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Research Article

Effectiveness of handmade forced-air warming blanket on body core temperature among post-cardiac surgery patients

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Abstract

Rewarming is one of the major factors influencing survival of post-operative cardiac surgical patients and forced-air warming blanket has been regularly used in intensive care unit at Central Chest Institute of Thailand for this purpose. However, this standard blanket is quite costly and irreusable. Thus, the implement of reusable handmade blanket should solve these unsatisfactories. This research aimed to study the effectiveness of rewarming post-operative cardiac surgical patients using standard or handmade blankets in accompany with forced-air warming system on scheduled sixty adult hypothermia cardiac surgical patients. Samples were convenience sampling of 30 cases in each of standard or handmade blanket groups in intensive care unit, Central Chest Institute of Thailand. Within 3 hours after rewarming, results showed that core temperature in standard blanket elevated from 35.21 to 36.49 ^{o}C while handmade blanket rose from 35.12 to 36.58 ^{o}C. No statistical difference had been found in both groups at confidential level of 95%. Hence, it could be concluded that rewarming post-operative cardiac surgical patients via handmade blanket increased core temperature similar to standard blanket.

Keywords: forced-air warming, hypothermia, rewarming, warming blanket

Introduction

A decline in body temperature to below 36°C or hypothermia is one of the several potential reasons leading to severe post-operative complications for instance cardiac arrhythmias, respiratory failure, sepsis, dehiscence and fatality. Likewise, the number of patient mortality is exactly associated with the duration of post-operative hypothermia since it was found that the longer duration of post-operative hypothermia the higher patient mortality (Cruyne & Miner, 1988; Karalapillai et al., 2013). Thus, the rewarm process for post cardiac surgical patients could improve the survival of this people.

Increasing patient's body temperature can be done in various ways such as passive rewarming, active surface rewarming and active core rewarming. These methods are typically used to minimize the severity of postoperative hypothermia. As a result, patient outcomes are improved including patient comfort, length of hospital stay and cost of care (Connolly & Worthley, 2000; Pikus & Hooper, 2010).

Forced-air warming blanket is an active warming device which has fast warm-up time, high warming capacity and no risk of burns. However, the notably weak point of this effective method is the high expenditure of disposable blanket (Torossian, 2008). During past 15 years, forced-air warming blankets purchasing from private company were exclusively used to rewarm the post-operative cardiac patient in intensive care unit (ICU) at Central Chest Institute of Thailand (CCIT). Nevertheless, the main problem on using this active warming method was the fee and its non-reuse. So far, it costs about 1,000 baht per piece and if there are 800-900 patients each year, it would cost 800,000-900,000 baht per annum. Besides, procurement of this private company device by the institute was not in time and the budget obtaining for this purpose was also inadequate.

To solve this problem, handmade blanket (version III), using in this experiment, had been modified after the first and second versions were made in 2011 and 2012, respectively. After trial and error, this third version blanket was launched in 2013 and used regularly in intensive care unit (ICU) at Central Chest Institute of Thailand (CCIT). Though the good outcome by means of this material was attained so far, it would be better to have a scientific verification. Therefore, author developed a handmade blanket and performed this research to investigate the effectiveness of this handmade device by comparing to standard blanket using on post cardiac surgery patients in ICU at CCIT.

Materials and methods

Sampling technique

This research was a Quasi-experimental study and operated for the period of January to December 2015 in intensive care unit (ICU), Central Chest Institute of Thailand (CCIT), Nonthaburi. The project was approved by Human Research Ethics Committee of CCIT and conceded the patient's consent for the research. Samples (≥18 years old) were selected from an initial group of scheduled 774 post-operative cardiac surgical patients undergoing coronary artery bypass or heart valve surgery with the use of an artificial heart and lung machine. The physical criteria for selection were 50-80 kg body weight, class I - II ASA physical status, ≥40% ejection fraction (EF) and <36°C body temperature of initial entering in ICU (by measuring the ear temperature). After 60 adult cardiac surgical patients were chosen, they were alternatively assigned to either standard blanket or handmade blanket group. There were 30 patients in each group (Figure 1).

