Crit Care Nurs J. 2018 May; 11(2):e68780. doi: 10.5812/ccn.68780.

Published online 2018 May 31. **Research Article**

The Effect of Thermal Therapy on Uremic Pruritus in Hemodialysis Patients

Hamed Zare [1], Majideh Heravi-Karimooi [2,*], Nahid Rejeh [2], Hamid Sharif Nia [3] and Nader Noori Majelan [4]

[1] Shahed University, Faculty of Nursing and Midwifery, Tehran, Iran
[2] Elderly Care Research Center, Faculty of Nursing and Midwifery, Shahed University, Tehran, Iran
[3] School of Nursing and Midwifery Amol, Mazandaran University of Medical Sciences, Sari, Iran
[4] Medical School, Shahid Sadoughi University, Yazd, Iran

[*] *Corresponding author*: Majideh Heravi-Karimooi, Department of Nursing, Shahed University, Opposite Holy Shrine of Imam Khomeini-Khalij Fars Expressway, P. O. Box 18155/159, Tehran, IR Iran. Tel: +98-2151210, Fax: +98-2166418580, E-mail: heravi@shahed.ac.ir

Received 2018 March 18; **Revised** 2018 April 22; **Accepted** 2018 April 22.

Abstract

Background: Uremic pruritus is one of the most common causes of despair with debilitating potential in hemodialysis patients. The mechanism of uremic pruritus is still unclear. Although acceptable treatments are identified and available in this regard, further studies are required to find a reliable treatment.

Objectives: The present study aimed to determine the therapeutic effect of thermal therapy on uremic pruritus in patients undergoing hemodialysis.

Methods: This quasi-experimental study was conducted in 2017. A total of 40 hemodialysis patients who suffered from uremic pruritus were selected randomly and divided into two groups: one treated with heat (case) and the other with no intervention (control). The case group was exposed to far-infrared (FIR) radiation at 40°C for 15 minutes daily in 18 sessions.

Results: All criteria for evaluating uremic pruritus (the history of pruritus, the effect of pruritus on sleep, daily activities, quality of life, description of the sensational and emotional dimensions, and severity of pruritus) had a significant difference between the case and control groups ($P < 0.001$).

Conclusions: The effect of thermal therapy on reducing the severity of uremic pruritus showed that patients suffering from uremic pruritus could use thermal therapy as a complementary therapy for pruritus.

Keywords: Hemodialysis, Quasi-Experimental, Thermal Therapy, Uremic Pruritus

1. Background

Patients with acute renal failure (ARF) undergoing hemodialysis have multiple problems and complications due to the type of disease and hemodialysis process in all aspects of life (1, 2). The common complication in patients with ARF undergoing hemodialysis is skin disorders called uremic pruritus due to impaired renal function and subsequent dialysis. The most important cause of pruritus is increased urea. Uremic pruritus is observed in 25% of patients with chronic renal failure (CRF) and 50% - 90% of patients undergoing the hemodialysis process at different levels (mild to severe) (3). The uncertainty of the underlying and pathogenic mechanism of pruritus is a major obstacle to developing an effective therapeutic strategy. The possible mechanisms include secondary hyperparathyroidism, ion concentration disturbances, histamine secretion, allergic reactions, stimulation of skin mast cell proliferation, iron deficiency anemia caused by nephropathy, renal changes, parathormone, histamine, calcium, and magnesium (1). Some recent findings suggest the destruction of opioid receptors and spot inflammation as a potential cause of uremic pruritus (4). The number of hemodialysis patients suffering from distressing symptoms is on the rise, and this disappointing problem has no effective scientific and satisfactory therapeutic strategy (5). This feeling causes skin disorder following hyperstimulation and infection, depression, and anxiety. Pruritus, irrespective of its severity, can be psychologically disturbing.

The usual medical solutions have only palliative and moderating effects. They include the use of dialysis to remove biochemical substances causing pruritus from the blood, local therapies with or without anti-inflammatory compounds, systemic treatments (such as gabapentin, opioid receptor antagonists, and serotonin antagonists with inhibitory effects), and systemic anti-inflammatory drugs, antihistamines, steroids, and erythropoietin. During the use of topical or systemic therapies, the patient continues to experience pruritus and its consequences and needs

more serious treatment. For drug treatment, there have been many interventions for patients with CRF, all of which showing several adverse effects (6). Pregabalin is an effective alternative to treat uremic pruritus while ondansetron has a minor efficacy with a high cost on the treatment of uremic pruritus (7).

