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EFFECTIVENESS OF DRY HEAT APPLICATION IN REDUCING PAIN AND ENHANCING PERIPHERAL VEIN ACCESS: A CLINICAL STUDY

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ABSTRACT

Background: Intravenous (IV) therapy is a common procedure in hospitals, with over 80% of patients receiving it during their stay. Although peripheral intravenous cannulation (PIVC) is usually common procedure, it can be difficult and may require multiple attempts, causing discomfort and anxiety. Successful cannulation depends on how visible and palpable the vein is. Applying dry heat is one of the useful techniques that can improve vein visibility and increase the success rate of IV insertion. This investigation has the potential to reduce patient discomfort, minimize complications, and improve the efficiency of peripheral intravenous cannulation, thereby contributing to enhanced clinical practice and patient care. **Methods:** This experimental study utilized a **non-randomized control group design** with **purposive sampling**. A total of **60 patients** admitted to a selected hospital in **Chamarajanagar** were included in the study, with **30 patients in each group** (experimental and control). The **Vein Assessment Scale** was used by the researcher to assess both the visibility and palpability of the veins. The **experimental group** received **dry heat therapy**, involving the application of a **hot water bag at 40°C**, covered with a cotton cloth, for **10 minutes** over the selected vein site. After the intervention, the researcher reassessed the vein using the Vein Assessment Scale, then performed **peripheral intravenous cannulation (PIVC)** according to a standardized protocol. The **number of pricks** required for successful cannulation was recorded, and **pain levels** were assessed by asking patients to rate their pain using the **Numeric Pain Rating Scale**. Data were analyzed using both **descriptive** and **inferential statistics** to draw conclusions regarding the effectiveness of dry heat therapy on the outcomes. **Results:** The experimental group showed significant improvement in vein visibility and palpability ($p = 0.000$), a reduction in the number of needle pricks ($p = 0.0001$), and lower pain levels ('$t_{(58)}$'=10.517, p=0.0001). Gender was the only personal variable significantly associated with the number of pricks. No other variables showed significant association with visibility, palpability, or pain levels. **Conclusion:** Dry heat application improves vein visibility and palpability effectively, reduces the number of pricks, and lowers pain during Peripheral intravenous cannulation. Additionally, the application of dry heat prior to IV cannulation was a more secure and cost-effective way.

KEYWORDS: Dry heat therapy; Peripheral intravenous cannulation (PIVC); Vein visibility; Needle prick reduction; Pain management.

INTRODUCTION

Peripheral intravenous cannulation (PIVC) is one of the most commonly performed procedures in clinical care, with over a billion PIVCS inserted annually across the globe.[1] More than 80% of hospitalized patients receive intravenous (IV) therapy during their hospital stay.[2], making it a fundamental aspect of nursing and medical practice.

Intravenous therapy plays a critical role in the rapid administration of fluids, medications, and nutrients to restore homeostasis and manage acute conditions.[3] Even though it is a common nursing intervention, IV cannulation is invasive and demands careful adherence to safety protocols to avoid complications. Historically, IV therapy can be traced back to Dr. Thomas Latta, who first

documented its use during the 1832 cholera outbreak in Britain, emphasizing its long-standing significance in clinical medicine.[4] Anatomically, the veins are composed of three layers: an internal endothelium, a thin layer of muscle fibre, and an outer layer of connective tissue.[5] Although cannulation is technically simple, successful PIVC placement can be challenging in certain patients due to poor vein visibility or condition. Difficulty in vein identification often results in multiple punctures, increased procedure time, and discomfort to the patient.[6]

Peripheral intravenous cannulation is more straightforward in larger veins, leading to the development of various techniques for vein identification. Among these, the application of heat, with local warming being a widely recognized and successful approach to enhancing vein visibility and palpability during cannulation.[7] Using heat before insertion of peripheral venous cannulas is one of the easiest, most convenient, and least expensive ways to facilitate accessing blood vessels. Local warming before insertion is thought to cause vasodilation by stimulating beta-adrenergic receptors.[8]

