Online Exclusive Article

The Impact of Dry Versus Moist Heat on Peripheral IV Catheter Insertion in a Hematology-Oncology Outpatient Population

Regina M. Fink, RN, PhD, AOCN®, FAAN, Ellen Hjort, RN, ND, Barbara Wenger, RN, MS, OCN®, Paul F. Cook, PhD, Mary Cunningham, RN, BSN, OCN®, Aimee Orf, RN, BSN, OCN®, Wendy Pare, RN, BSN, OCN®, and Jennifer Zwink, RN, BSN, OCN®

Purpose/Objectives: To determine whether dry versus moist heat application to the upper extremity improves IV insertion rates.

Design: Two-group, randomized, controlled clinical design.

Setting: An academic cancer infusion center in the western United States.

Sample: 136 hematologic outpatients with cancer or other malignancies.

Methods: Participants were randomly assigned to dry or moist heat with warmed towels wrapped around each patient's arm for seven minutes prior to IV insertion. Skin and room temperatures were monitored pre- and postwarming. Two experienced chemotherapy infusion nurses performed the venipunctures according to protocol. Outcomes were examined using variance analysis, with 34 patients for each combination of nurse and heat type.

Main Research Variables: Number of IV insertion attempts, time to achieve IV insertion postheating, patient anxiety levels pre- and postheating, and patient comfort.

Findings: Dry heat was 2.7 times more likely than moist heat to result in successful IV insertion on the first attempt, had significantly lower insertion times, and was more comfortable. Heat type had no effect on patient anxiety.

Conclusions: Dry heat application decreases the likelihood of multiple IV insertion attempts and procedure time and is comfortable, safe, and economical to use in an outpatient oncology setting.

Implications for Nursing: Dry heat application may improve successful IV insertion rates, decrease costs, and improve patient satisfaction.

Peripheral IV catheter insertion is a common nursing procedure often required for the administration of chemotherapy, antibiotics, blood products, fluids, and other medical therapies in hematologic patients with cancer. Although necessary and usually brief, IV insertion often is a source of patient anxiety and discomfort and can be extremely difficult to achieve, particularly in individuals receiving repeated courses of chemotherapy. Unfortunately, not all IV insertions are successful on the first attempt; multiple attempts may occur, which may cause patient distress and anxiety and increase costs as a result of additional supplies and nursing time. Nurses currently use various techniques, including heat, to improve the success rates of IV insertion; however, few are based on evidence.

Literature Review

An extensive search of methods used to facilitate successful IV starts, decrease pain and anxiety, and improve patient comfort and the safe use of heating devices revealed a paucity of literature based on research. Most studies involving IV insertion focus on decreasing pain associated with the procedure and improving patient comfort. Five double-blind, randomized, prospective studies noted a continuing controversy over which local anesthetic injected intradermally provided optimal analgesia for IV insertion. Nuttall et al. (1993) found that alkalinized lidocaine was the best local anesthetic for IV insertion when compared to benzyl alcohol, chloroprocaine, lidocaine with or without preservative, normal saline, or control in 280 healthy adult patients. In addition, Hattula, McGovern, and Neumann (2002) studied 33 medical inpatients and showed a lower pain score in the group receiving alkalinized lidocaine. However, McNelis (1998), Brown (2004), and Windle et al. (2006) discovered no statistical difference between the local anesthetic

effects of intradermal injection of normal saline with benzyl alcohol or lidocaine in 40, 47, and 221 preoperative adults, respectively. Other researchers investigated alternative methods of analgesia for IV insertions, including topical skin coolants (Hartstein & Barry, 2008), a topical local anesthetic cream (Luhmann, Hurt, Shootman, & Kennedy, 2004) or patch (Sethna et al., 2005), and self-selected music therapy (Jacobsen, 1999), all with positive results. Svensson, Rosen, and Nilsson (2006) randomized 125 ambulatory patients to receive either local warming for one minute or no treatment prior to IV insertion and found that local warming did not have any pain-reducing effect. However, none of the investigational studies examined healthcare professionals' number of IV insertion attempts or the time taken for insertion.