For this purpose, complementary therapies such as phototherapy, acupuncture, and thermal therapy by infrared have been proposed (3, 6). Today, most patients are looking for methods for relieving the symptoms of pruritus without using medicines. Accordingly, the health staff, especially nurses, who are at the highest contact with patients, can use complementary methods to help improve the treatment process (8).

Recently, during the process of controlling and relieving uremic pruritus in patients undergoing dialysis, thermotherapy or heat therapy, acupressure, laser therapy, and acupuncture suggested as part of physiotherapy should be considered. Studies have shown that thermal therapy with infrared significantly improves the adequacy of dialysis (9). Thermal therapy is used to treat pain (10), depression (11), chronic fatigue syndrome (12), menstrual disorders (13), and endothelial dysfunction and improve coronary artery, endothelial function, nitric oxide expression, etc. (14).

Electromagnetic waves with high-wavelength infrared and far-infrared rays (FIR) create heat through contact with objects, including live tissues and the body surface, and penetrate the subcutaneous tissues through the skin with sufficient power, which reduces discomfort (15). Specifically, it has been shown that thermal therapy increases blood flow and cell metabolism (16), reduces the feeling of pain (17), re-synthesizes body tissue, increases body oxygenation, and activates the immune response system (18). The sympathetic nervous system is stimulated with increased temperature (19). 40°C temperature, caused by FIR waves, enters multiplying energy into the subcutaneous tissues without excessive skin stimulation or skin irritation. The stimulation of the sympathetic nervous system affects the uremic pruritus (20). Moreover, infrared electromagnetic waves of FIR are effective in stimulating inflammatory suppressor (21). They are used for pain relief, burn repair, tumor growth retardation, and stimulation of macrophage function (21, 22). However, molecular mechanisms by which they cause FIR function are still unclear (23). During the course of treatment with infrared waves, the symptoms significantly improve, including pruritus of the eyes and nose, nasal congestion, runny nose, and sneezing (24). Research shows that FIR can reduce the value of numerical visual analog scale (VAS) indicating pain and thus reduce discomfort experienced by the patients. The findings of studies have shown that the effective use of FIR waves reduces serum levels of interleukin (IL-6) and endothelin-1, both of which represent the mental index of pain (25).

Evidence suggests that FIR waves are non-invasive and easy to use. Thus, thermotherapy using electromagnetic FIR waves is considered as an effective type of physiotherapy for improving the health of patients with cardiovascular disease, diabetes, and chronic kidney disease. The usefulness of FIR and its positive protective effects have been proven on endothelium (26).

Therefore, as presented in the introduction, paying attention to plan for uremic pruritus reduction in hemodialysis patients is of great importance and complications of ARF, which causes uremic pruritus, should be controlled. Accordingly, using electromagnetic waves is considered due to positive effects without side effects and the ease of thermal therapy and the fact that this complementary therapy following patient's hemodialysis improves the quality of dialysis, as well.

In one study, it has been shown that thermal therapy by infrared reduced uremic pruritus by the mechanism of decreasing serum calcium levels as a cause of pruritus induction (27). Another study also found that thermal therapy with FIR and ceramic powder (CFIR1) delayed fatigue induced by muscle contractions due to affecting muscle myoblast cell culture under oxidative stress. Mechanisms such as antioxidant properties and preventive effects of acid production in muscle tissue may also be exerted by CFIR (1).

The unpleasant sensation that elicits the desire to scratch causes complications, for example, skin lesions or infections and depressed mood, especially for patients whose pruritus progressively deteriorates. However, uremic pruritus is a very frustrating condition for both patients and healthcare providers because no interventions have been demonstrated to be effective in relieving the itch.

In spite of the high number of hemodialysis patients and the high prevalence of pruritus and the fact that reducing pruritus is of nursing care duties and considering the increased interest in thermal therapies, a few studies have evaluated the effect of this therapy on uremic pruritus in hemodialysis patients in Iran. Therefore, the present study aimed to determine the effect of thermal therapy on uremic pruritus in patients undergoing hemodialysis.

