ORIGINAL PAPER

The Effect of Thermal Exposure to Carbon Fiber Filament in the Thermoreceptor Area on the Physiological Response of Hypothermic Baby Rabbits

Wincoko Wincoko[1], Yuyun Yueniwati[2], Setyawan Purnomo Sakti[3], Retty Ratnawati[4]

[1]Student of Doctoral Program in Medical Science, Faculty of Medicine, Universitas Brawijaya, Indonesia

[2]Lecture of Radiology Department, Faculty of Medicine, Universitas Brawijaya Indonesia

[3]Lecture of Physics Department, Universitas Brawijaya, Indonesia

[3]Lecture of Doctoral Program in Medical Science, Faculty of Medicine, Universitas Brawijaya, Indonesia

Corresponding author: Wincoko, Ir. S.T., M.M.,M.Kom, Doctoral Program in Medical Science, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia, address: Jl. Candi Panggung Barat No. 48 Malang Phone, +6281334359019 E-mail: wincokojurnal@gmail.com. ORCID ID: http//www.orcid.org/0000-0000-0000-0000.

doi: 10.5455/aim.2023.31.92-95

ACTA INFORM MED. 2023 JUN 31(2): 92-95

Received: MAY 15, 2023

Accepted: JUN 25, 2023

ABSTRACT

Background: The body has a thermoregulation setting where when it gets hot, the body responds by dilating blood vessels or vasodilation, otherwise it gets a cold response, which causes narrowing of blood vessels or vasoconstriction. The thermal conditioning system is a system that can influence the baby in terms of its thermal quality. So that the baby can feel a comfortable environment or not. Skin temperature is a fundamental factor in heat exchange between the body and its environment. **Objective:** The purpose of this study was to analyze the effect of thermal exposure to carbon fiber filaments in the thermoreceptor area on the physiological response of hypothermic baby rabbits to changes in body temperature, to analyze the time needed for physiological adaptation of the body's skin to occur and to analyze the response of the thermoreceptor area on the head, neck, chest, arms, wrists, soles of the feet, to changes in each local area of the body. **Methods:** The research method used is pure experimental or laboratory experimental, with a post-test only control group design approach that uses experimental animals as experimental objects. The treatment in this study was using baby rabbits. The Sampling of test animals was carried out using simple random sampling. Statistical analysis was performed using IBM SPSS Statistics version 20. The confidence level was set at 95% by one way ANOVA test. **Results:** The results showed that the response of the thermoreceptor area to thermal exposure on the neck was the highest with an average of 39.77'. **Conclusion**: Based on the results of the analysis, it was concluded that there was an effect of thermal exposure to carbon fiber filaments in the thermoreceptor area on the physiological response of hypothermic baby rabbit models to changes in body temperature.

Keywords: Thermal Exposure, carbon Fiber Filament, Thermoreceptor, Hypothermic, Baby Rabbits.

1. BACKGROUND

Indonesia has a high neonatal mortality rate (NMR), estimated to be 15 per 1,000 live births in 2017 (1). Kangaroo mother care has been shown to reduce morbidity and mortality in low birthweight infants, including reducing the risk of hypothermia (2). Hypothermia has also been shown to be a risk factor for neonatal sepsis, intra-ventricular hemorrhage, and necrotizing enterocolitis.

Hypothermia in newborns is common worldwide with a prevalence ranging from 32 to 85 percent. Hypothermia is an involuntary decrease in body temperature to <350C (960F). low temperatures in the operating room, the spread of maternal heat from the center to the environment, and a decrease in the mother's central temperature. An important role in preventing hypothermia is to keep the baby's body temperature warm (3-5).

When the body is hot, the arteries will widen (Vasodilation) but when the body is cold, the arteries will narrow (vasoconstriction). With the Vasodilation process, blood will flow smoothly and quickly (6-8).

Vasodilation can be caused by various things, one of which is heat. Vasodilation is a series of stimuli) which are processed by the hypothalamus and

forwarded by the efferent nerves (connecting nerves) to become a response (vasodilation). Changes in the size of blood vessels are regulated by the vasomotor center under the influence of the anterior hypothalamus so that vasodilation occurs (9, 10). The background above that providing thermal exposure by conduction in the area of strong thermoreceptor density to get vasodilation for the comfort of the baby's body temperature. Thus the thermal energy generated does not require a large amount of power to warm the baby's body, which is a solution for incubators that require large electrical energy (9, 11, 12).

The use of heat or cold induction on parts of the body can affect changes in the body's physiology (13). The resulting output is the energy expended for the desired comfortable body temperature, which can be as small as possible but produces appropriate thermal comfort (14).