Other nursing articles offer suggestions for IV insertion, such as choosing the correct site and vein, using a bright light for visualization, keeping the patient warm (Rosenthal, 2005), or using a variety of catheter cannulation approaches (Hadaway & Millam, 2005). Jacobson and Winslow (2005) found that several nurse-related factors (e.g., age, years of experience, specialized certification, self-reported skill level, self-positioning) influenced IV insertion success. Their research also revealed that patient variables (e.g., movement, dark or difficult-to-puncture skin, veins that rolled) increased IV insertion failures. They found that patient positioning, mechanical stimulation, and vein stabilization were key techniques nurses used to facilitate successful IV insertions. Research on professional factors associated with IV insertion success and difficulty suggests that IV-trained nurses and clinical nurse specialists have better success rates, fewer attempts, and fewer complications (Frey, 1998; Ung et al., 2002).

Nurses often apply heat to the IV insertion site to assist with vein visualization and increase the likelihood of a successful insertion, but the technique has rarely been studied. Cutaneous blood flow increases up to 70% during periods of heating because of an increase in sympathetic vasodilator activity (Roberge, 2004). Another method that improves venous dilatation is the local application of nitroglycerin ointment, which resulted in fewer IV insertion attempts in multiple settings (Roberge et al., 1987). Many warming methods have been anecdotally reported by nurses and other healthcare professionals: immersion of a patient's hand and arm in warm water, wrapping a patient's arm with a moist towel that has been placed in warm water or microwaved, application of a dry heat chemical warm pack, use of a microwaved wheat-filled bag (Beer, 2002), or insertion of a forced-air warming hose into a plastic bag wrapped around a patient's arm (Wong, 2006). Lenhardt, Seybold, Kimberger, Stoiser, and Sessler (2002) conducted two rigorous single-blinded, prospective, randomized controlled and crossover trials in patients who were neurosurgical and hematologic with an application of heat prior to the IV insertion procedure. Lenhardt et al. found that local warming using dry versus no heat facilitated IV insertion, reducing the number of attempts as well as nursing time for insertion. Wagner, Byrne, and Kolcaba (2006) determined that efforts to warm the arm had a positive effect on patients' thermal comfort and sense of well-being. Wagner et al. further concluded that anxiety can be decreased when patients are normothermic.

Anxiety has been found to cause vasoconstriction (Johnstone, 1976), which can lead to difficult IV insertion. Patients undergoing invasive procedures, such as IV insertions, may display signs of anxiety (Bartfield, Janikas, & Lee, 2003; Soysal et al., 2005). About 20% of adults experience a mild-to-moderate fear of needles and have anxiety leading to bradycardia and hypotension (Rosenthal, 2005). Nurses should acknowledge the patients' concerns and offer heat modalities to encourage vasodilation. Skin temperatures of 102°F–108°F induce optimal vasodilatation (Roberge, 2004); however, care must be taken to avoid excessive temperatures, which can cause heat damage to an extremity. No national standard exists for temperature settings on warming devices, such as heating pads and blanket-warming cabinets. Manufacturers' recommended temperature ranges vary, as do patients' perception and tolerance of heat (Petersen, 2006). Although generally safe, therapeutic heat devices (e.g., heating pads, microwavable hot packs) can cause burns, even when used appropriately (Todd, 1997). Soffer (2004) noted that the use of microwave-heated cryogel packs resulted in serious second- and third-degree burns as a result of uneven heating and deep penetration over time of application. Despite the potential risks of some heating procedures, others hold promise as effective, inexpensive, and easy-to-implement strategies to help patients cope with pain, distress, and anxiety in frequently performed routine IV insertion. Research is needed particularly to examine dry and moist heat's efficacy in this context. As a result, the current study sought to determine whether dry versus moist heat application to the upper extremity improves peripheral IV catheter insertion in hematologic outpatients with cancer, with respect to the number of attempts, the time needed for IV insertion, and anxiety. The study also examined heat's effect on the comfort, safety, feasibility, and acceptability of IV insertion.

Methods

Sample

The sample included 136 hematologic outpatients with cancer or other malignancies scheduled to receive chemotherapy or other infusion therapy. Patients were recruited from the University of Colorado Cancer Center, which averages 10,495 patient infusion visits per year. Ineligibility criteria included being younger than age 18, having breast cancer history with previous axillary

lymph node dissection, or having only one arm evaluable for IV insertion.

