Xu H, et al. J Anesth Clin Care 2021, 8: 065
DOI: 10.24966/ACC-8879/100065

HSOA Journal of Anesthesia & Clinical Care

Research Article

Efficacy and Safety of Forced-Air Warming System versus Passive Warming Measures in Major Surgeries: A Systematic Review

He Xu[1,2], Yijuan Lu[1,2], Xin Guan[1,2], Yue Ma[1,2], Aixia Ma[1,2] and Wenxi Tang[1,2*]

[1]School of International Pharmaceutical Business, China Pharmaceutical University, Nanjing, China

[2]Center for Pharmacoeconomics and Outcomes Research, China Pharmaceutical University, Nanjing, China

Abstract

Purpose: To compare the clinical impact of forced-air warming system (Bair HuggerTM, BH) and passive warming measures in major surgery patients.

Methods: Databases including Pubmed, Cochrane Library, Clinical Trials.Gov and CNKI were searched to collect studies published before January 2019 that were concerned the clinical effects of Bair Hugger. Two reviewers independently screened the literatures, extracted the data. The revised Jadad scale was used to evaluate the methodological quality of the literatures. Meta-analysis was performed by using Review Manager 5.3.0.

Findings: A total of 27 studies were included. The result of meta-analysis showed that BH had a significant advantage in rate of hypothermia (RD = -0.42, 95%CI (-0.68, -0.16)) , shivering (RD = -0.28, 95%CI (-0.43, -0.13)), anesthesia recovery time (MD = -8.27, 95% CI (-13.49, -3.05)), hospital stay (MD = -1.27, 95% CI (-2.05), -0.48)), while incision infection RD = -0.15, 95%CI (-0.40,0.11)), intraoperative blood loss (MD = -16.88, 95%CI(-34.73,0.96)), intraoperative blood transfusion (MD = -41.49, 95% CI(-108.36, 25.38)), pain RD = -0.02, 95%CI(-0.08, 0.03)) and other complications (RD = -0.13, 95%CI (-0.39,0.12)) had an advantage but not significant. Subgroup analyses showed that operation mode and operation duration was the sensitive factors.

Conclusion: Compared to passive warming, Bair Hugger has significant advantages in hypothermia protection and further reduces the risk of incision chills and prolonged hospital stay. Combined with the current status of body temperature protection in China, it is necessary to enhance the awareness of body temperature protection, standardize medical behavior, and increase the popularity of active warming systems.

Keywords: Bair Hugger Forced-air warming; Hypothermia; Passive warming measure; Systematic review

List of Abbreviations

ASPAN: American Society of Peri-Anesthesia Nurses

BH: Bair Hugger™

CI: Confidence interval

CNKI: China National Knowledge Infrastructure

FAW: Forced-air warming system

NICE: National Institute for Health and Care Excellence

RD: Risk difference

MD: Mean difference

Introduction

Body temperature is an important vital sign of the human body. In normal conditions, body temperature is regulated by nerves-body fluids and maintained at approximately 37°C to ensure the stability of physiological functions [1]. However, during surgical operation, patients are prone to hypothermic events (core temperature < 36°C) due to the influence of various factors such as anesthesia, operating room temperature, and warming measure, intraoperative transfusion and infusion, and patients themselves, leading to intraoperative and postoperative rehabilitation risks [2,3]. In 2014-2015, Yi, et al., conducted a nationwide epidemiological survey in China, which showed that the incidence of intraoperative hypothermia was approximately 44.3% in this country [4].

