Dzulfaijah, N. E., Mardiyono., Sarkum., et al. Belitung Nursing Journal. 2017 December;3(6):757-764
Received: 16 March 2017 | Accepted: 27 December 2017
http://belitungraya.org/BRP/index.php/bnj/

ORIGINAL RESEARCH **ISSN: 2477-4073**

COMBINATION OF COLD PACK, WATER SPRAY, AND FAN COOLING ON BODY TEMPERATURE REDUCTION AND LEVEL OF SUCCESS TO REACH NORMAL TEMPERATURE IN CRITICALLY ILL PATIENTS WITH HYPERTHERMIA

Nur Eka Dzulfaijah*, Mardiyono, Sarkum, Djenta Saha

Postgraduate Nursing Program, Semarang Health Polytechnic, Central Java, Indonesia

***Corresponding author:**
Nur Eka Dzulfaijah
Postgraduate Nursing Program, Semarang Health Polytechnic
Jl. Tirto Agung, Pedalangan, Banyumanik Kota Semarang, Jawa Tengah, Indonesia (50268)
Email: ekatamtam44@yahoo.com

Abstract
Objective: To examine the effect of the combination of cold pack, water spray, and fan cooling on body temperature reduction and level of success to reach normal temperature in critically ill patients with hyperthermia.
Methods: This was a randomized control trial (RCT) with pretest posttest control group design and repeated measurement, conducted on December 2016 – January 2017. There were 32 respondents selected using total sampling, with 16 respondents randomly assigned in the experiment and control group. A digital thermometer was used to measure hyperthermia. Paired t-test, Repeated ANOVA with post hoc, and Mann Whitney were used for data analysis.
Results: Findings showed that the mean of body temperature in the experiment group in pretest was 38.762ºC and decreased to 37.3ºC after given intervention for 60 minutes. The mean difference of body temperature was 1.4625, with p-value 0.000 (<0.05). In control group, the mean of body temperature in pretest was 38.669ºC and decreased to 38.188ºC given intervention for 60 minutes. The mean difference of body temperature was 0.4812, with p-value 0.000 (<0.05).
Conclusion: There was a significant effect of the combination of cold pack, water spray, and fan cooling on body temperature reduction and level of success to reach normal temperature in critically ill patients with hyperthermia. This combination is more effective than water compress alone.

Keywords: cold pack; water spray; fan cooling; hyperthermia

INTRODUCTION

Increased body temperature or fever is a frequent problem in the intensive care unit, with incidence ranging from 23% to 70% caused by infection or non-infection (Kothari & Karnad, 2005; Sari, Redjeki, & Rakhmawati, 2013). Hyperthermia is associated with local or systemic infection caused by bacteria, viruses or parasites; and with non-infection caused by environmental factors, autoimmune disease, malignancy, drug use and central nervous system disorders such as cerebral hemorrhage, epilepsy status, coma, and hypothalamic injury (Nield & Kamat, 2011).

Typhoid, sepsis, head injury, stroke are some types of diseases that have an increase in body temperature. WHO stated that the prevalence of typhoid was 16 million cases per year with 600 death cases, while Indonesia is the third from the ten most prevalent disease patterns of inpatients supported by the data of the Indonesian Ministry of Health in 2011. The incidence of head injury in Indonesia reaches 7.5% of the population (MOH, 2013). Head injuries are the leading cause of death and morbidity in the world under the age of 45 years, requiring proper handling of health personnel (Werner & Engelhard, 2007).

Editor's Note: This article has been updated on 6 July 2020 in terms of minor changes in the reference format. The update is according to BNJ Policy on article correction.

Increased body temperature in head injury generally occurs due to a set point disorder in the hypothalamus, which is caused by bacterial endotoxins stimulate PMN cells to produce endogenous pyrogens i.e. interleukin-1, interleukin 6 or TNF (tumor necrosis factor). Pyogen is a substance that can cause fever. Pyogen is composed of endogenous and exogenous. Exogenous pyrogens are pyrogens that come from outside the body, especially microbes and products such as toxins. Endotoxin is a potential substance that is not only a pyrogen but also as an inducer of varying pathological changes observed in gram-negative infections (Kothari & Karnad, 2005; Sari et al., 2013). However, temperature increase in head injury can cause higher intracranial pressure and a mortality rate of 78% (Diringer, Reaven, Funk, & Uman, 2004).