The state of the art of this research is what distinguishes it from previous research, namely that the object of this study used experimental animals of rabbits with the results of thermal exposure by conduction in 6 areas, namely the neck, arms, wrists, soles of the feet, head, and chest. Then an analysis of the relationship between the physiological response of the skin to changes in thermal exposure and the conduction process was carried out (15, 8, 16).

2. OBJECTIVE

The aim of the study was threefold: (1) Analyzing the Effect of Thermal Exposure of Carbon Fiber Filaments in the Thermoreceptor Area on the Physiological Response of Hypothermic Baby Rabbits to changes in body temperature. (2) Analyze the time needed for physiological adaptation of the body's skin to occur and (3) analyze the response of the thermoreceptor areas on the head, neck, chest, arms, wrists, and soles of the feet, to changes in each local area of the body.(2)

3. MATERIAL AND METHODS

Material and Methods

The research design used was purely experimental or laboratory experimental, with a post-test only control group design approach that used experimental animals as experimental objects (17). The treatment in this study was using baby rabbits. The sampling of test animals was carried out using simple random sampling. The treatment grouping is as follows:

K = control group, namely baby rabbits that were not given any treatment;

P1 = treatment group 1, namely baby rabbits that were given thermal exposure to the head;

P2 = treatment group 2, namely baby rabbits that were given thermal exposure to the neck;

P3 = treatment group 3, namely baby rabbits that were given thermal exposure to the chest;

P4 = treatment group 4, namely baby rabbits that were given thermal exposure to the arm;

P5 = treatment group 5, namely baby rabbits that were given thermal exposure to the wrist;

P6 = treatment group 6, namely baby rabbits that were given thermal exposure to the soles of their feet after checking the temperature changes, the experimental animals will be put in the battery cage.

Research population

The population consisted of newborn New Zealand rabbits weighing approximately 60 grams. The reason for choosing baby rabbits as a research sample is because some of their characteristics almost have physiological similarities to humans (In addition, adjustments to the tools used in this study made it possible to carry out baby rabbits that met the inclusion and the exclusion criteria. Sampling was done by simple random sampling to avoid bias due to variations in age and weight.

Research Sample

1. Criteria for inclusion of research subjects

Inclusion criteria are the general characteristics of research subjects from a population, a target, and reachable will be studied (17). In this study, namely:

a) New Zealand baby rabbit breed,

b) Gender male or female,

c) Body weight is approximately 60 grams,

d) Newborn age 0-5 days,

e) Rabbits are in good health, no visible anatomical abnormalities

2. Exclusion criteria for research subjects

Exclusion criteria are as follows:

a) Rabbit is sick,

b) There are visible anatomic abnormalities,

3) How to determine the sample.

Sampling was done by simple random sampling to avoid bias due to variations in age and weight. Randomization was carried out because there were inclusion and exclusion criteria so that it was considered quite homogeneous. The study used seven, namely one control group and six experimental groups, by comparing the results of observations in each control group and experimental group. Each group consists of four rabbits, so that the total number of rabbits 28 rabbits used in this study. All of them were taken randomly from a group of rabbits that had been adapted to feed for a week.

Determine the sample size

The size of the study sample was determined based on the federer formula: $(t-1)\ (n-1) \geq 15$

t = treatment group

n = number of samples per group

The number of samples in this study is:

$(t-1)\ (n-1) \geq 15$

$(7-1)\ (n-1) \geq 15$

$n \geq 2.5 + 1$

$n \geq 3.5$

Based on these calculations, the number of samples needed is rabbits for each experimental group. So the required sample size is 28 rabbits for 7 treatment groups.

Research variable.

The variables of this study are as follows: The independent variable is Thermal Exposure to Fiber Carbon Filament. The dependent variable is the Physiological Response of Baby Rabbits Body temperature of baby rabbits after thermal exposure

Tools and materials

Tools and Materials, namely: This study used 28 samples of rabbits with a new birth weight of approximately 60 grams. Experimental animals were conducted by giving thermal exposure to carbon fiber filament (18, 2).

No	Tools and materials	Function	Amount
1	Temperature Sensors	Detect temperature changes	1
2	Datalogger temperature	Knowing the change in temperature in seconds	1
3	Carbon Fiber Filaments	Thermal/heat generator	1
4	Thermal Camera (FLIR TG 267)	Notice changes in temperature visually	1
5	Animal testing using baby rabbits	Animals for trials	24
6	Laptops	Data processing (displaying data)	1
7	Software	Data processing (displaying data)	1

Descriptives

baby rabbit temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Head thermal exposure	4	39.7750	.25000	.12500	39.3772	40.1728	39.40	39.90
Neck thermal exposure	4	39.4500	.12910	.06455	39.2446	39.6554	39.30	39.60
Chest thermal exposure	4	39.0000	.21602	.10801	38.6563	39.3437	38.70	39.20
Sleeve thermal exposure	4	38.5500	.12910	.06455	38.3446	38.7554	38.40	38.70
Wrist thermal exposure	4	38.5250	.09574	.04787	38.3727	38.6773	38.40	38.60
Sole thermal exposure	4	38.3750	.09574	.04787	38.2227	38.5273	38.30	38.50
Total	24	38.9458	.54771	.11180	38.7146	39.1771	38.30	39.90

Test of Homogeneity of Variances

baby rabbit temperature

Levene Statistic	df1	df2	Sig.
1.150	5	18	.371

Table 1.