Power analysis, which was based on the ability to detect a moderate effect size (d = 0.9), power of 0.8, and family-wise alpha set at 0.05 (two-tailed t test), determined that a sample size of 128 participants was necessary to detect differences between groups. Additional participants were enrolled to account for attrition resulting from multiple IV insertion attempts or disqualification and to ensure that each RN IV starter had equal numbers in dry and moist heat groups. To evaluate the effect of an individual RN's IV insertion technique, each of two RN IV starters enrolled 34 participants per treatment group.

Design and Procedure

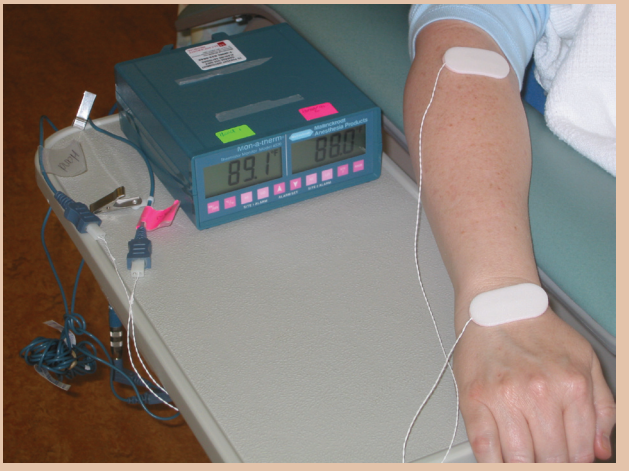
A two-group, randomized controlled design was used to study the effect of dry versus moist heat on IV insertion. The study was approved by the Colorado Multiple Institutional Review Board, and data were collected from November 2007–March 2008 by research team members who were trained in the informed consent process, participant assessment and history taking, and protocol, including temperature monitoring and provision of heat source. A charge nurse employed in the cancer infusion center routinely reviewed the infusion schedule and notified the nurse caring for each patient about the patient's eligibility. After checking into the infusion center, potential participants were told about the study, provided a brochure by their oncology nurse, and asked whether they wished to be contacted by an investigator to learn more about the project.

After consent was obtained, 155 participants were randomly assigned based on computer-generated codes to receive either dry heat or moist heat using towels (12" x 24") wrapped around the participant's upper extremity and IV insertion site for seven minutes prior to IV cannulation. Insertion time for the procedure was measured with a stopwatch from the placement of the tourniquet to the successful infusion of the IV fluid without signs of infiltration. If a second IV insertion attempt was required, the time continued to accrue until insertion was successful or until the participant was disqualified because more than two IV insertion attempts were required (n = 19). According to the Infusion Nurses Society ([INS], 2006) guidelines, if a nurse is unsuccessful at IV insertion after two attempts, another competent nurse should be requested to assess the patient for additional attempts. Towels were warmed to the maximum permissible temperature using one of the following: Getinge® 5524 warming cabinet (Getinge USA) for dry heat (160°F) or Equipro Spa-Cabi® 61101 (Sundaes Novelty, Inc.) for moist heat (178°F). Because of significant skin temperature heating differences between the dry (94°F) and moist (98.7°F) towels alone, participants in the dry heat modality required the additional placement of a heating pad around the warmed towel on the extremity to achieve a similar increase in skin temperature (98.9°F).

All RNs employed at the cancer infusion center were administered a questionnaire to determine years of nursing experience, experience starting IVs, comfort with the procedure, and personal rating of skill level. Two charge RNs with similar backgrounds, including moderate skill level and comfort with IV insertion, were chosen to perform all of the venipunctures according to a designated protocol for IV insertion. An IV insertion procedure based on INS (2006) standards outlining detailed steps associated with venipuncture was reviewed with both IV starters. Their IV insertion techniques were observed and critiqued to establish inter-rater reliability prior to starting the study.

Measures

Room, baseline, and postheating forearm and hand skin temperatures were measured using the Mon-a-Therm® 4070 temperature monitoring system (Nellcor Puritan Bennett LLC) (see Figure 1). After each insertion, the RN IV starters rated the difficulty of the procedure on an interval numeric rating scale from 0 (not difficult) to 10 (most difficult insertion the nurse has ever done). They also assessed participants' vein status pre- and postwarming using a reliable scale: 1 (veins neither visible nor palpable), 2 (veins visible but not palpable), 3 (veins barely visible and palpable), 4 (veins visible and palpable), and 5 (veins clearly visible and palpable) (Lenhardt et al., 2002). A 24-gauge angiocath, standard for insertions, was used unless a larger bore cannula was medically indicated for blood product administration. Patients completed a 100 mm visual analog scale (VAS)



Note. Device pictured is the Mon-a-Therm® 4070 (Nellcor Puritan Bennett LLC).

