

The Impact of Passive Body Heating on Quality of Sleep: A Review Study

Hassan Talebi^{1*}, Mohammad Ali Heydari-Gorji¹, Zoya Hadinejad²

¹ Department of Medical Surgical Nursing, Nasibeh School of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran

² Department of Emergency Medical Service, Mazandaran University of Medical Sciences, Sari, Iran

Received: 26 Aug. 2016 Accepted: 14 Nov. 2016

Abstract

Background and Objective: Lack of sleep (insomnia) is a common problem involving society members and inpatients causing different physiological effects. Treatment includes a variety of several pharmacologic or other techniques. One of the non-pharmacologic methods is local heating of terminal organs (passive body heating). Manipulation of body temperature is a potential therapeutic intervention. The purpose of this study was to review the impact of passive body heating on the sleep quality.

Materials and Methods: After searching in available databases with proper keywords in both Persian and English language and with no time limits, 114 articles were collected. Of these, 31 were selected as the most relevant and were reviewed.

Results: Based on the previous researches, the warm footbath was selected for implementation of passive body heating which was the most common and safest method. In some studies, the warm footbath also improved mental sleep and polysomnography findings.

Conclusion: Although the impact of passive body heating on sleep has not been proved in all studies, it increases patient comfort and relaxation and the parasympathetic stimulation. Hence, this method can be used as a non-complicated nursing procedure in patients with insomnia.

© 2016 Tehran University of Medical Sciences. All rights reserved.

Keywords: Sleep; Passive body heating; Foot bath, Insomnia; Core body temperature

Citation: Talebi H, Heydari-Gorji MA, Hadinejad Z. **The Impact of Passive Body Heating on Quality of Sleep: A Review Study.** *J Sleep Sci* 2016; 1(4): 176-81.

Introduction

Sleeping is a dynamic necessary physiological state for human life (1). Sleep is an ordered and repetitive state that decreases the response threshold to external motives than wake state. It is necessary for human's physical, and survival ability of problem-solving and creativity (2).

Lack of sleep is a common problem in hospitalized patients, with many factors affecting the rhythm of sleep either internal among such as pain, distress, medicines, anxiety, stress, oldness, and external such as unfamiliar environment unit, environmental sounds, bright light, consecutive nursing healthcare, medicines (such as sedatives and inotropes) (3). Insomnia is divided into delay

in sleep onset, early awakening, disorder in maintaining sleep, and ineffective sleep along with performance disorders (4). Low quality of sleep causes different physiological effects including but not limited to performance changes of immune system, increase in pain sensitivity, decrease in critical capacity, decrease in volume of forced expiration, metabolic changes of endocrine glands, increase in secretion of norepinephrine and epinephrine, increase in sympathetic activity and decrease in parasympathetic activity followed by increase in heart beat and blood pressure, increase in heart work, intensification of cardiac ischemia and infarct (5, 6). There are different therapeutic methods for insomnia such as ground treatment, psychotherapy, and decrease in environmental upsetters and pharmacotherapy. Pharmacotherapy is a common method to treat insomnia in intensive care units (ICUs). Although the therapeutic methods have short-term outcomes

* **Corresponding author:** H. Talebi, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran
Tel: +989124585974, Fax: +981133369957
Email: h.tghems@yahoo.com

with serious complications, but nonmedical treatments have later effect with longer duration and less complications (7, 8). One of the nonmedical methods incurring the patients with insomnia is local heating of terminal organs; manipulating the body temperature can be a potential intervention in the management of insomnia (9). A study on the relationship between environmental temperature and central body temperature has shown that central body temperature will decrease by transferring heat to the skin of terminal organs through blood vessels at the onset of sleep (10). The peak of central body temperature occurs at about 16-20 in the afternoon and then it starts to decrease, and the body is ready to rest (11). The lower the central body temperature, the higher is the environmental temperature, namely, the more the difference between central and environmental temperature that is called gradient of proximal-distal temperature (DPG), the better sleep onset and quality happens (12).

The purpose of this study was to review the impact of passive body heating on the sleep quality.

Materials and Methods

A systemic search of the relevant literature was performed within international databases including PubMed, Medline, Scopus, Science Direct as well as Google Scholar using the following search terms: circadian rhythm, sleep, footbath, passive body heating, body temperature, insomnia. Scientific database of English papers between 2000 and 2016 was evaluated.