2. Methods

This quasi-experimental one-blind randomized clinical trial (RCT) study was performed in 2017. The sample size was calculated by G power software based on a study investigating the effect of thermal therapy on uremic pruri-

tus and biochemical parameters in hemodialysis patients (28). Considering $\alpha = 0.05$, test power of 80%, and the effect size of 0.8, 20 patients in each group and 40 patients in total were selected as sample. The patients were selected from male patients undergoing hemodialysis at the hemodialysis center of Shahid Sadoughi hospital in Yazd. Inclusion criteria consisted of patients having 18 years of age or more, ability to communicate in Persian, diagnosis of uremic pruritus by a physician, undergoing hemodialysis three times during the last 3 months, having three attacks of pruritus (each for 5 minutes or more) within the past two weeks, no skin problems other than uremic pruritus, not using any anti-emetic drugs such as oral or injectable antihistamine, no open wounds, cellulitis, infection, deep venous thrombosis, epilepsy, bleeding, paraplegia and pacemaker, as well as no liver problems. Patients with the event of hemodialysis sessions more than 3 times per week, with kidney transplantation, any skin disease, vascular disorders, and malignancy during the study, patients reluctant to continue cooperation, patients who used another method to reduce pruritus, patients who developed psychological problems during the study, and those who changed their hospital were excluded from the study.

Before data collection, the ethics code (IR.Shahed.REC.1395.195) and IRCTID (IRCT2017041333245N2) were obtained. Data were collected from June to October 2017. Patients undergoing hemodialysis referring to the hemodialysis center of Shahid Sadoughi hospital in Yazd, who were eligible for inclusion in the study, were first familiarized with the study and recruited after giving their consent. The patients were randomly selected from the general list of patients by the simple random sampling method using a table of random numbers.

The control and case groups were similar in terms of all demographic variables (Table 1). The intervention was evaluated in three intervals: before, one-month later (mid-test), and after the intervention (after 2 months). First, the demographic and clinical characteristics were completed, including age, educational level, marital status, patient's income and occupation, the history of previous and current smoking, and the history of using antihypertensive drugs. Then, the Yosipovitch pruritus questionnaire, which contains 16 items and examines issues including the history of dialysis and pruritus, duration of pruritus, duration of dialysis, association of pruritus with dialysis, the timing of pruritus with dialysis, the severity of pruritus, and sleep disturbances. Yosipovich et al. (2001) calculated the reliability of this tool by Cronbach's alpha of 0.75 and test-retest of 0.72. The validity and reliability of its Persian version were confirmed by Abbasi et al. (2011) (28).

For sampling, first, a coordination was made with hospital officials. Then, on a daily basis, dialysis patients were randomly selected from those who were eligible for the study, based on performing the hemodialysis on odds or even days. The participants were presented with a complete explanation of the study and then the subsequent steps were taken. In addition, by expressing the research objectives, attracting the participation of research sample, and obtaining a written consent form, the research questionnaires were completed without any alteration or interpretation for participants in the research. All participants were visited by a nephrologist for complete baseline clinical examinations before the intervention. Then, the patients were randomly assigned to the case and control groups based on the day of hemodialysis. After this step, the intervention was performed only on the case group.

For the intervention, the employed device, which had a non-observable light lamp, was kept on for 15 minutes before use to allow the device to reach its maximum radiation. For preparation, the patient was placed in an appropriate and safe position so that the treated organ was exposed well. Anything that prevented infrared emission to the skin or prevented the area's blood circulation was removed. If the eyes were exposed to radiation, they were covered with a towel. The patients were placed in the supine position for 15 minutes on the dialysis bed and kept warm by a blanket. The case group received thermal therapy at 40°C by FIR, 20 minutes after dialysis, on the dialysis bed and separated by a curtain from the side bed. The thermal therapy was performed once a day for 15 minutes, 2 days a week, in a total of 18 sessions. The intervention was done without disturbing the patient's usual treatment process.

