0	247.81	–	–

Note. Data were reported with the Greenhouse-Geisser correction.

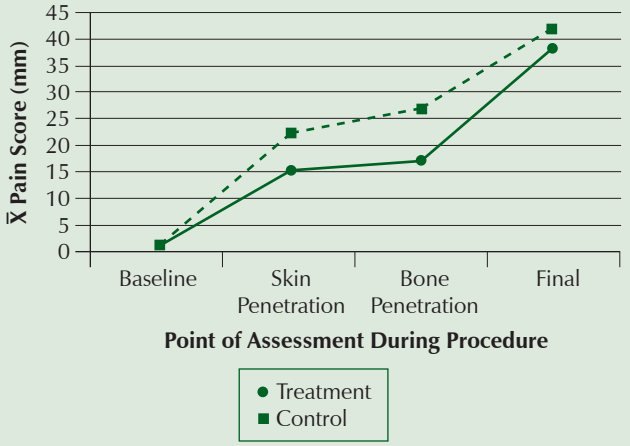

Figure 1. Mean Pain Scores by Point of Assessment During Procedure and Side

by time by ethnicity was 8.2%, and the portion of the variance explained by side by ethnicity was 12.2% (see Figures 4 and 5).

Little difference was found in the mean scores between the minority and the Caucasian group on the treatment side, but the minority group had much higher mean pain scores than the Caucasian group on the control side. This may suggest that the buffered lidocaine was especially helpful in reducing the ethnic minority group's perceived pain.

Discussion

The findings of the current study are consistent with previous research involving the comparison of local anesthetics. Lidocaine is the most common and effective local anesthetic used in a variety of procedures but produces a painful sensation on injection. Research has shown that when lidocaine is buffered with sodium bicarbonate, patients report lower pain scores than with unbuffered lidocaine. The current study confirms that finding in patients undergoing bone marrow biopsy procedures.

In a study by Edwards, Doleys, Fillingim, and Lowery (2001), African American subjects reported higher levels of pain as well as pain-related disability than Caucasian participants. Sixty-eight African American and 269 Caucasian participants were administered painful stimuli with a tourniquet procedure. VAS scores were analyzed and found to be significantly higher among the African American group than the Caucasian group related to rating painful stimuli. Differences in pain tolerance also were found, demonstrating that African Americans had lower tolerance for pain. Mechlin, Maixner, Light, Fisher, and Girdler (2005) found that differences existed between African Americans and Caucasians when tourniquet ischemia and thermal heat and cold pressor tests were administered. African Americans had lower pain tolerance when the stimuli followed periods of rest and mental stress. Faucett, Gordon, and Levine (1994) examined differences in postoperative pain severity among four ethnic groups: Asian, African American, Caucasian, and Latino. Five hundred and forty-three subjects underwent a standard dental molar extraction procedure. Analysis from participants' VAS scores demonstrated that subjects of African American and Latino descent had significantly more postoperative pain than subjects of Caucasian descent. Determining differences in cutaneous pain perception between men and women and between Caucasians and African Americans was the focus of a study by Sheffield, Biles, Orom, Maixner, and Sheps (2000). Fifty-one subjects were administered painful thermal stimuli, and VAS scores were collected after each one. African American participants had statistically significant higher VAS scores related to pain intensity and unpleasantness.

In the current study, patients who had a higher number of past painful surgical events seemed to anticipate more pain. A patient's surgical history and experiences with painful procedures have been found to influence

Table 4. Mean Pain Scores by Number of Past Surgeries

Group/Time/Past Surgeries	n	X̄	SD
Treatment/baseline			
≤ 2	32	1.3	2.9
> 2	16	1.0	1.4
Treatment/skin			
≤ 2	32	13.3	17.3
> 2	16	18.8	24.0
Treatment/bone			
≤ 2	32	13.3	14.2
> 2	16	23.8	26.2
Treatment/final			
≤ 2	32	36.0	26.7
> 2	16	43.5	28.1
Control/baseline			
≤ 2	32	1.2	3.2
> 2	16	0.9	1.2
Control/skin			
≤ 2	32	20.9	17.1
> 2	16	26.7	29.5
Control/bone			
≤ 2	32	28.1	23.9
> 2	16	23.5	21.3
Control/final			
≤ 2	32	44.8	31.3
> 2	16	36.9	26.5