The equivalent of the keywords in Farsi was also searched in Persian electronic databases such as Iranian Journal Database (Magiran), Scientific Information Databases, and Iran Medex (Iranian Biomedical Journal Database). In addition, search of article references was done to ensure completeness of the search. The search was limited to the English and Persian languages.

The process of selecting paper was conducted based on the below protocol:

1. The study of thematic relative of founded topics with study objective
2. The study of abstract relation with study objective
3. The study of the complete context of article (in case of availability) and its relation with study objectives after conducting above steps; the qualified papers have been studied:

- The study of effect of local heat on temperature of terminal skin
- The study of effect of local heat on temperature of terminal skin on sleep quality.

Results

A research about the effect of local heat on the quality of sleep in people suffering insomnia dates back to four decades ago, among which Kiltman (1950) showed:

- There is a relationship between core body temperature (CBT) and circadian rhythm (13).
- A study on the relationship between terminal temperature of toes and insomnia by Brown (1979) recognized that people with insomnia typically try to increase terminal temperature of toes (10, 14).
- Melatonin is the regulator of overnight rhythm of the body. When the level of melatonin reaches its peak, the central temperature falls in its lowest level at 4-7 A.M., and when the melatonin reaches its lowest level, the central temperature goes up to its highest level at 19-20 P.M. (10, 14). The lowest temperature of body is in wake-up time and during the day it gradually increases with activity till early night, and at night it reduces at the same time with melatonin secretion (15).
- Gradisar and Lack (16) in a research showed that there is a close relationship between central temperature peak and toes' temperature peak with sleep and wakefulness.
- A study determined that the center of controlling sleep and regulating body temperature is located in an area in anterior hypothalamus of the brain (preoptic anterior hypothalamus) (17). Another study found that central body temperature (proximal) by the onset of sleep will decrease by transferring heat through widening blood vessels to the skin of foot and hand (distal) and will increase the temperature of skin of terminal organs such as hand and foot. The more heat transfers namely (DPG), the better and easier is the sleep onset (18).

Now, the question is whether passive and artificial heating of the skin of terminal organs improves the sleep quality of the people with insomnia?

Freedman and Sattler in the study of physiological and psychological factors in sleep onset found that there is a significant difference between the temperature of terminal skin of people with insomnia compared to that in healthy people (9, 19).

A research by Holmes et al. (20) showed that keeping people awake causes the change in central temperature while they found no changes in the foot temperature. Other research showed that people with vasospastic disorder has insomnia more frequently (21).

- Sawatari et al. (2013) found that improvement in sleep quality in patients with congestive heart failure could be obtained by local foot heating through ultra-red heating system which causes foot vasodilation and decrease in sympathetic activity (22). Yamamoto et al. (23) showed that foot hot bath causes relaxation, convenience, and sympathetic stimulation and decrease in sympathetic stimulation in the patient with stomach cancer.

Using foot hot bath through ultra-red heating in the patients with heart failure, Inoue et al. (24) showed that heating causes vasodilation and improvement in foot blood flow without any side effects.

In a research, it was showed that foot hot bath in 40 and 45 °C has no effect on women's heart beat and blood pressure but increases the convenience and patient skin temperature, with greater convenience and increase in temperature in the group of 45 °C (25). Toki et al. (26) compared the effect of foot hot bath in patients with stroke to healthy people. They found that foot hot bath had no effect on healthy people skin temperature but caused the change in blood pressure and heart rate and the sense of convenience in both groups. Koike et al. (27) studied the effect of foot hot bath by mineral water in the elderlies, the results showed that it had no effect on patient's sleep but decreased blood pressure.

In a research by Silva et al. (28) foot hot bath caused decrease in time of sleep onset, rapid eye movement and slow-wave sleep in patients with fibromyalgia.