Hyperthermia can be associated with a number of damaging effects, especially increased cardiac output, oxygen consumption, carbon dioxide production, and an increase in basal metabolic rate (BMR). Increased oxygen consumption of about 10% per 0^C can cause death, so that some incidents of temperature increase must be handled properly to avoid negative impact, including excessive body fluid evaporation resulting in lack of fluids and seizures (Kothari & Karnad, 2005; Setiawati, 2009).

Severe hyperthermia (temperatures greater than 41°C) can also cause hypotension, multiple organ failure, coagulopathy, and irreversible brain damage. Heart rate and breathing will increase as well as the nutritional needs of the body. This metabolism uses energy that generates additional heat. Patients suffering from heart or respiratory problems, the fever becomes severe. Long-term fever will waste the patient's energy savings and become weak. Increased metabolism requires additional oxygen, if the body cannot meet the need for supplemental oxygen, then cell hypoxia may occur. Myocardial hypoxia can cause angina (chest pain) and cerebral hypoxia to cause anxiety (Susanti, 2012).

Increased temperature is one of the disturbances that patients often experience so that the nurse is responsible for identifying patients who have increased body temperature, planning nursing care as well as implementing and evaluating it. In critical nursing manner, provision of cooling method is very important due to the magnitude of the effect of increased body temperature on the chances of cure and increased risk of death of the patient. Management of hyperthermia with pharmacological method is by giving antipyretic such as paracetamol, acetaminophen, and others; and non-pharmacology is by external cooling. Compress is one of external cooling or physical methods of cooling. The types of compresses include warm compresses, cold compresses, alcohol compresses, wet blankets, cold packs, water spray to the body area and fan cooling (Purwanti & Nur Ambarwati, 2008).

Previous study on the effects of wet blanket compress and cold-packs on body temperature in head injury patients, indicated that the usual wet blanket compress method has the same effect on the decrease in body temperature of head injury patients with cold-pack compress, which the results obtained effect size value -1 as a weak category (Pratiwi, Ropi, & Sitorus, 2015). Thus, an instant cold-pack made from ammonium nitrate gel was developed and used to lower body temperature. In addition to cold pack, water spray and fan cooling are used as a medium of temperature (Sari et al., 2013). This study aimed to use the combination of cold pack, water spray and fan cooling that has never been done in previous studies.

However, cold packs and wet blankets and ordinary compresses have an external cooling method so that most conduction will affect the periphery compared to core temperature (Scrase & Tranter, 2011). In addition, physical cooling therapy implements the concept of radiant body heat transfer to the environment by radiation, evaporation, conduction and convection. The combination of physical cooling and antipyretics is the most frequently studied and most widely applied topic for reducing fever in critically ill patients (Price & McGloin, 2003).

The success of temperature to normal is what every research wants to achieve, such as in previous study that provided warm compress intervention which the normal temperature occurred within 15 minutes and 20 minutes while in the onion intervention group within 10 minutes. While another study obtained the temperature decrease in 20 minutes but not yet reached the success of temperature become normal, similar with another study that the success of temperature decrease occurred significantly in 60 minutes but not yet achieved the success of temperature become normal (Cahyaningrum & Julianti, 2015; Pratiwi et al., 2015).

Result of effect size calculation in previous research indicated that the effect size of water spray was in medium category (0.625), fan cooling with warm water increased to 0.8 (1.9%), and cold water increased to 0.5 (1.1%). Another research showed weak effect size (0.42), with improvement on wet blanket compress to 0.16 (0,3%), and cold pack to 0.19 (0.4%) (Pratiwi et al., 2015; Sari et al., 2013). So, to increase the effect size of cold pack, its combination with water spray and fan cooling is needed.

METHODS

Study design

This was a randomized control trial (RCT) with pretest posttest control group design and repeated measurement.

Setting

This study was conducted on December 2016 – January 2017 in the Hospital of West Nusa Tenggara Province, the General Hospital of Mataram, the Hospital of Patuh Patut Patju Gerung, and the General Hospital of Praya.

Sample

The number of populations in this study was 32 people, and the sample of respondents was 32 using total sampling, with 16 respondents randomly assigned in the experiment and control group. The inclusion criteria of the sample were patients with hyperthermia in inpatient ward, having antipyretic, and body temperature ≥38.3ºC.