The primary harm of intraoperative hypothermia is a resultant poor prognosis. Existing studies have shown that the occurrence of intraoperative hypothermia can affect blood coagulation function in patients and lead to increased bleeding amount and prolonged operation time; increase wound infection rate; slow down bodily and drug metabolism; impair the function of respiratory system; and increase the possibility of shivering and cardiovascular complications, causing a decline in patient satisfaction with treatment and quality of life [5,6],

***Corresponding author:** Wenxi Tang, School of International Pharmaceutical Business, China Pharmaceutical University, Nanjing, China, Tel: +86 13770302713; Email: tokammy@cpu.edu.cn

Citation: Xu H, Lu Y, Guan X, Ma Y, Ma A, et al. (2021) Efficacy and Safety of Forced-Air Warming System versus Passive Warming Measures in Major Surgeries: A Systematic Review. J Anesth Clin Care 8: 065.

Received: February 19, 2021; **Accepted:** March 08, 2021; **Published:** March 15, 2021

Currently, the methods of intraoperative body temperature protection can be divided into passive warming and active warming. The former method achieves warming by increasing insulating material to reduce heat dissipation, such as covering a quilt, multilayer surgical drapes and insulating blanket. The latter method actively provides conductive, convective, or radiative heat energy, including warmed intravenous fluid and intraabdominal irrigation fluid for internal use, and circulating water mattress with alternating temperature and Forced-Air Warming System (FAW) for external use. It has gradually become a consensus in medical practice across various countries to apply prewarming before surgery and take active warming measures in a timely manner for patients presenting with preoperative or intraoperative hypothermia [4,7]. However, with regard to clinical practice, intraoperative body temperature protection is still primarily limited to passive warming for patients in China [2]. Yi, et al., showed that active warming devices were used in only 10.7% of Chinese patients, while the application of warming devices with higher efficiency has not yet been popularized [8].

Existing reviews on the effects of warming measures have mainly focused on the change of body temperature and the incidence of hypothermia, while lacking exploration into a series of adverse events caused by intraoperative hypothermia. In the present study, we selected the Bair Hugger™ (BH), a FAW blanket that performs well in active warming, to systematically evaluate its clinical effects versus passive warming measures. The results of this study could provide more sufficient clinical evidence for the selection of suitable warming method in the Perioperative period.

Methods

Search strategy

Computer searches were performed in the Pubmed, Cochrane Library, Clinical Trials.Gov, and China National Knowledge Infrastructure (CNKI) databases to retrieve studies related to the clinical effects of BH. The time limit of the search was set to January 2019. Search with "Bair Hugger" as the key word. The citations and grey literature were searched manually.

Inclusion and exclusion criteria

Inclusion criteria: The inclusion criteria were formulated according to the principle of PICOS. Target population: patients undergoing major surgery (with high complexity and high risk); intervention method: BH FAW blanket; control group: passive warming measures, such as covering a cotton blanket; outcome indicators: relevant clinical effects, such as infection and shivering; and study design: randomized clinical trial.

Exclusion criteria: 1. Articles that did not meet the inclusion criteria; 2. not published in Chinese or English; 3 incomplete outcome indicators, for example, not reporting the parameter estimation range; 4. Repeated publication; and 5. not intraoperative warming.

Literature selection, data extraction, and quality evaluation

Two researchers independently carried out literature selection, data extraction and quality evaluation. Divergence of opinions was resolved by discussion or assistance from a third party. Data extraction information included author, year of publication, country, sample size, basic patient information, type of surgery, intervention measures for the experimental group/control group, and outcome indicators. The quality of the included studies was evaluated using the modified Jadad scale [9,10]. The evaluation items comprised random sequence generation, randomization concealment, blinding method, withdrawal and dropout. The scoring criteria are listed in table 1. The quality of literature was indicated by the score: 1-3 points for low quality and 4-7 points for high quality.

Statistical analysis: The effect size of count data and measurement data was estimated using Risk Difference (RD) and Mean Difference (MD), respectively. The 2 test was used to evaluate the heterogeneity of included study results, and I2 was used to quantitatively determine the level of heterogeneity. If there was low statistical heterogeneity between the results of different studies, the fixed-effects model was used for meta-analysis; if there was high statistical heterogeneity, the source of heterogeneity was further analyzed, and if there was evident clinical heterogeneity, subgroup analysis or sensitivity analysis was performed, or only qualitative description was used; otherwise, the random-effects model was adopted for meta-analysis. For all tests the level of significance was set at $\alpha = 0.05$.