Research tools

Handmade blanket (version III) had been made from non-woven fabric (Figure 2). It consisted of 2 pieces (1.8 m width X 2.0 m length each) and was sewed down the edge to splice 2 pieces of fabrics. The outer one was waterproof and prevented hot air moving out to the atmosphere whereas the inner one was soft and used for covering patient's body. Inner fabric could ventilate and distribute warm air to the patient very well. Below the patient's chest, there was a cavity on the blanket making pathway for intercostral drainage tube (Figure 2 left). Besides, there was an opening for insertion the hose from the forced-air warming unit (3M™ Bair Hugger™ Temperature Management Unit Model 775) at the lower end (Figure 2 right). This forced air was set up at 38°C. Standard blanket (3M™ Bair Hugger™ Full Body Blanket Model 30000-PW) using in this research was single-use disposable. To perform the experiment, patient's body was firstly covered with a thin cotton blanket. Then, placed with a standard or handmade blanket and finally covered with a thick cotton blanket as shown in (Figure 3).

Body temperature measuring

Core temperature of patient was continuously measured by nasopharyngeal temperature probe (PHILIPS, model 21075A) with precision at ±0.1°C (range from 25.0 to 45.0°C).

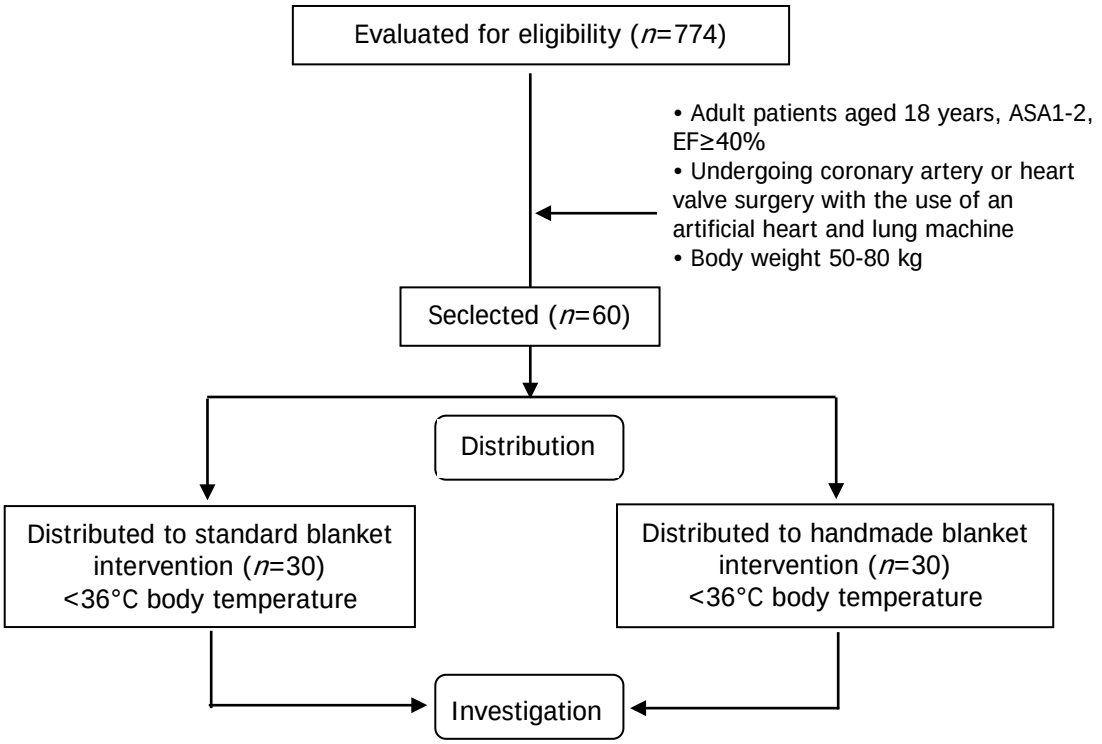

Figure 1. Diagram illustrating of patient sampling in this research

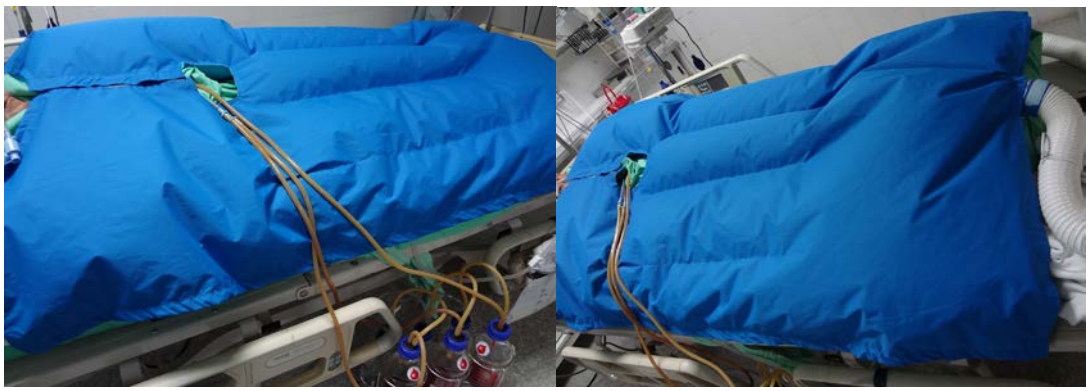

Figure 2. Handmade blanket (version III) showing a cavity for intercostral drainage tube at the patient's chest (left) and an opening for the warming unit at the lower end (right)

Figure 3. Handmade blanket (version III) covered with a thick cotton blanket showing a cavity for intercostral drainage tube at the patient's chest (left) and an opening for the warming unit at the lower end (right)