Intervention

The experiment group was given a cold pack in the axillary, a water spray sprayed on the stomach every 10 minutes and repeated 6 times for 60 minutes, and fan cooling exposure for 1 implemented by researchers. While control group was given a plain water compress with temperature ranging from 26^0C -28^0C.

Instrument

A digital thermometer placed in the axilla area every 10 minutes of intervention and performed for 60 minutes. Normal body temperature if ranging from 36.5ºC -37.5ºC, hyperthermia if >37.5ºC, and hypothermia if <36.º5.

Ethical consideration

Ethical approval was obtained from the General Hospital of West Nusa Tenggara with No. 070.1/07/KEP/2016. Study permission was also obtained from each hospital in this study prior to data collection. An appropriate informed consent was done by the researchers.

Data analysis

Shapiro-Wilk test was used for testing normality of data distribution, and the results showed that data were in normal distribution. Paired t-test, Repeated ANOVA with post hoc, and Mann Whitney were used for data analysis.

RESULTS

Table 1 shows that the mean age of respondents in the experiment group was 41.50 years old and the control group was 40.94 with p-value 0.430 (>0.05), which indicated that there was no difference characteristic of respondent based on age between the two groups. The majority of respondents in both groups was female with p-value 0.154 (>0.05), and had medical diagnoses of post craniotomy (18.75%), post laparotomy (12.5%), sepsis (18.75%), DHF (25%), and SNH (25%), with p-value 1.000 (>0.05). In conclusion, there was no significant differences of the characteristics of the respondents in the experiment and control group.

Table 1 Frequency distribution of the characteristics of respondents based on age, gender, and medical diagnosis (n = 32)

Variable	Experiment group		Control group		P-value
	N	%	N	%	
Age (year)	**Mean ± SD** (41.50±17.478)		**Mean ± SD** (40.94±12.923)		
< 25	3	18.75%	5	31.25%	0.430
25-50	6	37.50%	4	25.00%	
>50	7	43.75%	7	43.75%	
Total	16	100%	16	100%	
Gender					0.154
Female	10	62.5%	12	75%	
Male	6	37.5%	4	25%	
Total	16	100%	16	100%	
Medical diagnosis					
Post craniotomy	3	18.75%	3	18.75%	1.000
Post laparotomy	2	12.5%	2	12.5%	
Sepsis	3	18.75%	3	18.75%	
DHF	4	25%	4	25%	
SNH	4	25%	4	25%	
Total	16	100	16	100	

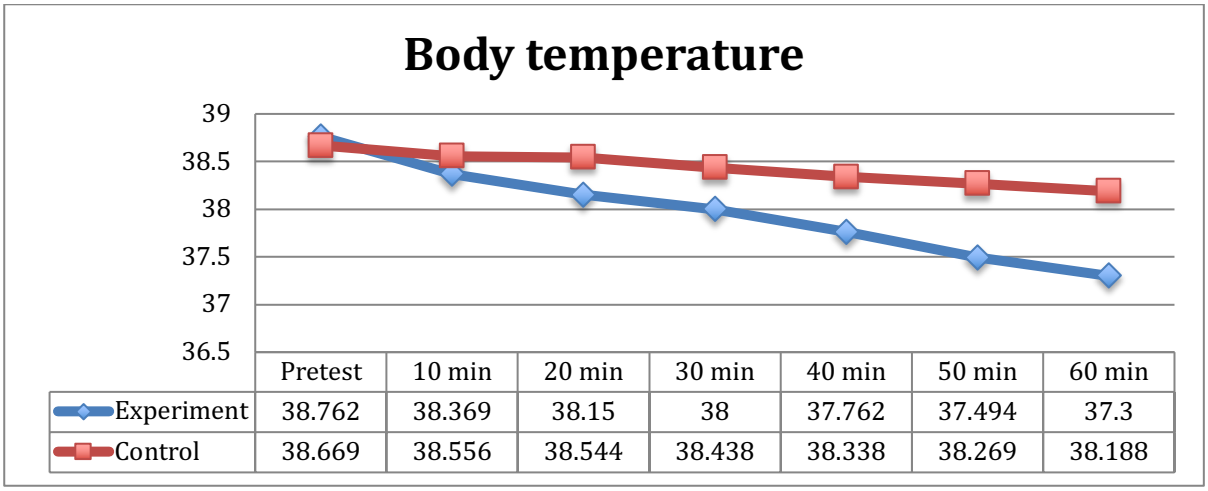

Figure 1 Description of the decrease of body temperature in the experiment and control group

Figure 1 shows that there was a decrease of body temperature in the experiment and control group from pretest and 60 minutes intervention. However, the experiment group showed the higher decrease of body temperature (37.3ºC) after 60 minutes intervention compared with body temperature (38.188ºC) in control group.