Figure 1. Temperature Monitoring System With Skin Probes

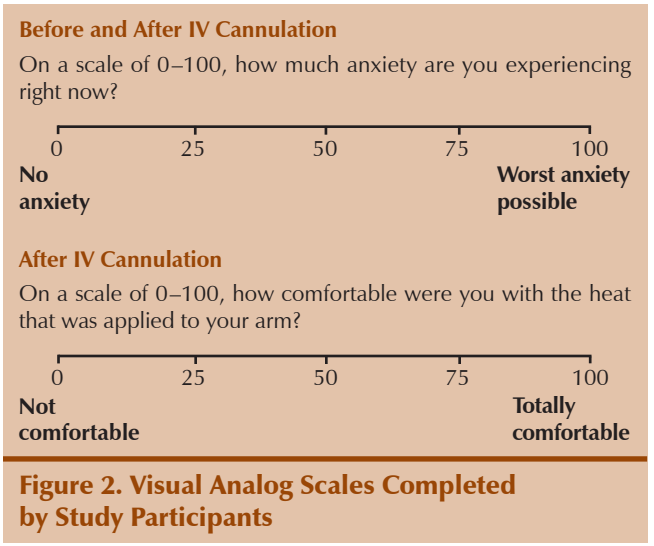


Figure 2. Visual Analog Scales Completed by Study Participants

(by placing a vertical mark on the line that was later measured) to assess their pre- and post-IV insertion anxiety level; a second visual analog scale post-IV insertion was used to measure their comfort level with the heat therapy (see Figure 2).

Data Analysis

Data were entered into SPSS® version 16. Analysis included descriptive statistics to display demographics and outcome variables of interest by groups; t tests and chi-square were then used to test group equivalence based on demographics. A significant non-normality of the dependent variables (insertion time, number of IV insertion attempts, and patient anxiety) was observed, which required a logarithmic transformation of the data. However, results did not change, so nontransformed results are reported. Two-by-two analysis of variance was used to analyze main effects for nurse and heat type (moist versus dry), as well as any interactions between them. Analysis of covariance (ANCOVA) was used to determine the effect of independent variables on postinsertion anxiety after controlling for each participant's preinsertion anxiety level. Statistical significance was computed using an alpha level of 0.05.

Results

Participant Demographics

Of the 163 eligible patients approached to participate, 155 (95%) consented. Those unwilling or unable to participate gave the following reasons: "not today," "too tired," and "don't have time." The average participant was a man (57%), aged 59 years, Caucasian (82%), weighed 170 pounds, had prior chemotherapy (82%), reported a mean of 42 venipunctures in the past year, had normal skin turgor (91%), and had no significant comorbidities (e.g., diabetes, peripheral vascular disease, long-term steroid use) that could influence IV insertion (79%) (see Table 1). A decrease in skin turgor and dehydration was evidenced when the skin on the back of the hand remained elevated for a few seconds after being gently squeezed and released (McCann, 2008). Categorized diagnoses consisted of 74% solid tumor, 19% hematologic malignancy, 4% nonmalignant hematologic condition, and 3% autoimmune disorders. IV catheters were predominantly inserted in the forearm (84%) and the left arm (55%).

Groups were similar on all demographic and clinical variables except for the number of months of chemotherapy, in which the dry heat group had longer prior treatment duration (moist = 5.7 months; dry = 9.6 months). Despite no difference in the number of ethnic minorities per heat modality or RN IV starter groups (4% African American, 13% Hispanic, 1% Asian), power was not sufficient to conduct detailed subgroup analysis.