Results

Literature retrieval results

A total of 289 relevant articles were retrieved through the preliminary search, and 27 articles were finally included after stepwise selection. The procedure of literature selection is shown in figure 1.

Basic characteristics of included studies

The basic characteristics of the included studies are summarized in table 2.

Quality evaluation of included studies

Among the 27 articles included, six (22.22%) were high-quality articles and 21 (77.78%) were low-quality articles. Ten of the low-quality articles scored 3 points (47.62%; Table 3). Overall, the quality of the included studies was not high.

	Randomization	Concealment of allocation	Double blinding	Withdrawals and drop-outs	Total
Appropriate	Random numbers, computer generated, etc	Central allocation, sequentially numbered drug containers of identical appearance, etc	Identical placebo or similar method was used	Reasons and numbers were stated	2
Unknow	Insufficient information about the sequence generation process to permit judgement	Insufficient information to permit judgement	The trial was described as blind, but the method was not described	Insufficient information to permit judgement	1
Inappropriate	Non-random component in the sequence generation process	Participants could possibly foresee assignments and thus introduce selection bias	No blinding or blind methods is inappropriate	Reasons and numbers were not stated	0

Table 1: Evaluation items and scoring criteria of literature quality.

Studies	Country	Sample size	Age	Gender	Surgery type	Category	Insulation measures for control group	Length of surgery
Pu Y 2013 [11]	China	55	68±11(44–89)	27/28	laparoscopic gastrointestinal surgery	laparoscopy	no warming intervention	1:146 ± 47 min
		55	67±11(43–83)	33/22				2:149 ± 46 min
Yi J 2018 [12]	China	30	57.9±11.8	21/9	open thoracic surgery and hip replacement surgery	non-laparoscopy	cotton blanket	/
		32	58.5±11.5	25/7				
Takashi Matsukawa 1994 [13]	Japan	20	61.8±2.5	9-Nov	open abdominal surgery	non-laparoscopy	warming blankets	168.8 ± 16.2 min
		20	61.3±3.0	16/4				
V.Pathi 1996 [14]	England	29	61.8±1.3	19/10	cardiac operations	non-laparoscopy	passive rewarming with an aluminum space blanket	/
		26	61.6±1.6	18/8				
Debra S.Mason 1998 [15]	America	32	38.5±6.1	Feb-30	Roux-en-Y Gastric Bypass	non-laparoscopy	warming blankets	1:156.1 ± 27.4min
		32	40.7±9.6	25-Jul				2:156.9 ± 31.6min
R. Lindwall 1998 [16]	Sweden	12	65 ± 18	/	extensive thoracoabdominal operations under standard combined general and regional anaesthesia	non-laparoscopy	conservative passive heat preservation techniques	1:280min
		13	66 ± 10	/				2:287min
Marianne Winkler 2000 [17]	Australia	75	65 ± 11	37/38	hip arthroplasty	non-laparoscopy	conventionally warmed	1:102 ± 36 min
		75	64 ± 10	28/47				2:97 ± 36 min
Wei YR 2012 [18]	China	50	6.7 ± 5.5(d)	68/32	surgery in neonates	non-laparoscopy		>2h
		25	7.2 ± 4.2(d)				room temperature was adjusted by the 38℃ open warm bed, the warm bed was not closed during the operation	