The other group of participants in the study, the control group, did not receive thermal therapy but routine medications and care. The researcher monitored the control group as long as the intervention group was monitored. To prevent bias, no information was provided to patients in this group on the methods of reducing pruritus. However, after the end of the study period, these patients were also explained about the methods of reducing pruritus and the effects of thermal therapy (after ensuring its positive effects) and, if requested, this technique was provided for them. Finally, in this study, instruments were used to collect data on demographic and clinical variables and the severity of pruritus.

In order to observe the ethical considerations, an approval was first obtained from the ethics committee, and after obtaining a license from the Shahed University, the researcher referred to the officials of Shahid Sadoughi Hospital, affiliated to Shahid Sadoughi University of Medical Sci-

Table 1. Demographic Characteristics of the Study Participants

Variable	Control Group	Case Group	P Value	Statistical Test
Age, mean ± SD	57.70 ± 3.067	55.65 ± 3.545)	0.664	t-test
Weight, mean ± SD	69.45 ± 1.464	71.95 ± 1.597)	0.256	t-test
Height, mean ± SD	172.75 ± 1.114	169.65 ± 1.746	0.143	t-test
Educational level			0.207	Chi square
Elementary school	13	10		
Secondary school	6	5		
High school or above	1	5		
Marital status			1	Fisher's exact tests
Single	1	1		
Married	19	19		
Income status			0.451	Fisher's exact tests
Insufficient	17	14		
Sufficient	3	6		
Job status			1	Fisher's exact tests
Employed	4	4		
Retired or unemployed	16	16		
Cigarette addiction			0.695	Fisher's exact tests
Smoker	5	3		
Non-smoker	15	17		
Taking anti-hypertensive medications			0.523	Fisher's exact tests
Yes	10	7		
No	10	13		

ences, Yazd, Iran, and asked for their permission. The purpose of the study was explained to the authorities of the hemodialysis department. Sufficient information about the goals and research details and their free choice to participate in the study were provided to the patients participating in the research before sampling. They were informed that participation in the study fully was voluntary and they could leave the study at any time. They were also assured about the confidentiality of information. An informed consent form was signed by every patient included in the research and the patients were assured that the implementation of thermal therapy program had no complications and would not endanger their health. The research team was not allowed to force, indulge, seduce, threaten, or push patients participating in the study to continue their participation in the study. We met all ethical principles throughout data collection and analysis and presented reports based on actual results. All research costs were paid by the researcher. The patients were assured that all information was kept confidential. At the end of the study, the "Thermal Therapy" sessions were conducted for the control group.

Initially, descriptive statistics were used to present the personal characteristics of the participants. Then, in order to investigate the effect of thermal therapy (by FIR) on uremic pruritus of patients, after confirming the normal distribution of data, repeated measures ANOVA was used. Data sphericity was evaluated using Mauchly test. The significance level was considered at $P < 0.05$.

3. Results

In this study, 40 patients were selected among the male patients undergoing hemodialysis at the hemodialysis center of Shahid Sadoughi hospital in Yazd. By using the KS test, the normality of the data was measured. According to the results, it was found that all the numeric data followed a normal distribution. According to Table 1, the mean age of participants was 57.70 years in the control group and 55.65 years in the case group; the mean weight was 69.45 kg in the control group and 71.95 kg in the case group; the mean height was 172.75 cm in the control group

and 169.65 cm in the experimental group. The frequency of educational level in the control group was as follows: 13 patients had elementary school education, six secondary school education, and one high school education or above. The educational level in the case group was as follows: 10 patients had elementary school education, five secondary school education, and five high school education or above. In terms of marital status, in both groups, one was single and 19 were married. In terms of income status, in the control group, 17 patients and in the case group, 14 had insufficient income and three in the control group and six in the case group had sufficient income. In terms of job status, four in both groups were employed and 16 were retired or unemployed. In the control group, five patients were smokers and 15 were not while in the case group, three patients were smokers and 17 were not. In terms of taking antihypertensive drugs, 10 patients in the control group and 7 in the case group used the drugs and 10 in the control group and 13 in the case group did not use the drugs. The results showed that both groups were identical in terms of demographic information (P values ranged from 0.143 to 1).

