Review Article

The Effect of Local Warming Before Vascular Access on Vascular Access Indicators in Adult Patients Receiving Chemotherapy: A Systematic Review

Abbas Heydari[1], Zahra-Sadat Manzari[1], Hasan Khalili[2]

[1]Nursing and Midwifery Care Research Center, School of Nursing and Midwifery, Mashhad University of Medical Sciences, [2]Department of Medical-Surgical Nursing, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran

ORCHID:

Abbas Heydari:
0000-0002-1082-7488

Zahra-Sadat Manzari:
0000-0001-8270-7357

Hasan Khalili:
0000-0001-8445-8534

ABSTRACT

Background: Intravenous (IV) cannulation is difficult, especially in patients undergoing chemotherapy due to frequent exposure to venous catheterization as well as the destructive effects of chemotherapy drugs on the vessel wall. Therefore, an easy, accessible, and fast method is needed to facilitate venous cannula insertion. **Objectives:** This study aimed to systematically review studies on the effects of local warming before insertion of peripheral venous cannulas on vascular access in adult patients receiving chemotherapy. **Methods:** This systematic review was conducted by searching databases including PubMed, Scopus, Cochrane, Embase, CINAHL, and ProQuest. The full search of information sources was conducted from the inception of the databases up to December 7, 2020, using the keywords namely "warming", "heat", "chemotherapy", "cancer", "vein score", "catheterization", "visibility," and "palpability." All randomized and nonrandomized trials that were in English language and full text were included. The search was based on the PRISMA guidelines, and finally, six articles were selected for the review. The 8-item JADAD scale was used to evaluate the quality of the included articles. **Results:** After a complete search, 244 articles were recovered and reviewed. Finally, six articles, including 516 samples, met the criteria for entering the study. Findings indicated that local warming at the IV insertion site increased insertion success rate at the first attempt, increased vein score, increased patient satisfaction and relaxation and reduced the catheterization time, reduced pain intensity, reduced pain perceived by the nurse, and reduced the number of pricks. **Conclusion:** Findings suggest that using local warming at the IV insertion sites in patients receiving chemotherapy is an effective, easy, and cost-effective method that can be performed using very simple tools and is recommended for all health care providers.

Keywords: *Catheterization, Chemotherapy, Peripheral, Systematic review*

Introduction

One of the most important nursing interventions is accessing the peripheral veins for prescribing drugs and delivering water and electrolytes. It is used in more than 80% of patients. Globally, the insertion of peripheral venous cannulas is performed more than 500 million times a year.[1] The most common reactions of patients during the insertion were pain (95%), anxiety (73%), needle phobia (53.2%), fear of employee empowerment (30.2%), and fear of bleeding (13%).[2] inappropriate catheter placement into the skin and vein or an attempt to repeat catheterization due to initial unsuccessful attempt may increase the risk of these complications.[3]

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Address for correspondence: Mr. Hasan Khalili, Department of Medical-Surgical Nursing, School of Nursing and Midwifery, Mashhad University of Medical Sciences, 7GJP+VPQ, Mashhad, Razavi Khorasan Province, Mashhad, Iran.
E-mail: Khalili894@gmail.com

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It has been reported that the rate of failure in peripheral intravenous catheter (PIV) insertion is a matter of concern and it is about 33% to 69%. One of the factors influencing this failure is the condition of the client's veins.[4]

In the chemotherapy unit, PIV insertion is a basic procedure that nurses typically perform, and placing the catheter is more difficult for patients receiving a repeated course of chemotherapy.[5] In patients with cancer, chemotherapy is one of the main treatments that can treat, control, or alleviate patients' symptoms. Chemotherapy drugs are most commonly given intravenously.[6]

The challenge of accessing the veins, especially in patients receiving chemotherapy, is usually more serious due to frequent exposure to venous catheterization and they have to deal with a fear of needles, stress, and anxiety.[7] Reattempt after initial unsuccessful attempt increases the patient's distress and anxiety, which in turn stimulates the sympathetic nervous system and provokes peripheral vasoconstriction thereby increasing the likelihood of failure.[6,8] Therefore, the successful insertion is very important in the initial attempt.[4]