Method of collecting data and data analysis technique

The data collection method used is: observation. Observation techniques or direct observation are data collection activities by conducting direct research on the environmental conditions of the research object that support research activities, so that a clear picture of the condition of the research object is obtained. The data collection technique is by direct observation. the object studied in the thermal exposure test on the baby rabbit's body through carbon fiber filament.

ANOVA

Baby rabbit temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.417	5	1.283	47.879	.000
Within Groups	.483	18	.027		
Total	6.900	23			

Table 2.

4. RESULTS

This study used 28 baby rabbits with 6 treatment groups and 1 control group where each group consisted of 4 baby rabbits that met the inclusion and exclusion criteria.

Descriptive analysis data on temperature measurements in 6 treatments, namely head, neck, chest, arms, wrists, soles of feet as follows:

Hypothesis determination

Ho: there is no difference in average temperature in each group of hypothermic baby rabbits with thermal exposure to different parts of the thermoreceptor area

Ha: there is a difference in average temperature in each group of hypothermic baby rabbits with thermal exposure to different parts of the thermoreceptor area

In the ANOVA test, if Ha is found, it is accepted or the difference is significant, so a t-test must be carried out to find out which groups are different. Based on Table 3, the sig value (0.371) is greater than α (0.05), so that Ho is accepted and it is concluded that the variation between groups is the same or homogeneous. Based on the ANOVA test in Table 4, the sig value (0.0001) was smaller than α (0.05), so Ho was rejected and it can be concluded that there is a difference in the average temperature in each group of hypothermic baby rabbit models by giving thermal exposure to the different thermoreceptor areas

In this study, the thermal exposure group was divided into more than 2 groups, so it is necessary to know which group has a significant difference. This is known through the post hoc table. In the Bonforrenni post-hoc test results we will find groups that are significantly different, with a sig value <α (0.05). Or by paying attention to the sign (*).

Based on the table above, it was found that the average temperature in each group of hypothermic baby rabbit models by giving thermal exposure to the thermoreceptor area that differed significantly was the group between thermal_chest exposure – thermal_arm exposure, thermal_wrist exposure, thermal exposure of the soles of the feet

5. DISCUSSION

Before proceeding with the One way Anova test, one of the assumptions is that the variances are the same. From the Test of Homegeneity of Variances table it can be seen that the test results show that the variants of the 6 groups are the same

(P-value = 0.371), so that the P value > 0.05 and the One way Anova test are valid to test this relationship.

This analysis was conducted to find out in which group there was a significant difference. The results of the L test after treatment showed that there were no significant differences between the various groups in the measurement so that it could be said that environmental conditions affected the condition of the newborn baby rabbits. Heat dissipation due to continuous exposure to cold affected the body's ability to produce heat, resulting in hypothermia (19, 20).

In this study, the results showed that the average temperature in all groups tended to increase after being given thermal exposure to newborn rabbits with hypothermic conditions compared to the normal temperature of baby rabbits, namely 38-39,9'C.

6. CONCLUSION

Overall the results of this study are among others the findings are there are an Effect of Thermal Exposure to Carbon Fiber Filament in the Thermoreceptor Area to changes in body temperature, which can be described by changes in the baby rabbit's temperature during hypothermia and after being given thermal exposure,.

There is a difference in the time it takes for the physiological adaptation of the body's skin to occur, which is about 5 minutes and the response of the thermoreceptor areas on the head, neck, chest, arms, wrists, soles of the feet, to changes in each local area of the body with the highest point on the head followed by the neck.

- **Author's contribution:** All authors were involved in all steps of preparation this article. Final proofreading was made by the firrst author.
- **Conflicts of interest:** There are no conflict of interest.
- **Financial support and sponsorship:** None.