N = 48

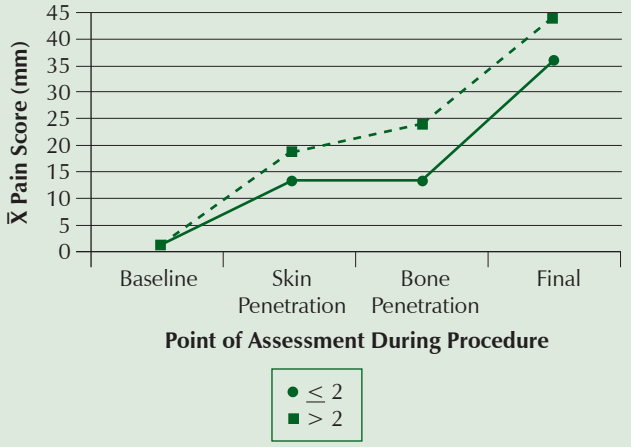

Figure 2. Mean Pain Scores on Treatment Side by Number of Past Surgeries

how he or she experiences future pain. Fear of pain is manifested as anxiety, therefore increasing stress levels and necessitating the use of coping skills (Deng & Cassileth, 2005). Although the actual inflicted pain is generally a forgotten feeling, patients conceptualize the experience, remembering how the procedure was tolerated overall. Linton and Melin (1982) conducted a study investigating the accuracy of memory for chronic pain and found that patients remembered having significantly more pain than what was recorded when the pain was actually experienced. Beese and Morley (1993) studied patients undergoing wisdom tooth extraction. Pain scores were collected immediately after the procedure and two weeks later. The accuracy of remembering the pain experienced was not significant; however, the patients remembered their overall mood as more negative than actually recorded, suggesting that, although the feeling of pain may have been somewhat forgotten, the perceived negative experience was not.

Ploghaus et al. (2001) found that anxiety related to invasive procedures can increase painful sensation. However, if a patient is accurately prepared with information specifically during the procedure, the pain experienced is actually decreased because the patient's hippocampus is disengaged. The author's results support the application that the hippocampus is responsible for intensifying negative responses to anxiety. If the hippocampus is not disengaged, the patient can experience a negative outcome with procedures. Deng and Cassileth (2005) affirmed that fear, anxiety, and tension can affect pain perception more in procedural pain than in chronic pain because it is related to a patient lacking of control over his or her situation. A loss of the feeling of control can lead to poor outcomes during procedures and the unnecessary use of increased amounts of analgesia and sedatives (Deng & Cassileth). The literature suggests that prior experiences with surgery or invasive procedures may have a negative impact on how a patient will perceive future procedural pain. The literature also implies that giving a patient information at each step during a procedure can lead to less anxiety, resulting in a decrease in perceived pain.

Every effort should be taken to address a patient's pain with each and every procedure. The current study shows that one way to lessen the pain experienced during a bone marrow biopsy procedure is to use buffered lidocaine as opposed to a more painful unbuffered lidocaine solution.

Study Limitations

This study was only performed at one site; replication studies at other sites are recommended. Another limitation is that the study included only patients getting their initial bone marrow biopsies. Future research should include patients receiving repeated bone marrow biopsies.

Implications for Nursing

The scope of advanced practice nursing allows APNs to perform a number of invasive procedures in accordance with individual state statutes. Best-practice standards mandate that clinical practice be based on the best possible evidence (Polit & Beck, 2008). Not only are APNs responsible for knowing current research findings, they also must implement research findings into practice. The results of the current study are an example of an expanding body of research findings that warrant incorporation into current clinical practice. All APNs (and other eligible providers) should use a buffered lidocaine solution as the preferred local anesthetic when performing bone marrow biopsies.