Table 2 Description of the level of success to reach normal temperature

Level of success to reach normal temperature	60 min Intervention			
	Successful		Unsuccessful	
	N	%	N	%
Experiment	15	93.75	1	6.25
Control	1	6.25	15	93.75

Table 2 shows that 15 respondents (93.75%) in the experiment group had a body temperature ranging from 36.5ºC to 37.5 ºC after given intervention for 60 minutes, while the control group only had 1 respondent (6.25) having normal body temperature while the other 15 respondents (93.75%) had body temperature >37^{0}C.

Table 3 Mean difference of body temperature in the experiment and control group using Paired t-test (n=32)

Group	Mean ±SD	Experiment			Mean ±SD	Control		
		Mean difference	SD	P-value		Mean difference	SD	P-value
Pretest – 60 min	38.762± 0.4603 37.300± 0.6218	1.4625	0.3612	0.000	38.669± 0.4045 38.188± 0.5807	0.4812	0.2562	0.000
Pretest – 10 min	38.762± 0.4603 38.369± 0.4701	0.3937	0.1289	0.000	38.669± 0.4045 38.556± 0.4366	0.1125	0.1500	0.009
10 min – 20 min	38.369± 0.4701 38.150± 0.5586	0.2188	0.1559	0.000	38.556± 0.4366 38.544± 0.4690	0.0125	0.1746	0.779
20 min – 30 min	38.150± 0.4701 38.000± 0.5621	0.1062	0.1506	0.001	38.554± 0.4690 38.438± 0.5188	0.1062	0.1237	0.004
30 min – 40 min	38.000± 0.5621 37.762± 0.5864	0.2375	0.1258	0.000	38.438± 0.5188 38.338± 0.5427	0.1000	0.0894	0.000
40 min - 50 min	37.762± 0.5864 37.494± 0.6180	0.2687	0.0873	0.000	38.338± 0.5427 38.269± 0.5486	0.0687	0.0687	0.011
50 min – 60 min	37.494± 0.6180 37.300± 0.6218	0.1938	0.2351	0.005	38.269± 0.5486 38.188± 0.5807	0.0813	0.1047	0.007

Table 3 shows that the mean of body temperature in the experiment group in pretest was 38.762ºC and decreased to 37.3ºC after 60 min intervention. The mean difference of body temperature was 1.4625, with p-value 0.000 (<0.05), which indicated that there was a statistically significant difference of body temperature in the experiment and control group. It also shows the significant difference of body temperature in every ten minutes of intervention (p=<0.05). In control group, the mean of body temperature in pretest was 38.669ºC and decreased to 38.188ºC after 60 min intervention. The mean difference of body temperature was 0.4812, with p-value 0.000 (<0.05), which indicated that there was a statistically significant difference of body temperature in the experiment and control group. However, this temperature was still far from normal body temperature.

Table 4 Mean difference of body temperature before and after given intervention using Pairwise comparison

Time	Group		P-value
Pretest	Experiment	Control	.545
	Control	Experiment	
10 min	Experiment	Control	.252
	Control	Experiment	
20 min	Experiment	Control	.039
	Control	Experiment	
30 min	Experiment	Control	.029
	Control	Experiment	
40 min	Experiment	Control	.007
	Control	Experiment	
50 min	Experiment	Control	.001
	Control	Experiment	
60 min	Experiment	Control	.000
	Control	Experiment	

Pairwise comparison test showed that the decrease of body temperature started from 10 minutes of intervention, and the difference of body temperature between experiment and control group started from 20 minutes of intervention.

Table 5 The level of success to reach normal body temperature before and after intervention in the experiment and control group

Variable	Group	N	Mean rank	Z	p
Level of success to reach normal body temperature	Experiment	16	21.03	-3.295	0.001
	Control	16	11.97		

Table 5 shows that the mean of level of success to reach normal body temperature in the experiment group was 21.03 and in the control group was 11.97, with p-value 0.001 (<0.05), which indicated that there was a significant difference of the level of success to reach normal body temperature between both groups.

