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Risk Factors of Postoperative Shivering at Post Anesthesia Care Unit in Normothermic Patients Underwent General Anesthesia

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Abstract:

Objective: The aim of study was to identify risk factors that can be modified to reduce incidence of postoperative shivering in normothermic patient who underwent general anesthesia.

Material and Methods: A retrospective case control study was conducted between January 2017 and August 2018 by assessing the anesthetic records of normothermic patients at a post anesthesia care unit who underwent general anesthesia. A control group of 201 patients was randomly matched with 201 cases by age (±5 years) and site of surgery. Medical records were reviewed for data including patient demographics, operative time, anesthetic medication, type of fluid, core temperature at the end of surgery and occurrence of postoperative shivering. Conditional logistic regression analysis was performed to assess the association between potential risk factors and postoperative shivering.

Results: Higher body mass index (BMI) [odds ratio (OR) 0.91, 95% confidence interval (CI) 0.87–0.96] and higher core temperature at end of surgery (OR 0.33 95% CI 0.18–0.63) are associated with reduced risk of postoperative shivering. Whereas emergency case compared with elective case (OR 3.06 95% CI 1.63–5.72) and longer duration every 10 minutes (OR 1.05 95% CI 1.03–1.08) are associated with an increased risk of postoperative shivering.

Conclusion: Emergency case, longer duration of surgery, lower BMI and lower core temperature at end of surgery were significantly associated with postoperative shivering.

Keywords: general anesthesia, normothermic patient, postoperative shivering, risk factors

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Introduction

Postoperative shivering is a frequent complication after general anesthesia that can be uncomfortable to patients and may impair quality of recovery from anesthesia.[1] Previous studies have reported a range from 5.0% to 65.0% after general anesthesia.[2] Postoperative shivering impacts many aspects for example, increased oxygen consumption, increased risk of hypoxemia and catecholamine release, and is occasionally associated with harmful sequelae especially in high risk patients (cardiorespiratory disease).[3]

Shivering is a physiological response to cold exposure and the body's next step in heat preservation after peripheral vasoconstriction.[1]The etiology of shivering is insufficiently understood[3], but most postoperative shivering is normal thermoregulation that is usually triggered by low core temperature.[4] Previous studies found that lower core temperature was associated with increased risk of postoperative shivering.[4,5] Furthermore, there were several variables impacting postoperative shivering including sex, age, type of procedure, blood loss volume and anesthetic technique.[4–6]

However, postoperative shivering can occur even in normothermic patients during the perioperative period. The etiology of shivering in normothermia is poorly understood. Tremors in patients who were normothermic were considered nonthermoregulatory.[7] Until now, there has been limited evidence of risk factors of postoperative shivering in normothermic patients.

The aim of this study is to identify risk factors that can be modified to reduce incidence of postoperative shivering in normothermic patients who underwent general anesthesia.

Material and Methods

This retrospective case-control study was conducted in Songklanagarind Hospital located in Southern Thailand, an institution that provides tertiary care including Anesthesiology. The cases were normothermic patients, which were defined as core temperature 36.0–37.8 degree Celsius (°C) at the end of surgery with postoperative shivering at the post anesthesia care unit (PACU) after undergoing general anesthesia, aged more than 18 years and American Society of Anesthesiologists classification (ASA) I–IV between January 2017 and August 2018. The controls were normothermic patients without postoperative shivering which were randomly selected and matched with cases by age (±5 years) and site of surgery. Patients with preoperative temperature >37.8 °C, receiving medication with the potential to influence thermoregulation (e.g. clonidine, phenothiazines, meperidine), bypassing the recovery room and operation time less than 30 minutes were excluded from the study. This study was approved by the Ethics Committee, Faculty of Medicine, Prince of Songkla University (REC 61–281–8–1).