Despite being a standard procedure, PIVC insertion has variable first-attempt success rates: adults have a 12% to 40% failure rate on their first try at cannula insertion, while children have a 24% to 64% failure rate9. The success percentage for anesthesiologists performing intravenous cannulation on their first try ranges from 50.9 to 79.7%. 10. In adult populations, first-time insertion success for PIVCs has been observed to range from 18% to 98%. 11The state of the client's veins is one of the elements affecting this failure. 12 In order to enhance the quality of nursing care and expedite IV cannulation for patients, nurses should employ the safe, evidence-based, and cost effective interventions like local warm compresses to improve cannulation outcomes and patient comfort.6 Therefore, the purpose of this study was to assess the effectiveness of dry heat therapy in improving vein visibility, number of pricks, and pain experienced during PIVC among hospitalized patients in selected hospital in Mysore, India.

Repeated attempts at cannulation not only delay diagnosis and treatment but also increase patient anxiety, pain perception, and dissatisfaction.[13] Furthermore, repeated punctures may also lead to "vascular exhaustion," a cumulative decline in the vascular tree that makes vascular access even more challenging during subsequent encounters with the patient.[6] Additionally, many clients experience anxiety about intravenous cannulation, with their fear influenced by factors such as personality, gender, culture, and past experiences, which can lead them to delay or avoid needed medical care.[14]

MATERIALS AND METHODS

The present study employed a Non-randomized control group design to evaluate the effectiveness of dry heat application on the visibility and palpability of peripheral veins prior to peripheral intravenous cannulation. The study was conducted in various wards of a selected Hospital, Chamarajanagara. Ethical clearance for conducting the study was obtained from the Institutional ethical committee, JSSMC/IEC/070324/50 NCT/2023-24.

Participants and Sampling

A total of 60 patients admitted to the Hospital were selected for the study using a non-probability purposive sampling technique. The patients undergoing peripheral intravenous cannulation with a vein assessment score of 1, 2, or 3, indicating suboptimal vein visibility or palpability, were selected for the study. Patients requiring emergency care or those who were unconscious were excluded from the study. Informed consent was obtained from all participants prior to data collection.

Study Instruments

Demographic and Clinical Data Form

A structured form was developed to collect data on age, gender, medical diagnosis, and vein assessment scores. Information was obtained through direct patient interviews and review of medical records.

Vein Assessment Scale

This scale was used to evaluate the visibility and palpability of peripheral veins before and after the intervention. Veins were graded on a score of 1 to 3, with lower scores indicating poorer visibility and palpability.

Numeric Pain Rating Scale (NPRS)

This validated self-report scale was used to measure patients' pain immediately after peripheral intravenous cannulation. Participants rated their pain on a scale from 0 (no pain) to 10 (worst possible pain).

Data Collection Procedure

Data collection was carried out over three phases, as outlined below.

Phase 1-Pre-intervention Assessment

Assessment of visibility and palpability of veins for both the experimental and control groups was done by using Vein Assessment scale to meet the criteria of inclusion and as a pre-intervention assessment. The researcher randomly assigned patients who met the inclusion criteria to either the control group or the experimental group.

Phase 2: Intervention and Post-test Assessment

The Researcher assessed the visibility and palpability of peripheral veins among control and experimental group by using Vein Assessment scale and the score was recorded immediately in the observation chart. The experimental group received dry heat therapy, which involved placing a hot water bag (filled with water at 40°C and wrapped in a cotton cloth) over the selected vein site for 10 minutes, in addition to routine hospital

care. Meanwhile, the control group received only the standard hospital care prior to the insertion of the peripheral intravenous cannula

The post-test assessment of peripheral vein visibility and palpability was conducted in the experimental group. Subsequently, the researcher performed peripheral intravenous cannulation on both the control and experimental groups, following a standardized protocol.