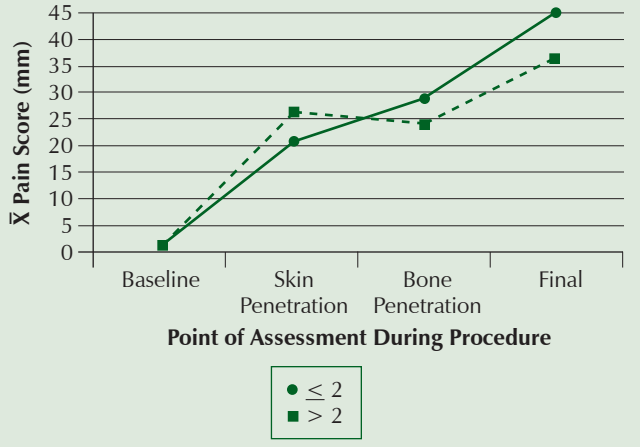

Figure 3. Mean Pain Scores on Control Side by Number of Past Surgeries

Table 5. Mean Pain Scores by Ethnic Group

Group/Time/Ethnicity	n	$\bar{X}$	SD
Treatment/baseline			
Minority	7	0.9	2.3
Caucasian	41	1.2	2.5
Treatment/skin			
Minority	7	20.6	24.6
Caucasian	41	14.2	18.9
Treatment/bone			
Minority	7	13.0	21.1
Caucasian	41	17.4	19.3
Treatment/final			
Minority	7	37.1	29.7
Caucasian	41	38.8	27.0
Control/baseline			
Minority	7	0.3	0.5
Caucasian	41	1.2	2.9
Control/skin			
Minority	7	30.1	21.7
Caucasian	41	21.6	21.9
Control/bone			
Minority	7	49.4	26.3
Caucasian	41	22.7	20.1
Control/final			
Minority	7	50.0	40.5
Caucasian	41	40.8	27.9

N = 48

Practitioners may encounter procedure delays when requesting the buffered lidocaine solution because of institutional medication compounding requirements that necessitate that the solution be prepared by a pharmacist. Despite the possible inconvenience, practitioners should use the buffered lidocaine solution for procedures to improve patient comfort.

Additionally, staff nurses have a responsibility to care for patients undergoing bone marrow biopsies according to current nursing practice standards. Nurses also have the responsibility to inform colleagues of new research that demonstrates better ways of providing patient care (American Nurses Credentialing Center, 2007). All nurses should proactively advocate for the integration of this particular study's findings into their institutional policies and procedures and ultimately into national nursing practice standards.

Conclusion

A significant number of healthcare providers perform bone marrow biopsies. Improving patient comfort during the invasive procedure is important. The research findings presented in this article should be disseminated and applied to all procedures in which unbuffered lidocaine is used. Unless a patient is allergic, buffered lidocaine should be the solution used as a local anesthetic during bone marrow biopsies.

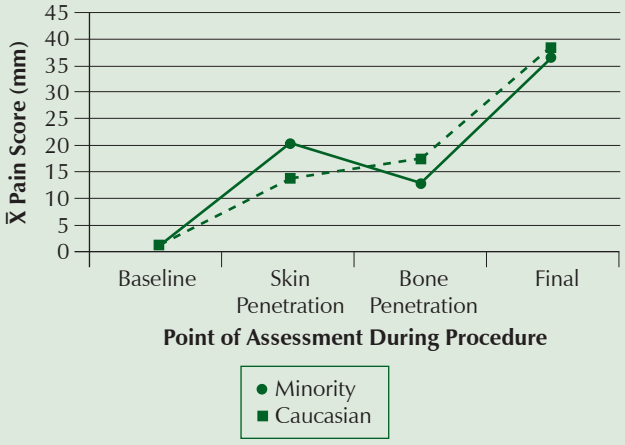

Figure 4. Mean Pain Scores on Treatment Side by Ethnic Group

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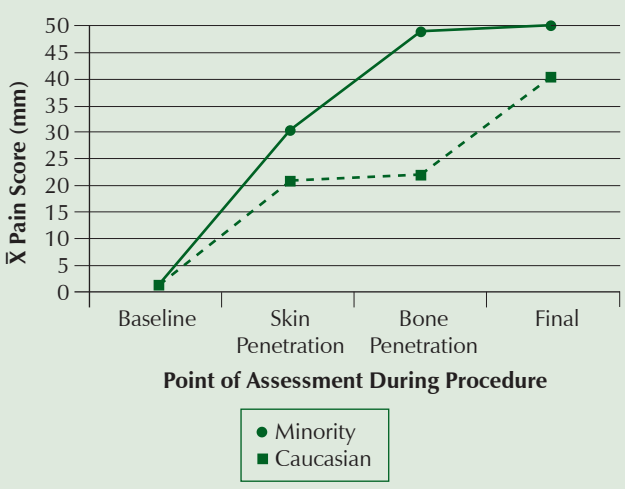

Figure 5. Mean Pain Scores on Control Side by Ethnic Group

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