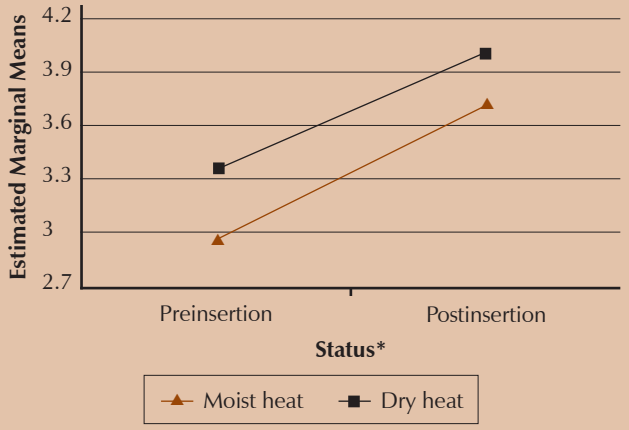
Exploratory Analyses

When comparing heating modalities, no significant differences were observed between the groups in pre- and postwarming temperatures or vein status. Moist heat applied to participants' hands caused a greater increase in temperature when compared to dry heat ($t = 4.88$, $p < 0.001$). Moist heat applied to participants' forearms caused a greater increase in temperature when compared to dry heat ($t = 6.74$, $p < 0.001$). Nurses who inserted the IVs rated the procedure more difficult in participants who had moist heat applied to their extremity ($\bar{X} = 4$, SD = 2.8) than in participants who had dry heat ($\bar{X} = 3.1$, SD = 2.4, $t = 2.01$, $p = 0.046$). Nurses' ratings of vein status improved from pre- to postinsertion, regardless of the modality used (see Figure 3). Participants receiving dry heat reported more anxiety

Table 1. Participant Demographics by Modality

	Moist Heat (N = 68)		Dry Heat (N = 68)	
Variable	$\bar{X}$	SD	$\bar{X}$	SD
Age (years)	59.9	12.7	59	11.3
Weight (pounds)	175.4	38.5	165.2	35.9
Months of chemotherapy*	5.7	8.2	9.6	15.5
Self-reported number of venipunctures per year	41.8	38.6	41.3	35.4
Prewarming vein status	3	1.4	3.4	1.3
Postwarming vein status	3.8	1.2	4	1.2
Hand temperature change*	+9.4	3.3	+6.9	2.6
Forearm temperature change	+11.1	3.2	+7.6	2.7
Anxiety change	−4.4	15.5	−8.3	16.7
Comfort postcannulation	89	19	94.2	12.7

* $p < 0.05$



* $p < 0.001$
Note. $\bar{X}$ = 3.15 preinsertion, 3.9 postinsertion

Figure 3. Nurses' Vein Status Ratings

preprocedure ($\bar{X}$ = 17, SD = 22.2) than those receiving moist heat ($\bar{X}$ = 10.9, SD = 15.6), but the finding was not statistically significant.

Number of Venipuncture Attempts

The IV catheter was successfully inserted in 110 of 136 first attempts (81% success rate) across both groups. Nineteen participants were disqualified from the study after two failed IV insertion attempts. Controlling for prewarming vein status, dry heat was 2.7 times more likely to result in successful IV insertion (Wald χ^2 [df = 1] = 4.25, p = 0.039 (see Figure 4).

Total IV Insertion Time

After controlling for preinsertion anxiety, vein status, and the participants' number of venipunctures in the prior year, dry heat resulted in significantly lower insertion times than moist heat (F[1, 128] = 5.29, p = 0.023). No differences between nurses (F[1, 128] = 1.87, p = 0.023) or nurse-by-modality interaction (F[1, 128] = 1.32, p = 0.254) in terms of total insertion time were found. The difference in mean insertion time between dry heat ($\bar{X}$ = 98.5 seconds, SD = 57.6) and moist heat ($\bar{X}$ = 127.6 seconds, SD = 86.1) was large enough to be clinically meaningful.