Moreover, it is important to be careful in accessing the peripheral veins and to ensure that the catheter is placed correctly, therefore, it should be tried not to damage the venous wall during insertion of cannulas in certain medical conditions such as chemotherapy. Leaks of chemotherapy drugs out of the veins of the insertion site can cause severe and irreversible complications for the patient. Complications such as erythema, blistering, tissue necrosis, and associated pain are among the complications that are of great importance for the treatment team and the patients.[9-11]

Also, in cancer patients receiving repeated infusions of chemotherapy, the higher pH and osmolarity of chemotherapy drugs stimulate the endothelial layer of blood vessels, resulting in drug leakage, pain, redness, ecchymosis, infiltration from the catheter site, and ultimately causing the vessel to overlap.[8,12] These side effects reduce the dilation of blood vessels, their visibility, and accessibility. Accordingly, it is more difficult to insert the catheter into the vessels.[8]

Having larger vessels makes them easier to access. A variety of methods are used to facilitate accessing the vessels, including the vein finder, the use of a tourniquet, hitting the vessels, punching the hand, and local warming.[5]

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; however, the existing knowledge about the application of local warming before catheter placement as well as nursing knowledge is not sufficient.[8,13] Also, the duration of applying the heat, the type of heat used, and the temperature of the heat used for this purpose are not specified.

To the best of the authors' knowledge, no systematic review study has been conducted so far to investigate the effect of local warming before insertion of the cannula on vascular access indicators.

Objectives: The aim of this study was to investigate the effect of local warming before vascular access on vascular access indicators in adult patients receiving chemotherapy.

Methods

Research protocol

This systematic review was conducted based on PRISMA guidelines.[14] The PICOS framework was defined as follows: (P) patients undergoing chemotherapy; (I) the use of local warming in addition to the Routine method (applying a tourniquet and asking the patients to clench their hands); (C) Routine method and non-application of heat; (O) vascular access indicators; (S) All intervention studies. Given that there were not enough randomized clinical trial (RCT) papers to conduct a systematic review study in this area, regardless of the quality score, all related intervention studies that had entry criteria were included in the study.

Eligibility criteria

All randomized and nonrandomized trials that compared the effect of local warming in comparison with the Routine method (applying a tourniquet and asking the patients to clench their hands) on vascular access indicators in adult patients undergoing chemotherapy, published in English language, and with available full text were included. The exclusion criteria of the study were as follows: abstracts, papers presented at a conference, letter to the editor, case report, non-English articles, and animal studies.

Variables of interest

The main outcome of this study was vascular access indicators, which has been evaluated through the following variables: vein score (ability to observe and touch the veins), pain intensity, number of attempts to access the vein, or insertion success rate of the peripheral venous cannulas, patient's anxiety, patient's satisfaction, patient's comfort, the time required for successful catheterization, difficulty perceived by

the nurse during the insertion of peripheral venous cannulas, and the number of pricks.

Search strategy

According to the predefined strategy based on MEDLINE, the following databases were searched: PubMed, SCOPUS, Cochrane, Embase, CINAHL, and ProQuest. References of related articles were also reviewed to access all relevant studies.

Both subject headings and free-text terms were used to search for databases. The search program consisted of three main components:[1] Warm* or heat or hot or tepid[2] "vein score" or "venous access" or catheterization or "intravenous catheter insertion" or "venous cannulation" or visib* or palpabl*[3] neoplasm or cancer or chemotherapy. The words within a component were separated using the "OR" Boolean operator. In addition, the three components were combined using the "AND" Boolean operator to obtain any connection between them (Box 1). All studies which had been published from the inception of databases up to December 7, 2020, were retrieved and assessed. All studies were stored and retrieved in Endnote X8 software and then were evaluated.

Two authors searched the database using predefined search strategies. They separately screened and evaluated the titles and abstracts of the recovered studies for their eligibility based on predefined inclusion criteria. The full text of the potentially relevant articles was reviewed for a comprehensive assessment of inclusion criteria. Cases of disagreement with the discussion and consultation with the third author were resolved.