		25	6.4 ± 5.2(d)				room temperature was adjusted by the 38℃ open warm bed, the warm bed was closed according to the heat tolerance	
V. N 2006 [19]	China	30	67.3 ± 9.1	21-Sep	total knee replacement	non-laparoscopy	electric heating pad	1:89.3±12.6 min
		30	67.4 ± 7.4	22-Aug				2:90.9±13.8 min
Alexander J. Butwick 2007 [20]	America	15	36 ± 2	0/30	cesarean delivery	non-laparoscopy	general cover	1:41±10 min
		15	32 ± 6					2:52±17 min
K. K. Leung 2007 [21]	China	30	66.1 ± 10.0	19/11	cesarean delivery	non-laparoscopy	electric heating pad	1:271±113 min
		30	64.1 ± 12.0	20/10				2:258±148 min
Jan L. De Witte 2010 [22]	Belgium	9	66 ±12	3-Jun	colorectal surgery	non-laparoscopy	cotton blankets	1:128±47min
		8	59 ±10	3-May				2:114±42min
Sung Hee Chung 2012 [23]	Korea	15	31.8 ± 3.9	0/45	cesarean section	non-laparoscopy	control group	<2h
		15	31.9 ± 4.6					
Song RY 2016 [24]	China	35	≥ 60	27/8	thoracic surgery	non-laparoscopy	cotton blanket	>2h
		35		20/15				
Wang YJ 2016 [25]	China	25	40-60	0/100	hysterectomy	non-laparoscopy	cotton blanket	>2h
		25	40-60					
		25	65-80					
		25	40-60					
		25	40-60					
		25	65-80					
Liu C 2018 [26]	China	30	> 65	16/14	Joint replacement, open spine surgery	non-laparoscopy	cotton blanket	1:150.17 ± 19.14min
		30		15/15				2:145.00 ± 24.87min
Liang H 2016 [27]	China	29	57.54 ± 13.84	16-Dec	hip arthroplasty	non-laparoscopy	conservative passive heat preservation techniques	>2h
		35	53.94 ± 14.63	17/18				
Ernst-Peter Horn 2002 [28]	America	15	33 ± 4	0/30	cesarean section	non-laparoscopy		1:38 ± 9min
		15	31 ± 5				intraoperative warming	2:37 ± 12min
Keun Man Shin 2015 [29]	Korea	36	56 ± 15	26-Oct	endovascular coiling of cerebral aneurysms	laparoscopy	cotton blanket	1:100 ± 45min
		36	60 ± 13	14/22				2:100 ± 37min
Qu DC 2016 [30]	China	20	60-80	10-Oct	total knee replacement	non-laparoscopy	cotton blanket	1:89 ± 6.15min
		20		9-Nov				2:90 ± 10.80min

Siew-Fong Ng-2002 [31]	Singapore	100	66.27 ± 0.91	49/251	hip arthroplasty	non-laparoscopy	Two cotton blankets	<2h
		100	66.61 ± 0.73					
Lai ZY 2017 [32]	China	25	68.3	15-Oct	total knee replacement	non-laparoscopy	no warming intervention	1:61.9 ± 14.2min
		25	67.8	13-Dec				2:60.8±13.4min
Isabelle Murat 1994 [33]	France	26	14.7 ± 1.7	/	spinal surgery	non-laparoscopy	surgical drapes	1:5.8 ± 2.0h
		25	14.9 ± 2.2					2:4.8 ± 1.2h
		15	32 ± 6					
Pei LJ 2018 [34]	China	50	54 ± 12	23/27	hip arthroplasty	non-laparoscopy	cotton gown and single layer of cloth surgical draping	>2h
		50	57 ± 11	32/18				
		48	54 ± 12	24/24				
		48	50 ± 12	19/29				
		49	54 ± 13	25/24				
		47	57± 11	25/22				
Gary M Onik 1993 [35]	America	44	/	/	Hepatic cryosurgery	non-laparoscopy	without Bair Hugger	>2h
		28	/	/				
Yuan GJ 2013 [36]	China	30	32-71	60/30	laparotomy	non-laparoscopy		>2h
		30					electric heating pad	
		30					electric heating pad and cotton blanket	
Katie Hooven 2011 [37]	America	77	64.87	36/41	Colorectal surgery	non-laparoscopy	No warming	<2h
		72	62.9	37/35				

Table 2: Basic characteristics of included studies.