Considering the mean and standard deviation (SD) of the history of pruritus in the two groups of control and case before the intervention, one month after the intervention onset, and two months after the intervention completion, the results of analysis (Eta = 0.203, P = 0.001, and F (2) = 9.7) showed that the level of pruritus decreased in the case group compared to the control group. Descriptive statistics showed that the mean and SD, measured in three intervals in the two groups, were different and this difference was statistically significant.

The mean and SD of the effect of pruritus on sleep (Eta = 0.223, P < 0.001, and F (1.6) = 10.9), on daily activities (Eta = 0.105, P = 0.015, and F (2) = 4.2), on quality of life (Eta = 0.296, P = 0.001, and F (2) = 15.98), on description of sensational and emotional dimensions (Eta = 0.427, P = 0.001, F (1.6) = 28.35), on severity of current pruritus (Eta = 0.478, P = 0.001, F (2)= 34.85), on severity of pruritus in the worst case (Eta = 0.498, P = 0.001 and F (2) = 37.74), and on the least severity of pruritus (Eta = 0.377, P = 0.001, F (1.41) = 19.32) in the control and case groups before the intervention, one month after the intervention onset, and two months after the intervention completion were shown.

Descriptive statistics showed that mean and SD, in the three intervals measured, were different between the two groups and this difference was statistically significant. However, the mean and standard deviation of the history of using anti-pruritus drugs (Eta = 0.046, P < 0.169, and F (2) = 1.8) were not significantly different between the two groups in the three intervals measured, and this difference was not statistically significant.

4. Discussion

As previously stated, despite different measures considered, pruritus seems an unresolved problem in hemodialysis patients. For this reason, this study examined the role of heat in treating pruritus and the results indicated that the FIR therapy, as a complementary method, could reduce the severity of uremic pruritus in hemodialysis patients. In addition, some other studies have confirmed the positive effects of heat on solving clinical problems. Despite researchers' efforts, evidence suggests that the effect of heat on uremic pruritus has been specifically studied only in one study with published results in the world. Considering pruritus can affect feelings, stress, sleep, quality of life, and other factors, many studies have addressed the effects of thermal therapy on various factors. For example, the results of Yaghoobi et al. (2012) (29), Mohammadpoor et al. (2016), and Young et al. (2010) showed that FIR had a favorable effect on pain relief (30), systolic and diastolic blood pressure in patients (31), and the sudden increase in tensile strength (TS) within one and two weeks (32). Nevertheless, the results of the study by Tabatabai et al. (2009) showed decreased pain intensity and increased the range of motion in patients treated with heat. However, statistical tests did not show any significant difference between the two groups (2). The results of the studies by Elizabeth et al. and Chiu Feng et al. confirmed the effect of non-pharmacological treatments on reducing uremic pruritus symptoms, emphasizing non-pharmacological interventions could be useful for hemodialysis patients suffering from uremic pruritus as complementary therapies (33, 34).

Considering the role of FIR therapy on pruritus, the results of a study by Hesu et al. (2009) were consistent with the various dimensions of the questionnaire (20). In this study, emotions improved in the intervention group compared to the non-heated group. In addition, the dimensions of stress, quality of life, and sleep improved in the thermal therapy group more than in the non-thermal therapy group.

The results of a study by Shui et al. (2015) showed that FIR waves could be used as complementary and alternative therapies for the diagnosis and treatment of chronic diseases (20).

It is worth noting that factors other than intervention, related to the researcher, could affect the intervention (for example, excessive noise may interact with patient's peace causing the patient to leave his/her place) as a limitation of this study. Based on the results of this study, further studies are required in future to compare the effects of thermal therapy and other methods. Regarding the results of this study, patients with uremic pruritus undergo-

Table 2. The Mean Scores ± SD of the Severity of Pruritus in Case and Control Groups Before the Intervention, One Month After the Intervention Onset, and Two Months After the Intervention Completion