Data extraction

The following data were extracted out of the included articles: Type of study, sample size, age of participants, characteristics of the control group, vein score before the intervention, characteristics of the tool (type of heat used, temperature, duration of heat used), the primary outcome (vein score, success in vein access at the first attempt or the number of pricks, catheterization time), secondary outcomes (the severity of pain perceived by the patient, patient anxiety, patient satisfaction, patient comfort, and the difficulty perceived by the nurse).

Box 1: Search strategy in the PubMed database	Hits
#4 , "Search (((warm* OR heat* OR hot OR tepid)) AND (neoplasm OR cancer OR chemotherapy)) AND ("venous access" OR catheterization OR "intravenous catheter insertion" OR "venous cannulation" OR "Intravenous Cannulation" OR "venous cannula" OR "Vein score" OR "successful catheterization" OR visibl* OR palpabl*)	102
#3 , "Search ("venous access" OR catheterization OR "intravenous catheter insertion" OR "venous cannulation" OR "Intravenous Cannulation" OR "venous cannula" OR "Vein score" OR "successful catheterization" OR visibl* OR palpabl*)	25412
#2, "Search (neoplasm OR cancer OR chemotherapy)	390821
#1, "Search (warm* OR heat* OR hot OR tepid)	11649

Risk of bias assessment

The methodological quality assessment of the included studies was independently conducted by two authors using the 8-item JADAD scale.[15] The JADAD scale score ranges from –2 to 8; a higher score indicates better RCT quality. Articles with JADAD scores more than 4, 3-4, and less than 3 points were considered as high, moderate, and low quality, respectively.[15] Disagreements were resolved after discussions with the consensus. There was one high-quality, four average-quality, and one low-quality study [Table 1].

Ethical considerations

In this systematic review, the collected data were used only for scientific purposes, and intellectual property was respected in reporting and publishing the results. The authors promised to avoid plagiarism, refrain from deliberately manipulating the data or analyses, and data making or fabrication.

Results

Study selection process

The search strategy resulted in the recovery of 244 studies [Figure 1]. After the first screening, 38 articles were remained and examined in more detail. Through full reading, only six articles included the final sample of this systematic review. The total sample size in the six articles was 615.

Study characteristics

In four studies, moist heat was used in the intervention group and no intervention was performed in the control group.[4,6,16,17] In one study, the dry heat was used.[8] In another study, the dry heat was compared to moist heat.[13] Tools used for moist heat were water-heated towels (in three studies). One study used a digital heating pad for moist heat.[16] In a study for dry heat, a fabric-coated carbon fiber element was used.[8] In a trial study, Getinge 5524 warming cabinet (Getinge USA) was used for dry heat and Equipro Spa-Cabi 61101 (Sundaes Novelty) was used for moist heat.[13]

In one study, the intervention was performed in two groups of patients (neurosurgery and leukemia patients). Due to the separation results, only patients with leukemia were examined.[8]

Table 1: Quality assessment of included studies (modified Jadad score)

Author, year	A	B	C	D	E	F	G	H	Total
Kaur M, 2011	0	0	0	0	0	0	0	1	1
Biyik Bayram S, 2016	0	1	0	0	0	1	0	1	3
Youssef Sharaf A, 2018	0	1	0	0	0	1	0	1	3
Lenhardt R, 2002	1	1	1	1	0	1	1	1	7
Fink R. 2009	1	1	0	0	0	1	0	1	4
Simarpreet K, 2018	0	1	0	0	0	1	0	1	3

Yes = 1; No = –1; Not described = 0.

Items:

A: Was the research described as randomized?

B: Was the approach of randomization appropriate?

C: Was the research described as blinding?

D: Was the approach of blinding appropriate?

E: Was there a presentation of withdrawals and dropouts?

F: Was there a presentation of the inclusion or exclusion criteria?

G: Was the approach used to assess adverse effects described?

H: Was the approach of statistical analysis described?