Phase 3: Outcome Measures

- **Visibility and palpability of peripheral veins**

The visibility and palpability of peripheral veins were evaluated using the Vein Assessment Scale following the dry heat therapy intervention.

- **Number of Pricks**

This measures the number of attempts or "pricks" required to successfully insert the peripheral intravenous cannula. Fewer pricks would indicate better outcomes, potentially due to improved vein visibility and palpability.

- **Pain During Peripheral Intravenous Cannulation**

The pain experienced by patients during the procedure was measured using the Visual Analog Scale (VAS), with a reduction in pain observed following dry heat therapy in the experimental group.

These outcome measures assess both objective clinical factors (vein visibility, palpability, number of pricks) and subjective experiences (pain), which together give a comprehensive understanding of the effectiveness of dry heat therapy in facilitating peripheral intravenous cannulation.

RESULTS

The study sample consisted of 60 patients admitted to the hospital, 30 each in the experimental and control groups. The selected personal variables in terms of frequency and percentage depicted in **Table 1**. In order to find out the significance of difference in the post-intervention scores of visibility and palpability of vein **Table 2**, and number of pricks **Table 3** of patients undergoing Peripheral intravenous cannulation among experimental and control group, Fishers exact test was computed and obtain a p value which shows highly significant results.

Significance of difference in the mean post-test score of level of pain of patients undergoing PIVC among experimental and control groups independent "t" test was computed and obtained value of independent 't'=10.517 is found to be significant. **Table 4.**

Wilcoxon signed rank test was computed to find the difference between pre intervention and post intervention scores of visibility and palpability of vein in experimental group and obtain a p value p=0.000 and found to be highly significant. **Table 5.**

Table 1: Frequency and percentage distribution of patients undergoing PIVC according to their selected personal variables.

N=60

Sample characteristics	Experimental group n=30		Control group n=30	
	f	%	f	%
Age in years				
18-27	8	26.7	4	13.3
28-37	3	10	3	10
38-47	8	26.7	10	33.3
47 and above	11	36.7	13	43.3
Gender				
Male	8	26.7	10	33.3
Female	22	73.3	20	66.7
Education				
No formal education	11	36.7	17	56.7
Primary	4	13.3	5	16.7
Secondary	12	40.0	7	23.3
Graduate	3	10.0	1	3.3
Religion				
Hindu	28	93.3	27	90.0
Muslim	2	6.7	3	10.0
Christian	0	0	0	0
Others	0	0	0	0
Residence				
Rural	23	76.7	26	86.7
Urban	7	23.3	4	13.3
BMI				
Underweight	2	6.7	0	0.0

Normal weight	15	50.0	19	63.3
Overweight	9	30.0	7	23.3
Obese	4	13.3	4	13.3
Skin turgor				
Normal	28	93.3	28	93.3
Poor	2	6.7	2	6.7
Site of cannulation				
Cephalic	13	43.3	12	40.0
Basilic	9	30.0	10	33.3
dorsal metacarpal	5	16.7	5	16.7
median ante brachial	3	10.0	3	10.0
Previous history of cannulation				
Yes	24	80.0	25	83.3
No	6	20.0	5	16.7
Size of cannula				
18g	0	0	0	0
20g	16	53.3	13	43.3
22g	14	46.7	17	56.7

Table 2: Fisher's exact test to find the significance of the difference between post-test scores of the visibility and palpability of veins in the experimental and control groups.

N=60

Post test vein score	Experimental n=30		Control n=30		Fishers exact test
	f	%	f	%	P=0.004*
Neither visible nor palpable	1	3.3	4	13.3	
Visible but not palpable	8	26.7	16	53.3	
Barely visible and palpable	14	46.7	10	33.3	
Visible and palpable	7	23.3	0	0.0	
Clearly visible and palpable	0	0.0	0	0.0	

P<0.05*significant

Table 3: Fisher's exact test to find the significance of difference between the post-test score of number of pricks among patients undergoing PIVC in experimental and control groups.