Data collection and analysis

Patient's core temperature was evaluated every half an hour. The independent, dependent and controlled variables in this Quasi-experimental study were custom-made blanket, patient's body temperature and standard blanket, respectively. After data collection, descriptive statistics had been performed. Subsequently, the data from two groups were examined for normal or non-normal distribution. Due to samples of both groups were independent, Independent Sample T-Test was carried out in case of normal distribution to compare mean. If there was non-normal distribution, hypothesis was assessed to compare mean of two groups via Mann-Whitney U Test at the 95% confidence level.

Results and discussion

From the experiment, results showed that patient's body temperature of two groups was nearly the same in both before and at ICU admission (Table 1). When these patients were warmed in ICU with two kinds of blanket and provided with the same set up condition of the forced-air warming unit at 38°C, core temperature of both groups obviously increased from the first hour and reached to 36.5°C (normothermia) after 3 hours. This reflected the high efficiency of rewarming patient's body by both sources and conformed the clinical practice guideline of National Institute for Health and Clinical Excellence which informed that "under typical care in ICU, it took around 2 hours to raise the temperature from around 35.0°C to 36.0°C and around 3 hours to reach 36.5°C" (NICE, 2008). At this temperature, the forced-air warming device was turned off and the blanket was still enclosed the patient for one more hour. Throughout this period, core temperature of both groups remained higher than 36.5°C (Figure 4).