Variable	Control (N = 20)			Intervention (N = 20)			P Value[a]
	Before Intervention	After One Mo	After Two Mo	Before Intervention	Before One Mo	After Two Mo	
The history of pruritus	10.6 ± 2.5	11.2 ± 2.35	10.8 ± 1.9	10.55 ± 2.1	9.3 ± 2.03	8.2 ± 2.2	0.0001
Taking anti-pruritus drugs	2.15 ± 0.48	2.15 ± 0.48	2.15 ± 0.48	2.25 ± 0.55	2.10 ± 0.44	2.10 ± 0.48	0.169
The effect of pruritus on sleep	2.1 ± 0.96	2.2 ± 1.01	1.6 ± 0.68	2.4 ± 0.88	1.7 ± 0.71	1.6 ± 0.68	0.0001
The effect of pruritus on daily activities	0.25 ± 0.68	0.90 ± 1.16	0.80 ± 1.64	0.50 ± 0.88	0.50 ± 1.05	0.0001 ± 0.00	0.015
The effect of pruritus on quality of life	0.45 ± 0.60	0.90 ± 0.87	0.80 ± 1.64	0.70 ± 0.80	0.25 ± 0.44	0.0001 ± 0.00	0.0001
Describing sensational and emotional dimensions	3.9 ± 2.06	4.4 ± 2.13	4.6 ± 1.8	4.6 ± 1.56	2.6 ± 1.26	2.4 ± 1.14	0.0001
The severity of current pruritus	4.8 ± 1.36	5.1 ± 1.36	5.5 ± 1.39	5.15 ± 1.53	3.2 ± 1.00	2.2 ± 1.11	0.0001
The severity of pruritus in the worst case possible	7.3 ± 1.38	7.3 ± 1.34	7.6 ± 1.27	7.7 ± 1.33	6.6 ± 1.38	5.59 ± 1.27	0.0001
The least level of pruritus	3.25 ± 0.55	3.35 ± 0.81	3.2 ± 0.76	3.35 ± 0.58	2.8 ± 1.00	1.4 ± 1.27	0.0001

[a] Statistical test used (ANOVA), repeated measures ANOVA with F statistics.

ing hemodialysis had a better feeling toward the treatment and this treatment can be used to treat pruritus at home.

4.1. Conclusion

Considering the results of this study, it can be stated that the use of FIR therapy, along with the usual treatments for patients, can relieve pruritus. Therefore, by providing appropriate facilities and educational programs on how to perform thermal therapy, nurses should be prepared to apply this complementary therapy beside other medical interventions to improve the patients' conditions.

Acknowledgments

The cooperation of the study hospital (Shahid Sadoughi) in the city of Yazd in the accomplishment of the current research is appreciated.

Footnote

Funding/Support: This manuscript is part of a thesis for the master's degree in critical care nursing at Shahed University. This study was funded by the research deputy of the University.

References

1. Kilic Akca N, Tasci S. Acupressure and Transcutaneous Electrical Acupoint Stimulation for Improving Uremic Pruritus: A Randomized, Controlled Trial. *Altern Ther Health Med*. 2016;**22**(3):18–24. [PubMed: 27228268].
2. Zyoud SH, Daraghmeh DN, Mezyed DO, Khdeir RL, Sawafta MN, Ayaseh NA, et al. Factors affecting quality of life in patients on haemodialysis: a cross-sectional study from Palestine. *BMC Nephrol*. 2016;**17**(1):44. doi: 10.1186/s12882-016-0257-z. [PubMed: 27117687]. [PubMed Central: PMC4847206].
3. Attia EA, Hassan AA. Uremic pruritus pathogenesis, revisited. *Arab J Nephrol Transplant*. 2014;**7**(2):91–6. [PubMed: 25366503].
4. Huang CY, Yang RS, Kuo TS, Hsu KH. Phantom limb pain treated by far infrared ray. *Conf Proc IEEE Eng Med Biol Soc*. 2009;**2009**:1589–91. doi: 10.1109/IEMBS.2009.5334124. [PubMed: 19964539].
5. Zachariae R, Lei U, Haedersdal M, Zachariae C. Itch severity and quality of life in patients with pruritus: preliminary validity of a Danish adaptation of the itch severity scale. *Acta Derm Venereol*. 2012;**92**(5):508–14. doi: 10.2340/00015555-1221. [PubMed: 22002738].
6. Brunicardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE. *Schwartz's Principles of Surgery*. 2005.
7. Kim KH, Lee MS, Kim TH, Kang JW, Choi TY, Lee JD. Acupuncture and related interventions for symptoms of chronic kidney disease. *Cochrane Database Syst Rev*. 2016;(6). CD009440. doi: 10.1002/14651858.CD009440.pub2. [PubMed: 27349639].
8. Cameron ID, Murray GR, Gillespie LD, Robertson MC, Hill KD, Cumming RG, et al. Interventions for preventing falls in older people in nursing care facilities and hospitals. *Cochrane Database Syst Rev*. 2010;(1). CD005465. doi: 10.1002/14651858.CD005465.pub2. [PubMed: 20091578].
9. Lin CH, Lee LS, Su LH, Huang TC, Liu CF. Thermal therapy in dialysis patients - a randomized trial. *Am J Chin Med*. 2011;**39**(5):839–51. doi: 10.1142/S0192415X1100924X. [PubMed: 21905276].