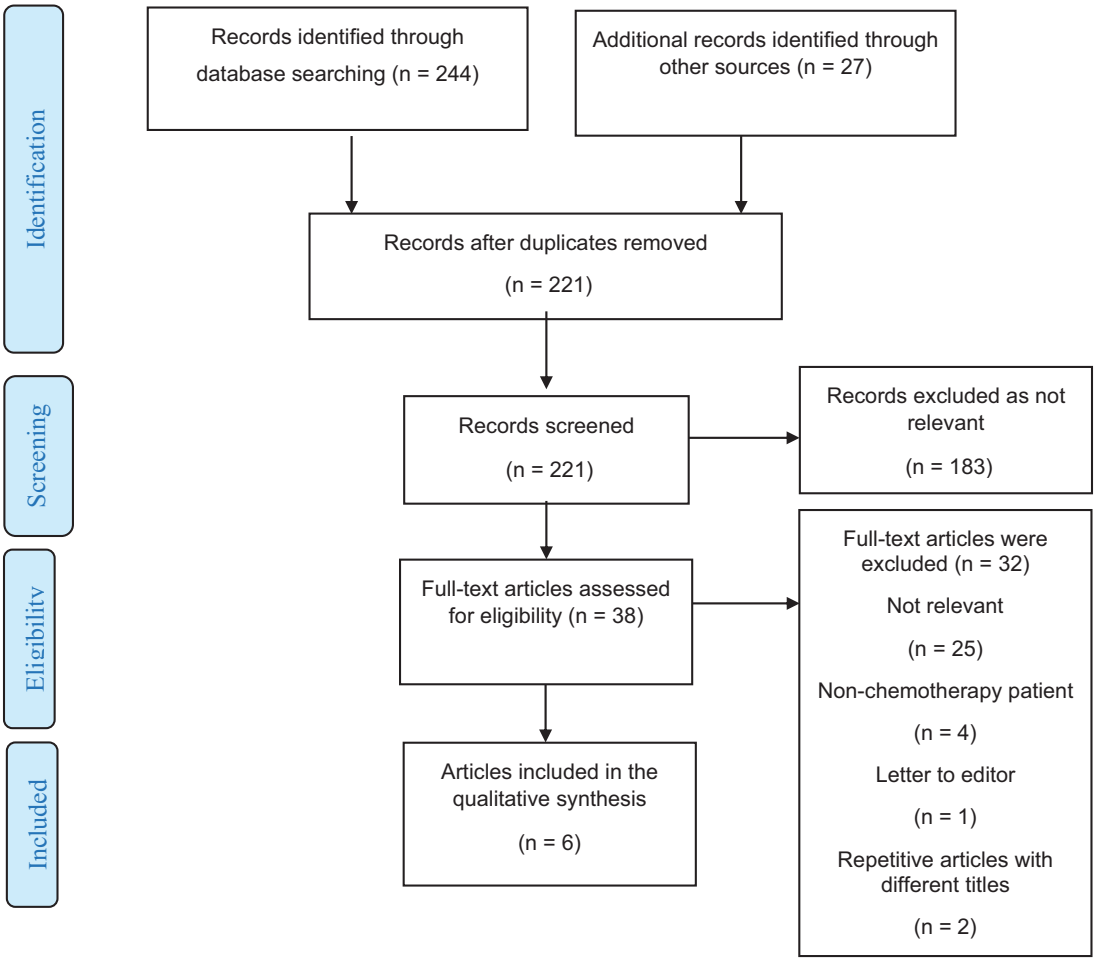

Figure 1: PRISMA flow diagram of the search strategy and study selection

The minimum and maximum ages of the participants in the studies were 18 and 75, respectively. The sample size in all studies was 516 subjects and ranged between 40 and 136. The minimum sample size was related to the study with two different groups of neurosurgery and leukemia patients in which the researchers eliminated the neurosurgery patients who did not coordinate with the aim of this study. Accordingly, only 40 leukemia patients who were receiving chemotherapy remained. It should be noted that the researchers selected 40 individuals separately and evaluated the intervention and outcomes separately from the other group.[8]

The warming time of the insertion site in five studies was 10 min,[4,6,8,16,17] and only in the comparative study (comparison of dry and moist heat), 7 min were used for warming.[13] In two studies that used a towel to warm up, the towel was used in two 5-min periods and the total time was 10 min.[6] Skin-surface temperature levels were ranged from 37 to 52°C in various studies. The characteristics of the studies included in the study have been reported in Table 2.