DISCUSSION

Findings of this study revealed that there was a significant effect of the combination of cold pack, water spray, and fan cooling on body temperature reduction and level of success to reach normal temperature in critically ill patients with hyperthermia with p-value <0.05; there was a significant difference of the effect of the combination of cold pack, water spray, and fan cooling in the experiment group compared with plain water compress in the control group on body temperature reduction and level of success to reach normal temperature with p-value <0.05. This proved that the combination of the three interventions was effective in reducing body temperature and reaching normal body temperature.

This finding is supported by previous studies indicated that water spray is a method for temperature reduction using evaporation principle, while fan cooling is to produce wind to prevent the air saturation by water vapor, thus the evaporation process stops so that the air flow causes the turn of the saturated layer with the dry air, which then the evaporation process continues (Sari et al., 2013). This is also supported by another research explaining that the use of water spray and fan cooling with low speed supports the evaporation process. Using high speeds can cause heat transfer process not by evaporation, but by convection, so that the water in the body evaporates not because of body heat but because of the wind (McDermott et al., 2009).

While cold pack can be used for hot and cold compresses, which contains a safe ammonium nitrate gel that can be used repeatedly. This gel can also keep the temperature cool for long periods of time. The use of cold pack is expected to absorb body heat by using the concept of conduction. Cold pack with surrounding tissue including blood vessels can cause the blood temperature that flow around the compressing area decrease due to the conduction process. This is in line with the study stated that handling the increase in body temperature with acetaminophen and cold compress method are more effective than the drug alone or just compress (Henker, 1999).

Compress is one of the measures to reduce heat production and increase heat expenditure. Compressive therapy performed on the axillary and groin area is done due to the presence of large blood vessels that can provide stimulation to the hypothalamus to lower body temperature (Potter & Perry, 2005). Heat moves from the blood, through the blood vessel wall to the skin surface and then disappears into the environment through a heat loss mechanism. By placing a cold pack in the axillary area and the water spray in the abdominal area, it is expected that the venous blood vessels will change the size regulated by the anterior hypothalamus to control the heat release, resulting in vasodilation of the blood vessels and heat production constraints (Potter & Perry, 2005).

On the other hand, findings of this study revealed that the combination of cold pack,

water spray, and fan cooling had a faster effect in reducing body temperature compared with water compress alone.

According to literature, the body temperature is regulated by thermostat in hypothalamus. The mechanism of body temperature reduction is a complex homeostatic system facilitated by feedback mechanisms, which the nerve cells control thermoregulation and many other aspects of homeostasis, especially in the hypothalamus. The hypothalamus has a thermostat that responds to changes in body temperature above and below the tide point by activating mechanisms that increase heat loss or heat gain. Nerve cells sensing body temperature lie in the skin, hypothalamus and some other nervous systems, including hot receptors that signal the thermostat in the hypothalamus as skin temperature increases. In addition, it is a cold receptor that signals the thermostat when the body temperature falls. The thermostat will respond to body temperature below normal range and inhibit heat loss mechanism, and activate heat saving mechanism, such as heat-generating supervisorial vasoconstriction (Wong, 2009).

In addition, findings of this study obtained effect size of 1.9, which indicated that there was a significant influence on the combination of cold pack, water spray and fan cooling in patients with hyperthermia. This shows that the strength of this study is very strong to be implied at the decrease in temperature as well as level of success to normal temperature. The position of this research occupies the first sequence that is equal to 1.9 when compared with previous research which was only 0.62 after given water spray and fan cooling, and 0.08 after the cold pack. Thus, it can be concluded that the effect size value in this study is quite large compared to the effect size of previous research (Pratiwi et al., 2015; Sari et al., 2013). The combination of cold pack, water spray and fan cooling given for 1 hour with 6 times repetition of intervention strongly influence the decrease in body temperature of patients with hyperthermia.

CONCLUSION

In conclusion, there was a significant effect of the combination of cold pack, water spray, and fan cooling on body temperature reduction and level of success to reach normal temperature in critically ill patients with hyperthermia. This combination is more effective than plain water compress alone. Thus, this intervention is expected to be an input material in nursing care, and can contribute to the development of nursing theory in the management of hyperthermia by including cold pack, water spray and fan cooling interventions in the application of Nursing Interventions Classification (NIC).

Declaration of Conflicting Interest
None declared.

Funding
This study was supported by Postgraduate Nursing Program, Semarang Health Polytechnic, Central Java, Indonesia.