10. Wong CH, Lin LC, Lee HH, Liu CF. The analgesic effect of thermal therapy after total knee arthroplasty. *J Altern Complement Med*. 2012;**18**(2):175–9. doi: 10.1089/acm.2010.0815. [PubMed: 22339105].
11. Schoonover KL. *Pain Free with Far Infrared Mineral Therapy: The Miracle Lamp*. iUniverse; 2003.
12. Masuda A, Kihara T, Fukudome T, Shinsato T, Minagoe S, Tei C. The effects of repeated thermal therapy for two patients with chronic fatigue syndrome. *J Psychosom Res*. 2005;**58**(4):383–7. doi: 10.1016/j.jpsychores.2004.11.005. [PubMed: 15992574].
13. Han SH, Hur MH, Buckle J, Choi J, Lee MS. Effect of aromatherapy on symptoms of dysmenorrhea in college students: A randomized placebo-controlled clinical trial. *J Altern Complement Med*. 2006;**12**(6):535–41. doi: 10.1089/acm.2006.12.535. [PubMed: 16884344].
14. Mettang T, Kremer AE. Uremic pruritus. *Kidney Int*. 2015;**87**(4):685–91. doi: 10.1038/ki.2013.454. [PubMed: 24402092].
15. Miyata M, Tei C. Waon therapy for cardiovascular disease: innovative therapy for the 21st century. *Circ J*. 2010;**74**(4):617–21. doi: 10.1253/circj.CJ-09-0939. [PubMed: 20154403].
16. Yu SY, Chiu JH, Yang SD, Hsu YC, Lui WY, Wu CW. Biological effect of far-infrared therapy on increasing skin microcirculation in rats. *Photodermatol Photoimmunol Photomed*. 2006;**22**(2):78–86. doi: 10.1111/j.1600-0781.2006.00208.x. [PubMed: 16606412].
17. Leung TK, Lee CM, Tsai SY, Chen YC, Chao JS. A Pilot Study of Ceramic Powder Far-Infrared Ray Irradiation (cFIR) on Physiology: Observation of Cell Cultures and Amphibian Skeletal Muscle. *Chin J Physiol*. 2011;**54**(4):247–54. doi: 10.4077/CJP.2011.AMM044. [PubMed: 22129823].
18. Masuda A, Koga Y, Hattanmaru M, Minagoe S, Tei C. The effects of repeated thermal therapy for patients with chronic pain. *Psychother Psychosom*. 2005;**74**(5):288–94. doi: 10.1159/000086319. [PubMed: 16088266].
19. Lin CC, Chang CF, Lai MY, Chen TW, Lee PC, Yang WC. Far-infrared therapy: a novel treatment to improve access blood flow and unassisted patency of arteriovenous fistula in hemodialysis patients. *J Am Soc Nephrol*. 2007;**18**(3):985–92. doi: 10.1681/ASN.2006050534. [PubMed: 17267744].
20. Shui S, Wang X, Chiang JY, Zheng L. Far-infrared therapy for cardiovascular, autoimmune, and other chronic health problems: A systematic review. *Exp Biol Med (Maywood)*. 2015;**240**(10):1257–65. doi: 10.1177/1535370215573391. [PubMed: 25716016]. [PubMed Central: PMC4935255].
21. Wang D, Zhang J, Jiang W, Cao Z, Zhao F, Cai T, et al. The role of NLRP3-CASP1 in inflammasome-mediated neuroinflammation and autophagy dysfunction in manganese-induced, hippocampal-dependent impairment of learning and memory ability. *Autophagy*. 2017;**13**(5):914–27. doi: 10.1080/15548627.2017.1293766. [PubMed: 28318352]. [PubMed Central: PMC5446056].