Patient type

Only patients who had cancer and hematological disorders and were currently receiving chemotherapy drugs were included in the study. The type of cancer was mentioned only in two studies (leukemia and breast).[8,13] The rest of the studies did not mention the exact type of cancer in patients

Outcomes

The patient outcomes and outcome measurements varied widely over the identified studies. The following outcomes were examined as primary outcomes (vein score, successful vascular access at the first attempt or the number of pricks, catheterization time) and secondary outcomes (pain intensity, difficulty perceived by the nurse, patients' anxiety, patients' satisfaction, patient comfort) [Table 3].

Primary outcomes

Vein score

The vein score was assessed in five studies. In two studies, this score was substantially different between the two groups after intervention.[4,8] Three studies compared the score before and after the intervention. In two of these three studies, the score was significantly different before and after the intervention.[4,17] But in the third study, they did not compare the significance level. In this study, patients were selected who had a vein score of 1 before the intervention. After the intervention, 40% of patients had a score of 5, 33% had a score of 4, and 12% had a score of 3, which indicates an increase in vein score and the ability to see and touch the vein and consequently an increase in the rate of vascular access. However, they did not specify a significant level difference before and after the intervention.[6]

Successful vascular access at the first attempt and the number of pricks

Four studies revealed success in catheter placement. In three studies that compared the intervention group

Table 2: Characteristics of the articles included in the study

First author, year, country	Type of study	Age, years	Sample	Temperature °C	Time, min	Tools	Control group	Type of heat
Kaur M, 2011, Pakistan	Before and after	47 (20–75)	60	39.5	10	Towel in lukewarm water	No	Moist
Biyik Bayram S, 2016, Turkey	Non-randomized trial	Over 18	80	52	10	Digital heating pad	Routine method	Moist
Youssef Sharaf A, 2018, Egypt	Quasi-experimental design	20–60	100	40	10	Moist towel	No intervention	Moist
Lenhardt R, 2002, Austria	Randomized, Single-Blind, Crossover Trial	Adult	40	52	10	Carbon fiber gloves covered with fabric	No intervention	Dry
Fink R, 2009, USA	A randomized trial comparing two groups	Over 18	136	Dry 71 Moist 81 (Tool temperature), the final temperature of towels was 37	7	A warm or moist towel	Compare moist and dry heat	Dry and moist
Simarpreet K, 2018, India	Parallel-group trial	48 (41–60)	100	39–40	Two 5-min times (10 min)	Towel in lukewarm water	Routine method	Moist

Table 3: Main outcomes reported in the included studies

First author, year	Vein score before intervention	Comparison of vein score in two groups or comparison before and after	Pain intensity	Success in vein access at the first attempt	Reduce catheterization time	Reduce the difficulty perceived by the nurse	Patient anxiety	Patient satisfaction	The number of pricks	Patient comfort
Kaur M, 2011	The vein score before the intervention was 1 in all patients	After the intervention, 40% of patients had a score of 5, 33% had a score of 4 and 12% had a score of 3	–	–	–	–	–	–	–	–
Biyik Bayram S, 2016	_	_	Significant difference $P = 0.011$	Significant difference $P < 0.004$	Significant difference $P < 0.001$	Significant difference $P < 0.001$	Significant difference $P < 0.001$	No difference $P = 0.409$		
Youssef Sharaf S, 2018.	_	Significant difference $P = 0.007$	Significant difference $P = 0.003$	–	–	–	–	Significant difference $P < 0.001$	–	–
Lenhardt R, 2002	_	Significant difference $P = 0.0027$	–	In the heat receiving group, it was 95% and in the non-intervention group, it was 73% $P < 0.001$	It decreased by about 20 (8 to 32) s ($P = 0.013$)	–	–	–	–	–
Fink R., 2009	_	The score before and after was significantly different in both groups, but it has not been compared between the two groups $P < 0.001$	–	Greater in the dry group $P = 0.039$ significant difference	Less in the dry group $P = 0.023$ significant difference	Less in the dry group $P = 0.046$ significant difference	significant difference $P = 0.0054$	–	–	Comfort was greater in the group receiving dry heat $P = 0.045$
Simarpreet K, 2018	_	Significant difference $P < 0.001$	–	No difference $P = 0.14$	Significant difference $P < 0.001$	–	–	–	Significant difference $P < 0.001$	–

and the routine method, a significant difference was reported between the two groups.[8,16,17] In the fourth study, which compared dry and moist heat groups, both groups reported an increase in vascular access, but in dry heat groups, the success rate in catheter placement was significantly greater than the moist group.[13] Only Simarpreet *et al.*[17] examined the frequency of injecting a needle into patients and stated that this parameter in the group receiving heat was significantly lower as compared with the non-heat-treated group.