Patient-Reported Anxiety

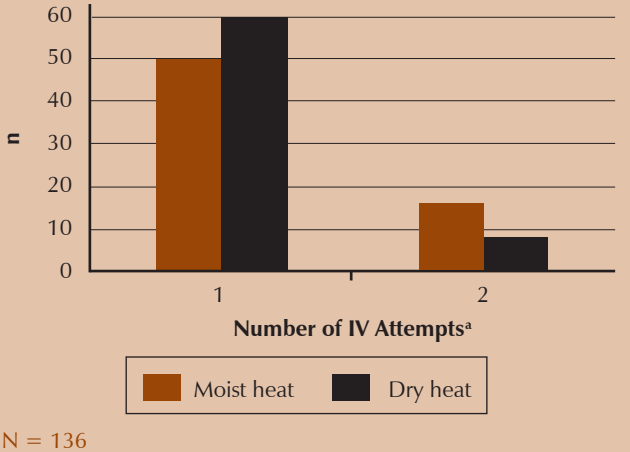
No significant difference was found between the heat modalities or between nurses on postinsertion patient-reported anxiety scores (p > 0.54). This analysis used ANCOVA to determine the effect of each independent variable on postinsertion anxiety after controlling for each patient's preinsertion anxiety level, so results are independent of any between-patient differences in anxiety. Anxiety scores declined from preinsertion to postinsertion (dry heat: $\bar{X}$ = –8.32, SD = 16.67; moist heat: $\bar{X}$ = –4.41, SD = 15.5), regardless of other variables (t = 1.42, p = 0.159), perhaps because the procedure was complete at that time.

Patient Comfort With Heat Modality

Dry heat was associated with significantly higher participant self-reported comfort (F[1, 128] = 4.09, p = 0.045) after controlling for preinsertion anxiety and vein status and the participants' numbers of venipunctures in the prior year. Mean VAS scores were 94.2 for dry heat and 89 for moist heat. No difference existed between nurses in patient self-reported comfort level (F[1, 128] = 1.16, p = 0.285). Acceptability of the intervention was demonstrated by the study's high recruitment rate and by the fact that all participants willingly kept the heating modalities in place for the seven-minute duration once applied. Safety of the intervention also was supported in the current study. Slight skin erythema was noted on the forearm of a few patients receiving moist heat, but quickly resolved after protocol completion.

Discussion

For nurses employed in busy outpatient infusion centers, insertion of peripheral IV catheters is a core activity that can be difficult, particularly for hematologic outpatients with cancer receiving repeated chemotherapy courses. Although IV insertion often is successfully performed on the first attempt, nurses constantly seek techniques to enhance their success rates. Warming of the IV insertion site using dry heat appears to be a faster and more comfortable means of facilitating IV insertion than using moist heat, at least on the first insertion attempt. In the current study, dry



N = 136
[a] Dry heat was 2.7 times more likely to result in successful IV insertion on first attempt (p = 0.039).

Figure 4. Venipuncture Attempts by Modality

heat was 2.7 times more likely to result in successful IV insertion on the first attempt. Insufficient data were obtained to determine which heat modality may be more effective on subsequent IV insertion attempts because the cancer center IV insertion policy limits each nurse to two attempts.

Both types of heat were feasible to use, safe, acceptable, and comfortable for patients in the current study. The temperatures used were not associated with tissue injury because the heat application lasted only seven minutes. None of the participants asked for the heat application to be discontinued.

Patients experiencing IV insertion typically are anxious about the procedure. Nurses should believe the patient if he or she expresses a fear of needles. A supportive approach, acknowledging feelings, and offering heat helps the patient to relax and can assist with decreasing anxiety and distress while promoting comfort. Results from the current study found that patient anxiety levels decreased in both heat groups, perhaps because the procedure was over and the nurse was successful in the IV insertion attempt. Of interest is that patient preprocedure mean anxiety levels were higher in the dry heat group than the moist heat group, possibly suggesting that patients believed that moist heat would be associated with a better outcome. Anecdotally, some patients expressed disappointment when they realized they would be receiving dry heat as they believed moist heat was a better option. When the study was completed, all of the infusion nurses were informally asked which modality they believed was associated with more successful IV insertion and decreased insertion time. Almost 100% of the infusion nurses believed that moist heat would be better for patients when, in fact, the dry heat was associated with better outcomes.

Because dry heat is feasible, safe, and economical and the current study demonstrates efficacy, it should be considered as an option in hospitals and infusion centers. Healthcare providers should continue to find efficient and safe methods to deliver the heat modality to patients and consider integrating heat into policies and procedures.