Studies	Randomization	Concealment of allocation	Withdrawals and dropouts	Total
Wei YR 2012	0	0	1	1
Pu Y 2013	1	1	1	3
Yi J 2018	2	1	1	4
Takashi Matsukawa 1994	0	0	1	1
V. Pathi 1996	1	1	1	3
Debra S. Mason 1998	1	1	1	3
R. Lindwall 1998	0	0	1	1
Marianne Winkler 2000	1	1	1	3
V. N 2006	0	0	1	1
Alexander J. Butwick 2007	1	1	1	3
K. K. Leung 2007	1	1	1	3
Jan L. De Witte 2010	2	2	1	5
Sung Hee Chung 2012	1	1	1	3
Song RY 2016	2	1	1	4
Wang YJ 2016	2	1	1	4
Liu C2018	0	0	1	1
Liang H 2016	1	1	1	3
Ernst-Peter Horn 2002	0	0	1	1
Keun Man Shin 2015	1	1	1	3
Qu DC 2016	2	1	1	4
Siew-Fong Ng 2002	2	2	1	5
Lai ZY 2017	0	0	1	1
Isabelle Murat 1994	1	1	1	3
Pei LJ 2018	1	0	1	2
Yuan GJ 2013	1	0	1	2
Gary M Onik 1993	0	0	0	0
Katie Hooven 2011	0	0	1	1

Table 3: Quality evaluation of included studies.

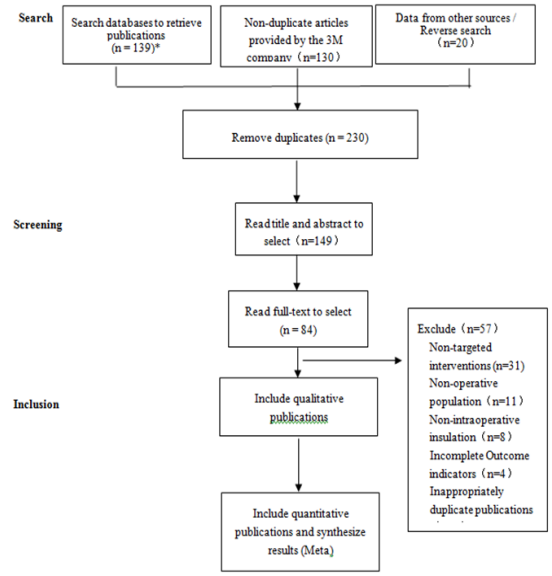

Figure 1: Flowchart of literature retrieval.

*English databases (PubMed, Cochrane Library, and Clinical Trials.Gov) = 126; Chinese database CNKI = 13

Meta-analysis results

Compared with the passive warming group, the patients using BH had lower incidence of hypothermia [RD = –0.42, 95% confidence interval (CI: –0.68, –0.16)], lower incidence of shivering [RD = –0.28, 95% CI (–0.43, –0.13)], shorter anesthesia recovery time [MD = –8.27, 95% CI (-13.49, -3.05)], and shorter hospital stay [MD = –1.27, 95% CI (–2.05, –0.48)]. The BH group also showed advantages in terms of other indicators including postoperative incision infection rate [RD = –0.15, 95% CI (–0.40, 0.11)], intraoperative blood volume [MD = –16.88, 95% CI (–34.73, 0.96)], intraoperative blood transfusion volume [MD = –41.49, 95% CI (–108.36, 25.38)], pain [RD = –0.02, 95% CI (–0.08, 0.03)], and other complications [RD = –0.13, 95% CI (–0.39, 0.12)], albeit not significant (Figure 2).