Catheterization time

Regarding the time spent on catheterization, four studies reported that the time was significantly reduced. Lenhardt *et al.*[8] found that the catheterization time was reduced by 20 s (8, 32). Bayram *et al.*[16] stated that catheterization time was shorter in the intervention group (P = 0.0001). Simarpreet *et al.*[17] also revealed that the mean vascular access time was shorter in the intervention group, compared to the control group (P = 0.001). Fink *et al.*[13] stated that the IV insertion time in the dry heat group was substantially lower than the moist heat group (P = 0.023).

Secondary outcomes

Pain intensity

Two studies examined the pain felt while inserting peripheral venous cannulas and stated that this pain in the group receiving heat was significantly lower than the control group.[4,16]

Difficulty perceived by the nurse

Two studies examined the difficulty perceived by nurses during catheterization. Fink *et al.*[13] stated that the difference in nurse-perceived difficulty score in the two groups during intervention was 0.7, and this difference was significant (P = 0.046). In Bayram *et al.*[16] study difference between the two groups during catheterization was 2.68 and this difference was significant (P = 0.001).

Patients' anxiety

In two studies, patients' anxiety during catheterization was evaluated. Fink *et al.*[16] stated that the difference in patients' anxiety in the two groups after the intervention was 1.21, and this difference was significant (P = 0.0054). In Bayram *et al.*[13] study difference between the two groups after the intervention was 1.47 and this difference was significant (P = 0.001).

Patients' satisfaction

Two studies examined patient satisfaction after the insertion of peripheral venous cannulas. Bayram *et al.*[16] measured satisfaction with the visual analog scale (VAS). They stated that the difference between the two groups after the intervention was 0.67 and this difference was not significant (P = 0.409). Sharaf *et al.*[4] measured satisfaction with patients' satisfaction Likert scale and reported that the majority of patients in the intervention group (88%) were highly satisfied after cannulation, whereas the majority of patients in the control group (64%) had low satisfaction, and the difference between two groups was significant (P < 0.001).

Patient comfort

Patient comfort levels from catheterization were assessed in only one study. It was reported that the comfort level reported in patients receiving dry heat was significantly greater compared to patients receiving moist heat.[13]

Discussion

This study includes a review of six intervention studies that examined the effect of local warming before PIV insertion on the insertion success rate in chemotherapy patients. Findings of this systematic review showed that using local warming as compared to routine methods at IV insertion site increases the insertion success rate at the first attempt, increases vein score, increases patient satisfaction and relaxation and reduces the catheterization time, reduces pain intensity, reduces difficulty perceived by the nurse and reduces the number of pricks.

Due to the low quality of some studies reviewed and the lack of sufficient RCTs to conduct the review and the fact that some of the outcomes have been assessed in only one or two studies, further studies are needed to confirm or refute these findings. In addition, because of differences in the intervention protocol and differences in the measured results, it was not possible to accurately compare the results with a meta-analysis.

In both chemotherapy and normal patients, pain, and anxiety before PIV insertion stimulate the sympathetic nervous system and cause vascular contraction.[6] This contraction reduces the success of vascular access. The results of this review study showed that pain and anxiety are substantially lower in the heat receiving group as compared to the control group. Therefore, vasoconstriction in this group was less and the vein score was greater. Also, vascular access is easier and shorter in ime. Moreover, the use of local heat causes vasodilation and can be effective. Therefore, using this method in these patients is a good suggestion to increase the vein score and vascular access.

Our findings show that a variety of outcomes have been investigated in these studies and local warming has had a positive effect on all outcomes.