N=60

Number of pricks	Experimental n=30		Control n=30		Fishers exact test
	f	%	f	%	P=0.0001*
One prick	28	93.3	14	46.7	
Two pricks	2	6.7	11	36.7	
Three or more pricks	0	0.0	5	16.7	

P< 0.05,*significant

Table 4: Mean, Standard deviation and independent't' value of post-intervention pain score among patients undergoing PIVC in experimental and control groups.

N=60

Groups	Mean	Std. Deviation	t value	P value
Experimental	4.37	0.81	10.517	0.0001*
Control	7.03	1.13		

$t_{(58)}$:1.96; p<0.05, *significance

Table 5: Wilcoxon signed-rank test to determine the significant difference between the pre-intervention and post-intervention scores of visibility and palpability of veins in the experimental group.

N=30

Characteristics of visibility and Palpability of vein	Experimental group n=30		
	Pre-intervention	Post-intervention	P value
Neither visible nor palpable	7	1	
Visible but not palpable	14	8	
Barely visible and palpable	9	14	P=0.000*
Visible and palpable	0	7	
Clearly visible and palpable	0	0	

P<0.05, *significant

DISCUSSION

The present study aimed to determine the effect of dry heat therapy on visibility and palpability of the vein and to reduce the number of pricks used for cannulation as well as the pain experienced by the patients while IV insertion.+

A **p-value of 0.004** indicates a highly significant difference between the experimental and control groups in **the post-intervention visibility and palpability of veins** in patients receiving PIVC. Compared to the control group, a much higher percentage of participants in the experimental group required **only one prick**; the difference is very significant, as indicated by the **p-value of 0.0001 from Fisher's exact test**. When the **independent "t" test** was used to calculate the mean post-intervention score of the **pain level of patients** receiving PIVC between the experimental and control groups, the resultant value of independent **"t"$_{(58)}$=10.517, p=0.0001**, was determined to be significant. To find the Significant change between **the pre-intervention and post-intervention scores of visibility and palpability of vein** among patients undergoing PIVC in the experimental group. **Wilcoxon signed rank test** was computed and obtained value of **p=0.000** and found highly significant.

According to Table 2, a p-value of 0.004 indicates a highly significant difference between the experimental and control groups in the post-intervention visibility and palpability of veins in patients receiving PIVC. These results were supported by additional research that showed a statistically significant difference ($p < 0.01$) between the study group's mean VAS score (post-intervention) and the control group's mean VAS score (just before IV insertion) of 3.800 ± 0.632 and 1.428 ± 0.502, respectively. ($p < 0.01$).[15]

According to Table 5, the Wilcoxon signed rank test was used to determine whether there was a significant difference between the pre-intervention and post-intervention scores of vein visibility and palpability among patients undergoing PIVC in the experimental group. The results showed a value of p=0.000, which was considered highly significant. These conclusions are corroborated by comparable study results from SGRD Hospital Amritsar, where the Wilcoxon sign rank test was used to statistically test the efficacy of heat therapy. The results showed that Z=6.124 and that the result was significant at the p=<0.001 level of significance.[16]

Compared to the control group, a much larger percentage of participants in the experimental group in this study required only one poke, indicating significantly better results. Fisher's exact test yielded a p-value of 0.0001, meaning that the difference is highly significant (HS). Similar study results corroborate the findings. The experimental group had a higher mean rate of successful I V cannulation than the control group (1.96±0.18 vs.1.86±0.35, t=1.50, p=0.14), and the experimental group had a significantly lower number of pricks (1.13±0.39 vs.1.74±0.75, t=2.78, p=0.001).[17]