- Dorsey et al. (29) showed that foot hot bath improves sleep quality in older women. After local heating of distal skin in eight persons, Raymann et al. (30) observed some improvement in sleep onset. Seyyedrasooli et al. (31) studied the effect of foot hot bath on elderlies and found that foot hot bath improved people sleep quality and duration. Another study done by Liao et al. (18) on elderlies with and without insomnia also showed that foot hot bath of 40° C had no effect on sleep quality and quantity but it increases DPG. They also stated that foot hot bath of 42 °C during 30 minutes increases the peripheral blood

flow without increase in central temperature in young women, whereas, 40-41 °C in older people increases the central temperature without any effect on sleep quality. Raymann et al. (30) and Sung and Tochiara (32) stated that foot hot bath in 42 °C improves sleep onset without increasing central temperature in young people. A study conducted in 2012 by Sheeba (33) showed a warm footbath can improve sleep onset in patients with cancer. In another study Namba et al. (34) found foot hot bath had no effect on 6 inpatients in ICU.

Summary of the basic features of the research articles that were included in the review is mentioned in table 1.

Discussion

There are different methods to treat insomnia among them are therapy with medicine, psychotherapy, traditional medicine, and therapy without medicine. In reviewing the literature, increasing the temperature of skin of terminal organs (distal) without increase in central temperature is suggested as one of the therapeutic methods. The justification for this is that as more difference of temperature exists, the better quality of sleep will be.

The published methods to increase temperature of terminal skin (passive body heating) include infrared heating system, warmer device, and foot hot bath. It has been shown in some of researches that persistent temperature or high temperature increases the central temperature which might make sleep disturbed. In passive body heating, no side effects have been reported in patients or healthy volunteers. Among the methods of passive body heating, foot hot bath is the most common one, which is simple, inexpensive and without major side effects. Several literatures have shown that this method causes an increase of DPG, convenience and relaxation, reduction in sympathetic activity, vasodilation, reduction in blood pressure, decrease in heartbeat and anxiety in patients, all of them are necessary for a comfortable sleep.

Conclusion

According to the present review study, the effects of passive body heating have not been definitely proved on sleep. This contradiction might be related to research settings, type of patients, methods, and other intervening factors. However, the foot hot bath can be used as a procedure with uncomplicated nursing in patients with insomnia,

Table 1. Summary of the basic features of the research articles that were included in the review

Author	Methods	Results
Liao et al. (11)	Clinical trial was conducted on 15 old-age patients under foot hot bath in 41 °C for 3 nights for 20 minutes. Sleep quality was measured by polysomnography.	A nonsignificant difference was observed in sleep quality but consciousness was decreased in the second stage of NREM and increased the extent of DPG
Liao et al. (18)	Crossover clinical trial was conducted on 43 volunteers with and without sleep disorder, under foot hot bath for 20 minutes in 40 °C. The quality of sleep was evaluated by polysomnography.	Foot hot bath increased DPG. No significant changes were observed in polysomnography
Sawatari et al. (22)	Clinical trial was conducted on 17 patients of CHF through ultrared in 40 °C three successive nights for 15 minutes. Sleep quality was measured by polysomnography.	A significant effect on depth and quality of sleep
Koike et al. (27)	Clinical trial was conducted on 13 patients with cognitive disorder under foot hot bath with mineral water in 42 °C for 20 minutes for 2 weeks (5 days of 7 days). Sleep quality was measured by actigraphy method.	No significant effect on total sleep time
Silva et al. (28)	Crossover clinical trial was conducted on 6 women with fibromyalgia under foot hot bath of 36 °C for 3 weeks every night for 30 minutes. Sleep quality was measured by polysomnography.	Significant effects on delay of sleep onset, SWS and REM but had no significant effects on sleep time
Seyyedrasooli et al. (31)	Crossover clinical trial was conducted on 46 old-age men, foot hot bath in 41-42 °C was provided for 20 minutes every night for 2 weeks. Sleep quality was evaluated by Pittsburgh questionnaire.	A significant impact on length and total quality of total sleep in control group
Sung and Tochiara (32)	Crossover clinical trial was conducted on 9 volunteer women under foot hot bath of one group in 40 °C for 20 minutes and the other group in 42 °C for 30-minutes sleep. Sleep quality was measured by polysomnography.	A significant reduction in sleep onset in steps of REM especially in the group of 42 degrees compared to the control group
Dorsey et al. (29)	Crossover clinical trial was conducted on 40 women with sleep disorder, two consecutive nights under foot hot bath in 30 minutes of 40-40.5 °C. Sleep quality was measured by polysomnography.	Improved sleep quality and increased SWS in initial stages of sleep
Sheeba (33)	Clinical trial was conducted on 40 patients with cancer. Underfoot hot bath for 20 minutes, delay of sleep onset was measured by checklist and observation.	A significant effect on sleep onset of patients in group of foot hot bath
Namba et al. (34)	Crossover clinical trial was conducted on 6 inpatients in ICU, under foot hot bath for 10 minutes in 40 °C for two nights and sleep quality was measured via polysomnography.	No significant effect on PSG but patients reported better sleep
van den Heuvel et al. (35)	Crossover clinical trial was conducted on 8 people with sleep disorder, under foot hot bath in 45 °C for 30 minutes.	No significant difference on sleep quality, but increased skin temperature
Yang et al. (36)	Clinical trial was conducted on 43 patients who were divided into two groups and control group under foot hot bath in 41-42 °C for 20 minutes.	Patients argued that it decreased fatigue and had significant effect on sleep quality