Tokizawa *et al.*[18] showed that reattempt after initial insertion failures increases nurses' costs, time, and

effort. The results of this systematic review also showed that as IV insertion time in the intervention group was reduced, and insertion success rates at the first attempt were increased, and PIV catheter consumption was decreased, nurses satisfaction nurses is increased. Therefore, this method of vascular access was cost-effective.

Regarding the superiority of using dry or moist heat, Fink *et al.*[13] stated that the use of dry heat was 2.7 times more effective than moist heat on vascular access at the first attempt. Given that only one study has compared the effects of dry and moist heat in chemotherapy patients and most studies have used moist heat, further research is needed. Concerning the appropriate time to use the heat, most studies used a time of 7–10 min.[4,6,8,13,17] Only one study applied a warm towel for two 5-min periods at the insertion site.[17] It would be better to use two towels so that there is no interval between the heating times of the area. We also do not know about the effect of using 5 min of local heat on vascular access. Due to the importance of time in health care systems, it is suggested that 5 min of local heat be studied in future experimental studies.

Regarding the appropriate temperature for local warming, the minimum and maximum temperature used for local warming was 37 and 52°C. The results of all studies indicated that the temperature was effective; thus, the selection of temperature that has more effect on increasing the vein score and making it possible to access the blood vessels in the best possible way requires further studies.

No specific side effects have been reported in these studies. However, the side effects of using local warming have only been discussed in one study. It has been stated that momentary redness has been observed at the site of heat use and disappeared immediately after removing the towel.[13] Therefore, it appears that the use of this method in the range of the mentioned temperatures does not have any side effects and should be considered to prevent burns and other complications.

The results of this study revealed that in most patients in the control groups, peripheral catheter insertion failed at the first attempt. This failure is due to the stimulating effect of chemotherapy drugs on the vessel walls and reducing their visibility in these patients. In these patients, due to receiving repeated courses of chemotherapy drugs and their effect on the vessel wall by hardening and contracting them, the likelihood of initial insertion failures is greater. Also, in case of insertion failures, vessel ruptures, or fixation of PIV catheter in the space outside the vein, chemotherapy drugs leak into space outside the vein and severe complications such as erythema, blistering, tissue necrosis, and associated pain are noticed by patients. Hence, these patients have a more urgent need for easier and safer access to blood vessels than normal patients. The results of these studies indicated that the use of local warming has significantly increased the insertion success rate.[9-11]

Finally, it may be noted that a local warm compress is a safe, easy, and cost-effective nursing intervention that facilitates venous cannulation in patients undergoing chemotherapy. The use of heat dilates blood vessels and increases blood flow, as well as delivering oxygen and nutrients to the needle insertion area. It appears that the increase in body temperature has a direct effect on the dilation of capillaries, arteries, and veins.[6] Therefore, it can be concluded that warming the patient for example using a warm blanket can increase vasodilation and improve vascular access indicators.

Given that no systematic review of the effect of local warming before PIV insertion on vascular access has been performed in chemotherapy patients, the results of this study could provide stronger findings on its use in these patients. However, further studies are needed to draw safe conclusions regarding these findings.

Despite comprehensive searching for evidence of the effect of local warming on vascular access indicators in chemotherapy patients, a limited number of articles have been recovered. All recovered studies were not RCTs. A number of studies were nonrandomized and one study was carried out with a before-and-after design without a comparison group. Thus, due to significant heterogeneity between studies, it was not possible to perform a meta-analysis.

Conclusion

This study is remarkable in several respects such as patient care and clinical performance because it can draw a successful and easy protocol to increase the success of vascular access in the initial attempt. The results of this study revealed that using local warming at IV insertion site increases the insertion success rate in the initial attempt, increases vein score, increases patient satisfaction and relaxation and reduce the catheterization time, reduces pain intensity, reduces difficulty perceived by the nurse, and reduces the number of pricks. In other words, vascular access is facilitated. Admittedly, the use of local warming at the insertion site in chemotherapy patients is an effective, easy, and cost-effective method that can be performed using very simple tools and is recommended for all members of the treatment team.

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Conflicts of interest

There are no conflicts of interest.

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