REFERENCES

1. Bredella MA. Sex Differences in Body Composition. In 2017. p. 9–27. Available from: http://link.springer.com/10.1007/978-3-319-70178-3_2
2. Cui Y, Gong H, Wang Y, Li D, Bai H. A Thermally Insulating Textile Inspired by Polar Bear Hair. Adv Mater [Internet]. 2018 Apr;30(14):1706807. Available from: https://onlinelibrary.wiley.com/doi/10.1002/adma.201706807
3. Alebachew Bayih W, Assefa N, Dheresa M, Minuye B, Demis S. Neonatal hypothermia and associated factors within six hours of delivery in eastern part of Ethiopia: a cross-sectional study. BMC Pediatr [Internet]. 2019;19(1):252. Available from: https://doi.org/10.1186/s12887-019-1632-2
4. Ali M, Abdelwahab M, Awadekreim SD, Abdalla S. Development of a Monitoring and Control System of Infant Incubator. 2018 Int Conf Comput Control Electr Electron Eng. 2018;1–4.
5. Tan CL, Knight ZA. Regulation of Body Temperature by the Nervous System. Neuron [Internet]. 2018 Apr;98(1):31–48. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0896627318301430
6. Abdo JM, Sopko NA, Milner SM. The applied anatomy of human skin: A model for regeneration. Wound Med [Internet]. 2020;28:100179. Available from: https://www.sciencedirect.com/science/article/pii/S2213909520300033
7. Bertile F, Habold C, Le Maho Y, Giroud S. Body Protein Sparing in Hibernators: A Source for Biomedical Innovation. Front Physiol [Internet]. 2021 Feb 18;12. Available from: https://www.frontiersin.org/articles/10.3389/fphys.2021.634953/full
8. Cao J, Spielmann M, Qiu X, Huang X, Ibrahim DM, Hill AJ, et al. The single-cell transcriptional landscape of mammalian organogenesis. Nature [Internet]. 2019 Feb 28;566(7745):496–502. Available from: https://www.nature.com/articles/s41586-019-0969-x
9. Bhatia P, Biyani G, Mohammed S. Hyperthermia and Heatstroke. 2020.
10. Zaitsu M, Yoshihara T, Nakai H, Kubota S. Optimal Thermal Control with Sufficient Nutrition May Reduce the Incidence of Neonatal Jaundice by Preventing Body-Weight Loss Among Non-Low Birth Weight Infants Not Admitted to Neonatal Intensive Care Unit. Neonatology [Internet]. 2018;114(4):348–54. Available from: https://www.karger.com/Article/FullText/491817
11. Demtse AG, Pfister RE, Nigussie AK, McClure EM, Ferede YG, Tazu Bonger Z, et al. Hypothermia in Preterm Newborns: Impact on Survival. Glob Pediatr Heal [Internet]. 2020 Jan 13;7:2333794X2095765. Available from: http://journals.sagepub.com/doi/10.1177/2333794X20957655
12. Visscher MO, Burkes SA, Adams DM, Hammill AM, Wickett RR. Infant skin maturation: Preliminary outcomes for color and biomechanical properties. Ski Res Technol [Internet]. 2017 Nov 24;23(4):545–51. Available from: https://onlinelibrary.wiley.com/doi/10.1111/febs.16015
13. Bambach MR. Direct Comparison of the Structural Compression Characteristics of Natural and Synthetic Fiber-Epoxy Composites: Flax, Jute, Hemp, Glass and Carbon Fibers. Fibers [Internet]. 2020;8(10). Available from: https://www.mdpi.com/2079-6439/8/10/62
14. de Aquino WKM, Lopes MV de O, da Silva VM, Fróes NBM, de Menezes AP, Almeida A de AP, et al. Accuracy of the Defining Characteristics of the Nursing Diagnosis Hypothermia in Newborns. Int J Nurs Knowl [Internet]. 2019 Jan;30(1):21–7. Available from: https://onlinelibrary.wiley.com/doi/10.1111/2047-3095.12188
15. Brown TM, Krishnamurthy K. Histology, Dermis [Internet]. StatPearls. Treasure Island (FL); 2023. Available from: http://www.ncbi.nlm.nih.gov/pubmed/0
16. Visscher MO, Burkes SA, Adams DM, Hammill AM, Wickett RR. Infant skin maturation: Preliminary outcomes for color and biomechanical properties. Ski Res Technol [Internet]. 2017 Nov;23(4):545–51. Available from: https://onlinelibrary.wiley.com/doi/10.1111/srt.12369
17. Sugiyono. Metode Penelitian Experimen. 2017.
18. Bhatt P, Goe A. Carbon Fibres: Production, Properties and Potential Use. Mater Sci Res India [Internet]. 2017 Jun 28;14(1):52–7. Available from: http://www.materialsciencejournal.org/vol14no1/carbon-fibres-production-properties-and-potential-use/
19. Cooke A, Bedwell C, Campbell M, McGowan L, Ersser SJ, Lavender T. Skin care for healthy babies at term: A systematic review of the evidence. Midwifery [Internet]. 2018 Jan;56:29–43. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0266613817303546
20. Collins L, Wood J, Faire A, Kakade G, Barrett S, Patel F, et al. 114 Hypothermia is preventable. Arch Dis Child [Internet]. 2021;106(Suppl 2):A48—A49. Available from: https://adc.bmj.com/content/106/Suppl_2/A48.3