Subgroup analysis results

To reduce the heterogeneity of the study results and explore the clinical effects of BH in more scenarios, subgroup analysis was carried out on the type of surgery (laparoscopy vs. non-laparoscopy), duration of surgery (with a 2-h boundary), and their combination. The heterogeneity was reduced, while the number of outcome indicators showing significant advantages in the BH group was increased. The number and heterogeneity of the included articles are listed in, and the results of the subgroup analysis are summarized in (Tables 4 and 5).

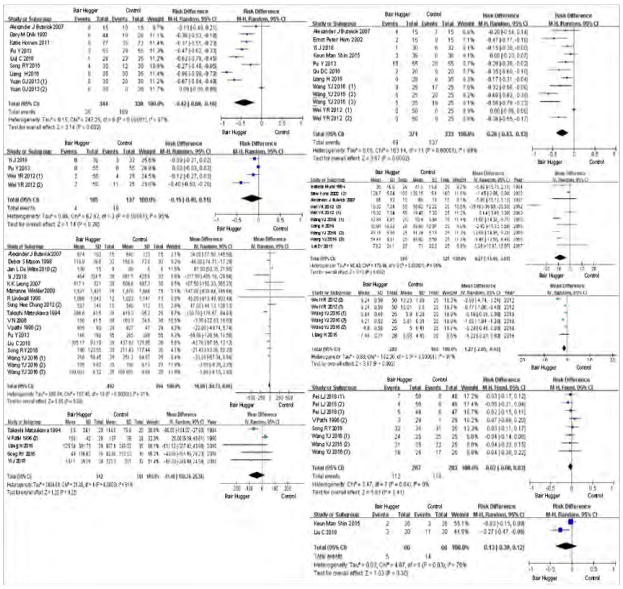

Figure 2: Meta-analysis results.

Note: On the left, from top to bottom are the results of incidence of hypothermia (%), incision infection rate (%), intraoperative blood loss volume (ml) and blood transfusion volume (ml); on the right, from top to bottom are the results of shivering (%), anesthesia recovery time (min), hospital stay (d), pain (%) and other complications (%).

Discussion and Conclusion

This study conducted a relatively comprehensive exploration into the indicators of the clinical effects of different warming measures. The results indicate that compared with passive warming measures, BH has remarkable advantages in reducing the risk related to hypothermia, shivering, and hospital stay in major surgeries. The results of the basic analysis are further supported by the subgroup analysis with more detailed subgroups.

	laparoscopy		non-laparoscopy		<2h		≥2h		laparoscopy≥2h		non-laparosco-py<2h		non-laparosco-py≥2h	
	numbers	I2	numbers	I2	numbers	I2	numbers	I2	numbers	I2	numbers	I2	numbers	I2
hypothermia RD, %	1	/	7	97%	5	98%	3	70%	1	/	5	96%	2	85%
incision infection rate RD, %	1	/	2	77%	/	/	2	97%	1	/	/	/	1	80%
intraoperative blood loss MD, ml	1	/	14	92%	5	88%	8	81%	1	/	5	88%	7	82%
blood transfusion MD, ml	/	/	5	81%	/	/	3	0%	/	/	/	/	3	0%
shivering RD, %	2	7%	7	92%	4	56%	4	94%	1	/	3	0%	3	96%
anesthesia recovery time MD, min	/	/	7	95%	3	0%	4	94%	/	/	3	0%	4	94%
hospital stay MD, d	/	/	3	97%	/	/	3	97%	/	/	/	/	3	97%
pain RD, %	/	/	4	0%	/	/	3	0%	/	/	/	/	3	0%
other complications RD, %	1	/	1	/	1	/	1	/	/	/	/	/	1	/

Table 4: Number and heterogeneity of articles included in the subgroup analysis.