Table 1. Patient's body core temperature (mean±SD) during operation and at ICU admission (n = 30 each) (CPB = Cardiopulmonary bypass machine)

Group	Lowest core temp during on CPB (°C)	Core temp before off CPB (°C)	Core temp at admission in ICU (°C)
Standard blanket	32.55±0.90	35.42±0.86	35.21±0.62
Handmade blanket	32.54±1.36	35.64±0.67	35.12±0.96

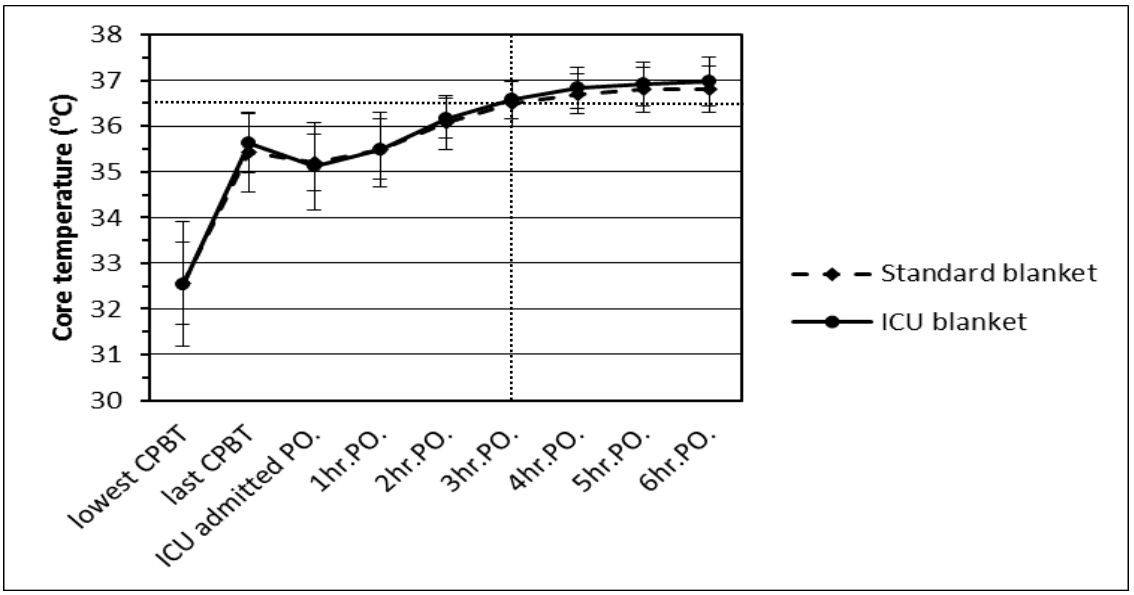

Figure 4. Changing in core temperature of patients in both groups during operation, at ICU admission and 1-6 hours in ICU (n = 30 each; data were plotted as mean±standard deviation) (CPBT = Temperature during turned on cardiopulmonary bypass machine, PO = post-operation, ICU blanket = handmade blanket)

After 4 hours in ICU, a standard or handmade blanket was removed from the patient while thin and thick cotton blankets were kept on covering to maintain the body temperature of patient under ICU temperature (22.0°C). It was observed that during 4-6 hours, without a standard or handmade blanket, patient's core temperature stayed higher than 36.5°C (Figure 4) which indicated that previous rewarm process by both types of blanket assisting the patient to retain normal body temperature.

The data from both groups were non-normally distributed. Thus, mean comparison of two groups was performed by Mann-Whitney U Test. It was found that core temperature after rewarming patient's body with a standard or handmade blanket had no significant difference at the 95% confidence level. This finding proved that handmade blanket could alternatively be used for active warming the ICU patients quite well.

In addition to cardiac surgical patient, handmade blanket together with forced-air warming device was also carried out in other wards. For 90 neonatal patients, Kongsayreepong et al. (2002) observed that the clinical efficiency of reusable blanket to prevent core hypothermia during major surgery was not different from disposable Bair Hugger® blanket (model 530 and 555).