22. Zhang C, Cao Y, Zhu B, Yang J, Li X, Wang Y. Impacts of dermabrasion on deep partial-thickness burn wound's ecological organization. *Int J Clin Exp Med*. 2017;**10**(5):8585–92.
23. Yue J, Jiao S, Xiao Y, Ren W, Zhao T, Meng J. Comparison of pregabalin with ondansetron in treatment of uraemic pruritus in dialysis patients: a prospective, randomized, double-blind study. *Int Urol Nephrol*. 2015;**47**(1):161–7. doi: 10.1007/s11255-014-0795-x. [PubMed: 25099523].
24. Heckel M, Heckel I. [Studies on 479 cases of infrared hyperthermia treatments. Contribution to the method of whole body hyperthermia]. *Med Welt*. 1979;**30**(25):971–5. [PubMed: 459827].
25. Hu KH, Li WT. Clinical effects of far-infrared therapy in patients with allergic rhinitis. *Conf Proc IEEE Eng Med Biol Soc*. 2007;**2007**:1479–82. doi: 10.1109/IEMBS.2007.4352580. [PubMed: 18002246].
26. Sobajima M, Nozawa T, Shida T, Ohori T, Suzuki T, Matsuki A, et al. Repeated sauna therapy attenuates ventricular remodeling after myocardial infarction in rats by increasing coronary vascularity of noninfarcted myocardium. *Am J Physiol Heart Circ Physiol*. 2011;**301**(2):H548–54. doi: 10.1152/ajpheart.00103.2011. [PubMed: 21622828].
27. Tabatabaei H, TABATABAEI A, Moosavi J. Effect of sauna on pain of rheumatoid arthritis patients. *Phys Educ Sport Sci Q*. 2009;**2**(7).
28. Abbasi A, Shariati A, Asayesh H, Ebrahimi M. [Frequency of the uremic pruritis and its associated factors in hemodialysis patients in the Golestan Province dialysis centers in 2009]. *J Dermatol Cosmet*. 2011;**2**(3):150–7. Persian.
29. Yaghoobi M, Fathi M, Roshani D, Valiei S, Moradi M, Hasankhani H. [Comparison of the effect of infra-red and hot pack on reduction of pain associated with lumbar discopathy]. *J Kurdistan Univ Med Sci*. 2012;**17**(2):72–81. Persian.
30. Mohammadpoor A, Basrimoghaddam M, Nematollahi M. The effect of local thermal therapy on physiological indices in patients with acute coronary syndrome. *Iran J Crit Care Nurs*. 2014;**7**(2):74–83.
31. Yang CS, Yeh CH, Tung CL, Chen MY, Jiang CH, Yeh ML. Impact of far-infrared ray exposure on the mechanical properties of unwounded skin of rats. *Exp Biol Med (Maywood)*. 2010;**235**(8):952–6. doi: 10.1258/ebm.2010.009372. [PubMed: 20660095].
32. Simonsen E, Komenda P, Lerner B, Askin N, Bohm C, Shaw J, et al. Treatment of Uremic Pruritus: A Systematic Review. *Am J Kidney Dis*. 2017;**70**(5):638–55. doi: 10.1053/j.ajkd.2017.05.018. [PubMed: 28720208].
33. Wu CF, Hsiao YC, Ko PC. The effects of nonpharmacological treatment on uremic pruritus patients: A systematic review. *Adv Nurs*. 2015;**2015**:1–9. doi: 10.1155/2015/258263.
34. Hsu MC, Chen HW, Hwu YJ, Chanc CM, Liu CF. Effects of thermal therapy on uremic pruritus and biochemical parameters in patients having haemodialysis. *J Adv Nurs*. 2009;**65**(11):2397–408. doi: 10.1111/j.1365-2648.2009.05100.x. [PubMed: 19737321].