The independent "t" test was used to determine the significance of the difference between the experimental and control groups' mean post-intervention scores of pain levels among patients undergoing PIVC. The resultant value of independent "t"$_{(58)}$=10.517, p=0.0001, was determined to be significant. Using the unpaired "t" test, similar study results showed that the calculated "t" value (4.62) was statistically very highly significant (p=0.001).[18]

According to table 1, The findings from the present study indicate that both the control and experimental groups were demographically comparable, supporting the validity of any observed intervention effects. Most participants in both groups were female, belonged to the Hindu religion, resided in rural areas, and had a previous history of IV cannulation. A majority also had normal skin turgor and fell within the normal BMI range. Commonly used cannula sizes were 22G in the control group and 20G in the experimental group. The cephalic vein was the most frequent site of cannulation.

Dry heat therapy promotes vasodilation by increasing the temperature of the skin and underlying tissues, which leads to the widening of blood vessels. This vasodilation enhances blood flow to the area, causing the veins to become more engorged and prominent, making them easier to identify and access for cannulation. The warmth from dry heat helps relax the surrounding muscles and tissues, which can reduce tension and discomfort. It also decreases nerve sensitivity in the applied area, thereby lowering the perception of pain. This combination of effects—improved vein visibility, muscle relaxation, and reduced pain—makes dry heat a useful intervention during procedures like peripheral intravenous cannulation.

Dry heat can be easily incorporated in pre cannulation protocol by applying a warm compress or dry heating pad to the cannulation site, so it **enhances first-attempt success**, **improves patient comfort**. Since dry heat uses basic, reusable equipment like heating pads or warm packs, it's also a low-cost method. Overall, adding dry heat is a practical, patient-friendly way to improve IV insertion success and satisfaction.

Limitations of the Study

A limited sample size could affect the generalizability of the study results. With a small number of participants, it may be challenging to draw broad conclusions about the effectiveness of dry heat therapy across different populations or settings. This **Single-Centre Study** conducted in single hospital, **Chamarajanagara, India**, may limit the diversity of the patient population. A broader, multi-centre approach would provide a more

comprehensive understanding of the therapy's effectiveness across different regions or healthcare settings.

The measurement of pain using the **Visual Analogue Scale (VAS)** is inherently **subjective**, as patients' pain experiences can vary based on individual pain tolerance, emotional state, and perception. This could introduce variability into the results. This study focuses on immediate post-procedure outcomes, such as vein visibility and palpability. However, it **does not assess longer-term outcomes**, such as the potential for vein damage, complications, or the recurrence of difficulties in vein access in future cannulation.

Suggestions for future research

Larger Sample Size and Multi-Center Trials Future studies should include a larger, more diverse sample size across multiple hospitals or healthcare settings to improve the generalizability of the findings.

Long-Term Follow-Up Studies To fully understand the impact of dry heat therapy, future research should include follow-up assessments to monitor long-term outcomes, such as vein health, the frequency of successful cannulations, and the incidence of complications.

Evaluation of Patient Satisfaction and Psychological Impact Beyond the physical measures, future studies should consider assessing patient satisfaction and the psychological impact of the intervention. Improved patient comfort during the cannulation process could lead to a better overall experience and patient outcomes.

Comparative Studies with Other Interventions Future research should compare the effectiveness of dry heat therapy with other vein enhancement techniques, such as mechanical compression, ultrasound-guided cannulation, or the use of topical anesthetics, to determine the most effective intervention for improving cannulation outcomes.

CONCLUSION

According to the findings of the study, the use of dry heat was effective in improving visibility and palpability of the vein, able to cut down on the number of IV insertion attempts and reduce the pain while undergoing peripheral intravenous cannulation. Additionally, the application of dry heat prior to IV cannulation was a more secure and cost-effective way**.**

Ethical consideration

Ethical clearance for conducting the study was obtained from the Institutional ethical committee of the JSS Medical college Mysuru (JSSMC/IEC/070324/50 NCT/2023-24). The participants were informed about the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information.

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Authors contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authours declared no conflict of interest.

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