In adult patients, Petcharatana et al. (1999) compared the heat transmission competence of home-made and standard blankets in 60 patients under orthopedic and eye surgery at Siriraj Hospital, Mahidol University, Bangkok, whereas Kabbara et al. (2002) assessed the effectiveness of forced-air warming hospital blanket and Bair Hugger® blanket (model 500) to create warm air for 83 patients under major surgery and Plicharoenpon (2015) evaluated the efficiency of forced-air warming handmade blanket and Bair Hugger® blanket (model 550) in 69 intra-abdominal surgical patients from Chaoprayayomraj Hospital, Suphan Buri. Although their types of surgery, severity of illness, body temperature measurement tools and blanket materials were different from the present research, results, however, appeared to be similar. There was similarity in the efficacy of using the handmade and commercial blankets. Besides, handmade blanket could reduce waste product, be recycled and save the cost of purchasing a standard blanket.

Conclusion

Thermal management for cardiac surgical patients plays an essential role to prevent the adverse effects of hypothermia or afterdrop. At present, forced-air warming device in association with full body blanket had been worldwide chosen for thermoregulation. However, a standard blanket was unable to use for many times. Despite the high cost of this disposable blanket, sometime, it was complicated to keep the patient's body temperature constantly during using in ICU. This occurred when intercostral drainage tube needed to be examined. In this practice, standard blanket must be uncovered periodically which reducing its capability to bring the patient's body temperature back to normal and forced-air warming unit had to be operated for more than 3 hours. To solve this problem, handmade blanket was decided to have a cavity at the patient's chest. Moreover, from this experiment, there was a scientific proof that this handmade blanket increased the post-operative cardiac surgical patient's temperature to normal level within 2-3 hours after surgery. Nevertheless, to increase understanding of its efficacy, hemodynamic monitoring while using forced-air warming handmade blanket should be investigated.

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References

Connolly, E. & Worthley, L. I. G. (2000). Induced and accidental hypothermia. *Critical Care and Resuscitation, 2*(1), 22-29.

Cruyne, H. L. & Miner, D. G. (1988). Thermo-resuscitation for postoperative hypothermia: using reflective blankets. *AORN Journal, 47*(1), 222-223, 226-227. https://doi.org/10.1016/S0001-2092(07)70072-8

Kabbara, A., Goldlust, S. A., Smith, C. E., Hagen J. F. & Pinchak, A. C. (2002). Randomized prospective comparison of forced air warming using hospital blankets versus commercial blankets in surgical patients. *Anesthesiology, 97*(2), 338-344.

Karalapillai, D., Story, D., Hart, G. K., Bailey, M., Pilcher, D., Schneider, A., et al. (2013). Postoperative hypothermia and patient outcomes after major elective non-cardiac surgery. *Anaesthesia, 68*(6): 605-611. doi: 10.1111/anae.12129

Kongsayreepong, S., Gunnaleka, P., Suraseranivongse, S., Pirayavaraporn, S., Chowvanayotin, S., Montapaneewat,T. et al. (2002). A reusable, custom-made warming blanket prevents core hypothermia during major neonatal surgery. *Canadian Journal of Anaesthesia*, *49*(6), 605-609.

NICE. (2008). *Clinical Practice Guideline: The Management of Inadvertent Perioperative Hypothermia in Adults*. London: Royal College of Nursing.

Petcharatana, S., Manon, C. & Santawat, U. (1999). Efficiency of warm air blower via home-made blanket compared with standard blanket. *Journal of Anesthesiology, 25*(4), 285-291.

Pikus, E. & Hooper, V. D. (2010). Postoperative rewarming: are there alternatives to warm hospital blankets. *Journal of PeriAnesthesia Nursing, 25*(1): 11-23. https://doi.org/10.1016/ j.jopan.2009.12.004

Plicharoenpon, P. (2015). Randomized prospective comparison of forced air warming using custom-made blankets from disposable surgical gown versus commercial blankets in patients undergoing intra-abdominal surgery: non-inferiority trial. *Region 4-5 Medical Journal, 34*(4), 281-296.

Torossian, A. (2008). Thermal management during anaesthesia and thermoregulation standards for the prevention of inadvertent perioperative hypothermia. *Best Practice & Research Clinical Anaesthesiology, 22*(4): 659-668. https://doi.org/10.1016/j.bpa.2008.07.006