	Laparoscopy	Non-laparoscopy	<2h	≥ 2h	Laparoscopy ≥ 2h	Non-laparoscopy <2h	Non-laparoscopy ≥ 2h
Hypothermia RD, %	3/55 vs 29/55[a]	-0.41	-0.4	-0.46	3/55 vs 29/55[a]	-0.3	-0.45
	P<0.01	(-0.71 -0.12)	(-0.77, -0.03)	(-0.65, -0.28)	P<0.01	(-0.60, 0.00)	(-0.80, -0.10)
Incision infection rate RD, %	0/55 vs 0/55[a]	-0.19	/	-0.17	0/55 vs 0/55[a]	/	-0.25
		(-0.37, -0.01)		(-0.59, 0.26)			(-0.54, 0.03)
Intraoperative blood loss MD, ml	146 vs 205[a]	-14.98	31.16	-26.43	146 vs 205[a]	31.16	-24.85
	P=0.043	(-33.18, 3.21)	(-17.83, 80.16)	(-41.31, -11.55)	P=0.043	(-17.83, 80.16)	(-39.87, -9.83)
Blood transfusion MD, ml	/	-41.49	/	-120.04	/	/	-120.04
		(-108.36, 25.38)		(-161.62, -78.45)			(-161.62, -78.45)
Shivering RD, %	-0.15	-0.31	-0.25	-0.31	18/55 vs 29/55[a]	-0.34	-0.33
	(-0.28,-0.03)	(-0.51, -0.11)	(-0.44, -0.06)	(-0.55, -0.06)	P=0.041	(-0.51, -0.17)	(-0.64, -0.02)
Anesthesia recovery time MD, min	/	-8.27	-1.47	-10.7	/	-1.47	-10.7
		(-13.49, -3.05)	(-2.86, -0.09)	(-16.74, -4.65)		(-2.86, -0.09)	(-16.74, -4.65)
hospital stay MD, d	/	-1.27	/	-1.27	/	/	-1.27
		(-2.05, -0.48)		(-2.05, -0.48)			(-2.05, -0.48)
pain RD, %	/	-0.02	/	-0.03	/	/	-0.03
		(-0.08, 0.03)		(-0.09, 0.03)			(-0.09, 0.03)
other complications RD, %	2/36 vs 3/36[a]	3/30 vs 11/30[a]	2/36 vs 3/36a	3/30 vs 11/30[a]	/	/	3/30 vs 11/30[a]
	P=1.000	P=0.046	P=1.000	P=0.046			P=0.046

Table 5: Subgroup analysis results.

Note: Bold text indicates a statistically significant difference. [a]: There was only one article.

In the case of high heterogeneity when combining some of the clinical evidence, it is impossible to perform subgroup discussions on the surgical site-a more critical factor-due to limited quantity of literature. Therefore, we conducted a subgroup analysis with regard to the characteristics of treatment regimen (laparoscopy/non-laparoscopy; surgical duration). We also performed a subgroup analysis based on the quality of literature. However, none of these analyses helped reduce the heterogeneity. This result might be related to factors such as the type of surgery and the year/country of publication that corresponded to the literature, and the long chain of evidence that led to the clinical results.

To date, intraoperative body temperature protection and monitoring have become a consensus in medical practice across various countries: Institutions such as the American Society of Peri-Anesthesia Nurses (ASPAN), National Institute for Health and Care Excellence (NICE), and Chinese Society of Anesthesia all recommend prewarming before surgery, continuous monitoring of body temperature and keeping the patient warm during surgery, and taking immediate active warming measures for patients with preoperative/intraoperative hypothermia [38]. However, the utilization rate of active warming devices in China is still not high, which would increase the risk of intraoperative hypothermia and other related events in patients, further causing a greater economic burden [8].

In summary, considering the difference of patient protection by various warming measures and the relatively low utilization rate of active warming devices in China, it is necessary to strengthen the awareness of patients and medical staff on body temperature protection, standardizes the medical behavior, and improve the application popularity of active warming measures.