Limitations

Research in a clinical setting is difficult when team members have time constraints. The study was completed in a very busy academic infusion center, so instances occurred in which the clinic was too busy or nurse-patient ratios were not conducive to enrolling participants. Continuation would have interrupted the flow and function of the unit, which the team wanted to avoid. The research team members voluntarily participated in the planning, development, preparation, and data collection process. With the clinic operating on weekday and daytime hours, data collection was performed around research team members' busy full-time schedules. Participants were sampled only when data collectors were available; as a result, opportunities to reach all potential participants were missed. Because both designated RN IV starters worked four 10-hour shifts per week, both were not available at the same time on one day per week. As a control, participants were randomized by treatment according to RN availability. Although the two RNs used as IV starters were trained according to protocol, slight inconsistencies may have occurred in performing IV starts and rating specific study criteria (e.g., vein status rating, RN difficulty in starting IV).

The spa warmer towels were heated to a temperature of 178°F. The temperature was too warm for some participants' comfort, and the towels needed to be air cooled slightly prior to applying. The cooling could have affected the change in pre- to postprocedure skin temperatures in those particular patients.

No attempt was made to audit the participants' medical records to determine prior chemotherapy agent administration and, in particular, vesicant drug use. Although the data may have proven beneficial in determining chemotherapy effects on vein status, many of the patients seen at the University of Colorado Cancer Center have been treated in other settings. However, gathering that data was beyond the current study's scope and would have been too time-consuming, yielding suboptimal data.

The study only was conducted in one institution and in a hematology-oncology population, which could limit the ability to generalize the results to other medical populations in different settings. In addition, social desirability, the effect of thinking that heat therapy either helps or does not help, could change the individual's perception about the therapy and anxiety associated with the type of heat therapy administered. As data collection occurred, most of the RNs and patients involved thought that moist heat was the better route, but data showed the opposite.

Implications for Nursing Practice

The current study is significant to patient care and clinical practice because it may potentially delineate a successful and straightforward protocol to improve the success of IV insertion on first attempt. Such a protocol may result in less discomfort and anxiety and improved satisfaction for patients undergoing IV insertion. The protocol also may be cost effective because of the decreased number of IV starts, less nursing time, and the need for fewer IV-start supplies. Future research in heat modalities could focus on using a more homogenous population or a nononcology patient group to improve generalizability, using one designated IV starter, comparing the heating modalities to participants who did not receive a heat intervention, or using patients as their

own control for cases in which study patients need two IV insertions simultaneously.

Conclusion

Hematologic patients with cancer often pose a challenge because of their need for frequent IV access. The use of dry heat application diminishes the likelihood of multiple IV insertion attempts and decreases procedure time. Dry heat is comfortable, safe, feasible, and economical to use in an outpatient hematology-oncology setting. Nurses should consider using heat as they develop evidence-based protocols to care for patients receiving infusion therapy who require peripheral IV catheter insertion.

The authors gratefully acknowledge Mary Bate, RN, BSN, OCN®, and Regin Beeter, RN, BSN, OCN®, both charge nurses in the University of Colorado Cancer Infusion Center who functioned as IV starters; Covidien/Nellcor for providing the Mon-a-Therm® temperature monitoring system 4070; and the patients who agreed to participate in this study.

Regina M. Fink, RN, PhD, AOCN®, FAAN, is a research nurse scientist, Ellen Hjort, RN, ND, is an inpatient staff nurse, and Barbara Wenger, RN, MS, OCN®, is an oncology bone marrow transplantation clinical nurse educator, all at the University of Colorado Hospital in Denver; Paul F. Cook, PhD, is an associate professor and director for the Center for Nursing Research in the College of Nursing at the University of Colorado in Denver; and Mary Cunningham, RN, BSN, OCN®, is a staff nurse in the outpatient cancer center at the University of Colorado Cancer Center in Denver. Aimee Orf, RN, BSN, OCN®, is a staff nurse, Wendy Pare, RN, BSN, OCN®, is a charge nurse, both in inpatient oncology, and Jennifer Zwink, RN, BSN, OCN®, is an oncology and bone marrow transplantation nurse manager, all at the University of Colorado Hospital. Funding for this research was provided by the DAISY Foundation. Mention of specific products and opinions related to those products do not indicate or imply endorsement by the *Oncology Nursing Forum* or the Oncology Nursing Society. Fink can be reached at regina.fink@uch.edu, with copy to editor at ONFEditor@ons.org. (Submitted August 2008. Accepted for publication November 11, 2008.)

Digital Object Identifier: 10.1188/09.ONF.E198-E204

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