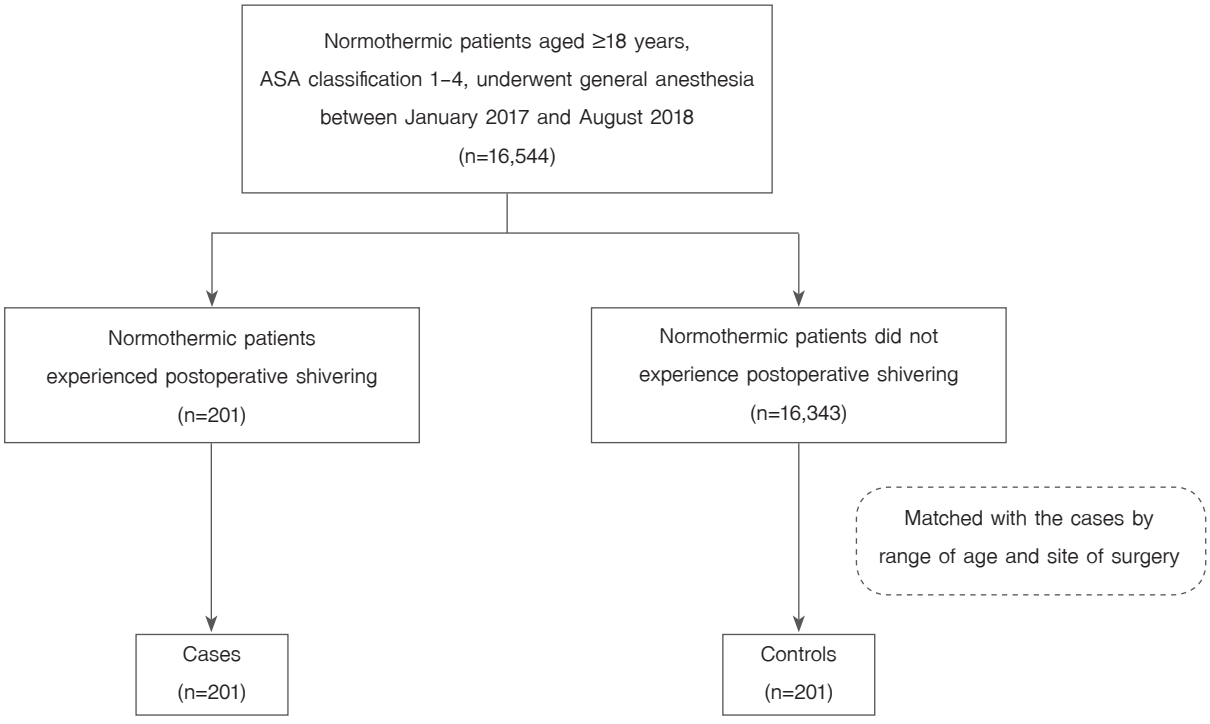
The patient's temperatures (90.0% core temperature, 10.0% peripheral temperature) are routinely measured intraoperatively when the operation time lasts more than 30 minutes. Core temperature was measured from nasopharynx, lower-third esophagus or rectum. Peripheral temperature was measured at axillary area and 0.5 °C was added in the record form to make this the core temperature. In patients with hypothermia during surgery (core temperature less than 36 °C), force-air warming and actively intravenous warmer were used. If the patients still had hypothermia, theatre suite temperature was increased until the patient's temperatures had reached 36 °C.

Postoperative shivering was defined as an involuntary, oscillatory muscular activity during early recovery after anesthesia (observed by a nurse anesthetist in PACU for at least 30 minutes). Medical records were reviewed for data including patient demographic, operative time, anesthetic medication, type of fluid, core temperature at the end of surgery, site of surgery and occurrence of postoperative shivering.

From a 3 month pilot study in our setting, sample size was calculated by accepting an alpha of 0.05 with power of 0.80, an estimated non-shivering prevalence in normothermia patients of 10.0%, and a shivering prevalence in normothermia patients of 20.0%, it estimated a sample of 199 cases and 199 controls. Data were analyzed by program R version 3.5.1 by Wilcoxon rank-sum test, chi-square test and Fisher exact test where appropriate. To assess the association between risk factors and outcome, conditional logistic regression was performed, accounting for matched design. The potential risk factors of postoperative shivering were included in the multivariate conditional logistic regression analysis if the p-value≤0.200 in the univariate analysis. The association between the outcomes and potential predictors were presented as odds ratio (OR) and 95% confidence interval. Stepwise regression method based on the lowest Akaike Information Criteria was used to select potential risk factors.