Author Contribution
All authors contributed equally in this study.

References

Cahyaningrum, E. D. C., & Julianti, H. P. J. (2015). Perbedaan kompres hangat dan kompres bawang merah terhadap penurunan suhu tubuh anak dengan demam [Difference in hot compress and onion compress in lowering temperature of children with fever]. *Jurnal Ilmu dan Teknologi Kesehatan, 5*(1).

Diringer, M. N., Reaven, N. L., Funk, S. E., & Uman, G. C. (2004). Elevated body temperature independently contributes to increased length of stay in neurologic intensive care unit patients. *Critical Care Medicine, 32*(7), 1489-1495.

Henker, R. (1999). Evidence-based practice: fever-related interventions. *American Journal of Critical Care, 8*(1), 481.

Kothari, V. M., & Karnad, D. R. (2005). New onset fever in the intensive care unit. *Journal of the Association of Physicians of India, 53*, 949-953.

McDermott, B. P., Casa, D. J., Ganio, M. S., Lopez, R. M., Yeargin, S. W., Armstrong, L. E., & Maresh, C. M. (2009). Acute whole-body cooling for exercise-induced hyperthermia: A systematic review. *Journal of Athletic Training, 44*(1), 84-93.

MOH. (2013). *Riset Kesehatan Dasar RISKESDAS [Basic Health Research]*. Jakarta: Ministry of Health of the Republic of Indonesia.

Nield, L. S., & Kamat, D. (2011). Fever without a focus. In R. M. Kliegman & W. E. Nelson (Eds.). *Nelson textbook of pediatrics* (pp 896-901). Philadelphia: Elsevier, Saunders.

Potter, P. A., & Perry, A. G. (2005). *Buku ajar fundamental keperawatan: Konsep, proses, dan praktik [Teaching book of fundamental of nursing: Concept, process, and practice]*. Jakarta: EGC.

Pratiwi, S. H., Ropi, H., & Sitorus, R. (2015). Perbedaan efek kompres selimut basah dan cold-pack terhadap suhu tubuh pasien cedera kepala di neurosurgical critical care unit [Difference in the effect of wet blanket compress and cold-pact on body temperature in patients with head injury in neurosurgical critical care unit]. *Jurnal Keperawatan Padjadjaran, 3*(3), 158-165.

Price, T., & McGloin, S. (2003). A review of cooling patients with severe cerebral insult in ICU (Part 1). *Nursing in Critical Care, 8*(1), 30-36.

Purwanti, S., & Nur Ambarwati, W. (2008). Pengaruh kompres hangat terhadap perubahan suhu tubuh pada pasien anak hipertermia di Ruang Rawat Inap RSUD Dr. Moewardi Surakarta [Effect of hot compress on body temperature change in children with hypetermia at inpatient ward of RSUD Dr. Moewardi Surakarta]. *Jurnal Berita Ilmu Keperawatan*, *1*(2), 81-86.

Sari, E. K., Redjeki, I. S., & Rakhmawati, W. (2013). Perbandingan pengaruh water spray dan fan cooling menggunakan air hangat dengan air suhu ruangan terhadap penurunan suhu tubuh [Comparison of effect of water spray and fan cooling using hot water and room temperature water on body temperature]. *Jurnal Ilmu Keperawatan, 1*(2), 150-156.

Scrase, W., & Tranter, S. (2011). Improving evidence-based care for patients with pyrexia. *Nursing Standard, 25*(29), 37-41.

Setiawati, T. (2009). *Effect of tepid sponge.* Jakarta: Universitas Indonesia.

Susanti, N. (2012). Efektifitas kompres dingin dan hangat pada penatalaksanaan demam [Effectiveness of cold and hot compress on fever management]. *Sainstis*, *1*(1), 55-64.

Werner, C., & Engelhard, K. (2007). Pathophysiology of traumatic brain injury. *British Journal of Anaesthesia, 99*(1), 4-9.

Wong, D. L. (2009). *Buku ajar keperawatan pediatrik [Teaching book of pediatric nursing]* (Vol 1). Jakarta: EGC.

Cite this article as: Dzulfaijah, N. E., Mardiyono., Sarkum., Saha, D. (2017). Combination of cold pack, water spray, and fan cooling on body temperature reduction and level of success to reach normal temperature in critically ill patients with hyperthermia. *Belitung Nursing Journal, 3*(6), 757-764. https://doi.org/10.33546/bnj.307