ICU: Intensive care unit, SWS: Slow-wave sleep, REM: Rapid-eye movement, CHF: Congestive heart failure, DPG: Distal proximal gradient; NREM: Non rapid-eye movement

since it will increase the sense of comfort, decrease anxiety, and increase skin temperature in most studies, with the temperature of water at a range of 40-42 °C. In this method, care should be given to avoid high temperature of water to not increase the central temperature.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

This article is a part of the thesis for MSA in

Critical Care Nursing. We would like to thank all the patients who assisted us in this research project. This study was financially supported by Mazandaran University of Medical Sciences, Iran. It was also financially supported by Mazandaran University of Medical Sciences.

References

- Schiza SE, Simantirakis E, Bouloukaki I, et al. Sleep patterns in patients with acute coronary syndromes. *Sleep Med* 2010; 11: 149-53.
- Neiseh F, Daneshmandi M, Sadeghi Shermeh

M, et al. The effects of ear and eye protect device application on quality of sleep of CCU patients with acute coronary syndrome (hospital military). *J Mil Med* 2011; 2: 67-80. [In Persian].

3. Kamdar BB, Needham DM, Collop NA. Sleep deprivation in critical illness: Its role in physical and psychological recovery. *J Intensive Care Med* 2012; 27: 97-111.

4. Smith MT, Huang MI, Manber R. Cognitive behavior therapy for chronic insomnia occurring within the context of medical and psychiatric disorders. *Clin Psychol Rev* 2005; 25: 559-92.

5. Fontana CJ, Pittiglio LI. Sleep deprivation among critical care patients. *Crit Care Nurs Q* 2010; 33: 75-81.

6. Baglioni C, Spiegelhalder K, Lombardo C, et al. Sleep and emotions: a focus on insomnia. *Sleep Med Rev* 2010; 14: 227-38.

7. Snyder L. Complementary and alternative medicine: Ethics, the patient, and the physician. Berlin, Germany: Springer Science & Business Media, 2007.

8. Richardson A, Allsop M, Coghil E, et al. Ear-plugs and eye masks: Do they improve critical care patients' sleep? *Nurs Crit Care* 2007; 12: 278-86.

9. Liao WC. Effects of passive body heating on body temperature and sleep regulation in the elderly: a systematic review. *Int J Nurs Stud* 2002; 39: 803-10.

10. Lack LC, Gradisar M, Van Someren EJ, et al. The relationship between insomnia and body temperatures. *Sleep Med Rev* 2008; 12: 307-17.

11. Liao WC, Chiu MJ, Landis CA. A warm footbath before bedtime and sleep in older Taiwanese with sleep disturbance. *Res Nurs Health* 2008; 31: 514-28.

12. Liao WC, Landis CA, Lentz MJ, et al. Effect of foot bathing on distal-proximal skin temperature gradient in elders. *Int J Nurs Stud* 2005; 42: 717-22.

13. Raymann RJ, Van Someren EJ. Time-on-task impairment of psychomotor vigilance is affected by mild skin warming and changes with aging and insomnia. *Sleep* 2007; 30: 96-103.

14. Chang AM, Reid KJ, Gourineni R, et al. Sleep timing and circadian phase in delayed sleep phase syndrome. *J Biol Rhythms* 2009; 24: 313-21.

15. Kakitsuba N, White MD. Effect of change in ambient temperature on core temperature during the daytime. *Int J Biometeorol* 2014; 58: 901-7.

16. Gradisar M, Lack L. Relationships between the circadian rhythms of finger temperature, core temperature, sleep latency, and subjective sleepiness. *J Biol Rhythms* 2004; 19: 157-63.