Results

Shivering cases comprised of 201 patients and 201 age and site of surgery- matched controls were recruited for the study (Figure 1). The baseline characteristics of patients are illustrated in Table 1. Sex, age and ASA classification were similar among the groups. Body mass index (BMI) was significantly lower for patients with shivering compared to patients without shivering (22.3 and 24.0 $kg.m^2$ respectively, p-value<0.001). Postoperative shivering occurred most in patients undergoing laparotomy, extremities and laparoscopic surgery (27.3%, 26.8%, and 18.9%, respectively).



ASA=American Society of Anesthesiologists

Figure 1 Flow diagram of the study

Patients with shivering usually received propofol at induction of anesthesia, and maintained anesthesia with volatile anesthetic, fentanyl and cisatracurium (Table 2). Anesthetic medications did not differ between the two groups. Patients with shivering received colloids and blood components more frequently than nonshivering group but were not statistically different except for fresh frozen plasma. Regarding surgical factors, type of cases (emergency vs elective cases) (p-value=0.024), duration of surgery (p-value=0.003), blood loss volume (p-value=0.009) and temperature at end of surgery (p-value=0.027) were significantly associated with shivering.

Based on the univariate statistical analysis, 11 factors, which had p-value<0.200 in the univariate statistical analysis, were initially included in the conditional logistic regression analysis, and 5 were removed because they proved not to be significant predictors at the 5.0% level. An identical model was achieved using backward logistic regression analysis. The 6 remaining factors are presented in Table 3.

Higher BMI [odds ratio (OR) 0.91 95% confident interval (CI) 0.87–0.96] and higher core temperature at end of surgery (OR 0.33 95% CI 0.18–0.63) are associated with reduced risk of postoperative shivering. Whereas emergency case compared with elective case (OR 3.06 95% CI 1.63–5.72) and longer duration every 10 minutes (OR 1.05 95% CI 1.03–1.08) are associated with an increased risk of postoperative shivering.

Table 1 Demographic and clinical data in patients with shivering and without shivering

Data	Patients with shivering (n=201, %)	Patients without shivering (n=201, %)	p-value
Female	120 (59.7)	131 (65.2)	0.303
Age (years) (mean, S.D.)	44.5 (17.9)	44.6 (17.8)	0.968
Body mass index (median, IQR)	22.3 (19.6, 25.4)	24.0 (21.7, 26.6)	<0.001
ASA classification	20 (10.0)	32 (15.9)	0.160
ASA I			
ASA II	130 (64.7)	128 (63.7)	
ASA III	50 (24.9)	41 (20.4)	
ASA IV	1 (0.5)	0 (0.0)	
Site of surgery			1.000
Laparotomy	55 (27.3)	55 (27.3)	
Extremities	54 (26.8)	54 (26.8)	
Laparoscopic	38 (18.9)	38 (18.9)	
Superficial trunk	14 (7.0)	14 (7.0)	
ENT	11 (5.5)	11 (5.5)	
Spine	11 (5.5)	11 (5.5)	
Urologic	9 (4.5)	9 (4.5)	
Others	9 (4.5)	9 (4.5)	

S.D.=standard deviation, IQR=interquartile range, ASA=American Society of Anesthesiologists, ENT=Ear Nose and Throat

Table 2 Anesthetic and surgical factors in patients with shivering and without shivering

Factors	Patients with shivering (n=201, %)	Patients without shivering (n=201, %)	p-value
Anesthesia induction*			
Propofol (Y/N)	199 (99.0)/2 (1.0)	200 (99.5)/1 (0.5)	1.000
Midazolam (Y/N)	36 (17.9)/165 (82.1)	39 (19.4)/162 (80.6)	0.798
Others (Y/N)	4 (2.0)/197 (98.0)	5 (2.5)/196 (97.5)	1.000
Maintenance of anesthesia			0.398
IV anesthetic	0 (0.0)	2 (1.0)	
Volatile anesthetic	201 (100.0)	199 (99.0)	
Use of nitrous oxide (Y/N)	15 (7.5)/186 (92.5)	12 (6.0)/189 (94.0)	0.690
Opioids*			
Morphine (Y/N)	35 (17.4)/166 (82.6)	46 (22.9)/155 (77.1)	0.214
Fentanyl (Y/N)	179 (89.1)/22 (10.9)	174 (86.6)/27 (13.4)	0.542
Non depolarizing muscle relaxant			0.732
None	29 (14.4)	34 (16.9)	
Cisatracurium	161 (80.1)	158 (78.6)	
Rocuronium	11 (5.5)	9 (4.5)	
Use of succinylcholine (Y/N)	41 (20.4)/160 (79.6)	36 (17.9)/165 (82.1)	0.612
IV fluid*			
Gelofusines (Y/N)	49 (24.4)/152 (75.6)	29 (14.4)/172 (85.6)	0.017
Voluven (Y/N)	5 (2.5)/196 (97.5)	2 (1.0)/199 (99.0)	0.449
Pack red cells (Y/N)	37 (18.4)/164 (81.6)	25 (12.4)/176 (87.6)	0.129
Fresh frozen plasma (Y/N)	14 (7.0)/187 (93.0)	4 (2.0)/197 (98.0)	0.030
Platelet concentration (Y/N)	7 (3.5)/194 (96.5)	1 (0.5)/200 (99.5)	0.068
Type of case			0.024
Elective	152 (75.6)	171 (85.1)	
Emergency	49 (24.4)	30 (14.9)	
Duration of surgery (min)	180 (125,320.0)	155 (110,240.0)	0.003
Blood loss volume (ml)	150 (50,400.0)	100 (20,350.0)	0.009
Temperature at begin of surgery (^{o}C)	36.5 (0.5)	36.4 (0.5)	0.112
Temperature at end of surgery (^{o}C)	36.5 (36.2, 36.8)	36.6 (36.3, 36.9)	0.027

*non-mutually exclusive

Y=yes, N=no, min=minute, ml=milliliter, ^{o}C=degree Celsius

Table 3 Independent factors associated with shivering based on conditional logistic regression

Independent factors	Crude OR (95% CI)	Adjust OR* (95% CI)	p-value
Body mass index (kg.m^{-2})	0.93 (0.89-0.97)	0.91 (0.87-0.96)	<0.001
Emergency case	1.84 (1.11-3.04)	2.31 (1.3-4.12)	0.004
Temperature at begining of surgery (^{o}C)	1.38 (0.93-2.05)	1.73 (1.05-2.83)	0.028
Temperature at end of surgery (^{o}C)	0.58 (0.35-0.97)	0.32 (0.17-0.59)	<0.001
Receive platelet concentration	7.22 (0.88-59.20)	10.59 (1.11-100.97)	0.016
Duration of surgery (per 10 minutes)	1.03 (1.01-1.04)	1.05 (1.03-1.07)	<0.001

OR=odds ratio, kg.m^{-2}=kilogram per square meter, ^{o}C=degree Celsius

Discussion

There were four factors associated with postoperative shivering, higher BMI and higher core temperature at end of surgery reduced risk of postoperative shivering while emergency case compared with elective case and longer duration increased risk of postoperative shivering. No association was found between anesthetic medications or type of fluids that patients received and developed incidence of postoperative shivering.

The study supported the findings equivalent to a previous study by Tsukamoto et al.[5] who found that lower core temperature at end of surgery is a risk factor for developing postoperative shivering. Another study by Eberhart et al.[4] reported that higher core temperature at PACU reduced risk of postoperative shivering. This was not wondering because shivering almost responses to low temperature.

Higher body mass index was a protective factor for postoperative shivering. It has been demonstrated that intraoperative core temperature is higher in obese patients. The protection of low temperature was better in obese patients, which rely on the degree of obesity.[8] The study confirmed the finding by Eberhart et al.[4] in that, longer duration of surgery associated with more postoperative shivering. This may explain that the operation was complicated and invasive. Greater injured tissue released pyogenic substances then impaired the thermoregulatory system and induced shivering.[9] Furthermore, emergency case increased risk of postoperative shivering when compared with elective case since patients with emergency conditions usually lost more blood. Tsukamoto et al.[5] reported that blood loss volume as a risk factor of post-operative shivering.

The strength of the study was the limited evidence available of risk factors of postoperative shivering in normothermic patients. There are some limitations of the study. First, each patient received a different method to prevent intraoperative hypothermia such as temperature set point of force-air warming or use of intravenous warmer. Another is that patients' core temperature was not routinely measured at the PACU.

Conclusion

Emergency case, longer duration of surgery, lower BMI and lower core temperature at end of surgery were significantly associated with postoperative shivering. Clinicians should pay attention and try to control these factors to improve quality of recover in surgical patients.

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Conflict of interest

The authors declare no conflict of interest.

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