17. Krauchi K, de Boer T. Body temperature, sleep, and hibernation. In: Kryger MH, Rosenberg R, Peggam GV, Editors. *Kryger's sleep medicine review: a prob-*

lem-oriented approach, expert consult: Online and print. Philadelphia, PA: Elsevier Health Sciences, 2011. p. 323-34.

18. Liao WC, Wang L, Kuo CP, et al. Effect of a warm footbath before bedtime on body temperature and sleep in older adults with good and poor sleep: an experimental crossover trial. *Int J Nurs Stud* 2013; 50: 1607-16.

19. Freedman RR, Sattler HL. Physiological and psychological factors in sleep-onset insomnia. *J Abnorm Psychol* 1982; 91: 380-9.

20. Holmes AL, Burgess HJ, Dawson D. Effects of sleep pressure on endogenous cardiac autonomic activity and body temperature. *J Appl Physiol* (1985) 2002; 92: 2578-84.

21. Romeijn N, Raymann RJ, Most E, et al. Sleep, vigilance, and thermosensitivity. *Pflugers Arch* 2012; 463: 169-76.

22. Sawatari H, Miyazono M, Ando S, Nishizaka M, Hashiguchi N, Rahmawati A, et al. Leg thermal therapy improved sleep structure in patients with congestive heart disease. *JSMBE* 2013; 51: R235.

23. Yamamoto K, Aso Y, Nagata S, et al. Autonomic, neuro-immunological and psychological responses to wrapped warm footbaths—a pilot study. *Complement Ther Clin Pract* 2008; 14: 195-203.

24. Inoue S, Takemoto M, Chishaki A, et al. Leg heating using far infra-red radiation in patients with chronic heart failure acutely improves the hemodynamics, vascular endothelial function, and oxidative stress. *Intern Med* 2012; 51: 2263-70.

25. Nishimura M, Tatsuya Saito TS, Kato T, et al. Effects of Water Temperature during Foot Bath in Young Females. *Yonago Acta Med* 2013; 56: 79-80.

26. Toki K, Yamai T, Fukai K. Skin temperature changes during a footbath in patients who had had a stroke with consequent sensory impairment. *Jpn J Nurs Sci* 2015; 12: 276-86.

27. Koike Y, Kondo H, Kondo S, et al. Effect of a steam foot spa on geriatric inpatients with cognitive impairment: a pilot study. *Clin Interv Aging* 2013; 8: 543-8.

28. Silva A, Queiroz SS, Andersen ML, et al. Passive body heating improves sleep patterns in female patients with fibromyalgia. *Clinics (Sao Paulo)* 2013; 68: 135-40.

29. Dorsey CM, Teicher MH, Cohen-Zion M, et al. Core body temperature and sleep of older female insomniacs before and after passive body heating. *Sleep* 1999; 22: 891-8.

30. Raymann RJ, Swaab DF, Van Someren EJ. Cutaneous warming promotes sleep onset. *Am J Physiol Regul Integr Comp Physiol* 2005; 288: R1589-R1597.

31. Seyyedrasooli A, Valizadeh L, Zamanzadeh V, et al. The effect of footbath on sleep quality of the elderly: a blinded randomized clinical trial. *J Caring Sci* 2013; 2: 305-11.

32. Sung EJ, Tochihara Y. Effects of bathing and hot footbath on sleep in winter. *J Physiol Anthropol Appl Human Sci* 2000; 19: 21-7.

33. Sheeba C. The effect of footbath on sleep onset latency and relaxation among patients with cancer. *Int J Nurs Educ* 2012; 4: 188-92.

34. Namba S, Shimoyama I, Kiguchi T. *Chiba Med-*

ical Journal Open Access Paper: Effects of foot baths on sleep in ICU patients. Chiba Med J 2012; 88: 59-64.

35. van den Heuvel C, Ferguson S, Dawson D. Attenuated thermoregulatory response to mild thermal challenge in subjects with sleep-onset insomnia. *Sleep* 2006; 29: 1174-80.

36. Yang HL, Chen XP, Lee KC, et al. The effects of warm-water footbath on relieving fatigue and insomnia of the gynecologic cancer patients on chemotherapy. *Cancer Nurs* 2010; 33: 454-60.