Funding

This study was supported by project of Postgraduate Education Reform under “double first-class” capability construction from China Pharmaceutical University (Grant NO: 3151920118), provided to WT.

Author’s Contribution

WT conceptualized the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study design: AM, WT. Literature review: HX, YL, WT, XG. Data analysis: HX, XG, YM, YL. Drafting of the manuscript: HX, WT.

Acknowledgments

We thank Qiang Liu, the former advanced health economist engineer in Health Care Business Group Medical and Clinical Affairs, 3M China R&D Center, for providing some articles about BH.

References

1. Hart SR, Bordes B, Hart J, Corsino D, Harmon D (2011) Unintended perioperative hypothermia. Ochsner J 11: 259-270.
2. Ma ZL, Yi J (2017) Consensus among experts on prevention and treatment of perioperative patients with hypothermia. Medical Journal of Peking Union Medical College Hospital 8: 352-358.
3. Burns SM, Kathy P, Guy C, Wojnakowski M (2010) Incidence of Postoperative Hypothermia and the Relationship to Clinical Variables. J Perianesth Nurs 25: 286-289.
4. Yi J, Lei Y, Xu S, Si Y, Li S, et al. (2017) Intraoperative hypothermia and its clinical outcomes in patients undergoing general anesthesia: National study in China. PLoS One 12: 177221.
5. Yu DN, Li D (2014) The harm and treatment of hypothermia. International Journal of Surgery 05: 258-261.

6. Cheng ZN, Zhang J, Li X (2018) Intraoperative hypothermia in patients undergoing surgery. World Latest Medicine Information 18: 52-53.

7. NICE Clinical Guidelines (2016) Hypothermia: prevention and management in adults having surgery. London: National Institute for Health and Clinical Excellence, UK.

8. Yi J, Ziyong X, Xiaoming D, Fan T, Fu R, et al. (2015) Incidence of Inadvertent Intraoperative Hypothermia and Its Risk Factors in Patients Undergoing General Anesthesia in Beijing: A Prospective Regional Survey. PLoS One 10: 136136.

9. Clark HD, Wells GA, Huet C, McAlister FA, Salmi LR, et al. (1999) Assessing the quality of randomized trials: Reliability of the Jadad scale. Control Clin Trials 20: 448-452.

10. Bhandari M, Richards RR, Sprague S, Schemitsch EH (2001) Quality in the reporting of randomized trials in surgery: is the Jadad scale reliable?. Control Clin Trials 22: 687-688.

11. Y Pu, Cen G, Sun J, Gong J, Zhang Y, et al. (2014) Warming with an underbody warming system reduces intraoperative hypothermia in patients undergoing laparoscopic gastrointestinal surgery: a randomized controlled study. Int J Nurs Stud 51: 181-189.

12. Yi J, H Liang, R Song, Xia H, Huang Y (2018) Maintaining intraoperative normothermia reduces blood loss in patients undergoing major operations: a pilot randomized controlled clinical trial. BMC Anesthesiol 18: 126.

13. Matsukawa T, Kashimoto S, Nakamura T, Kume M, Kanda F, et al. (1994) Effects of a forced-air system (Bair Hugger, OR-type) on intraoperative temperature in patients with open abdominal surgery[J]. J Anesth 8: 25-27.

14. Pathi V, Berg GA, Morrison J, Cramp G, McLaren D, et al. (1996) The benefits of active rewarming after cardiac operations: A randomized prospective trial[J]. The Journal of Thoracic and Cardiovascular Surgery 111: 637-641.

15. Mason DS, Sapala JA, Wood MH, Sapala MA (1998) Influence of a Forced Air Warming System on Morbidly Obese Patients Undergoing Roux-en-Y Gastric Bypass. Obes Surg 8: 453-460.

16. Lindwall R, Svensson H, Söderström S, Blomqvist H (2010) Forced air warming and intraoperative hypothermia. Eur J Surg 164: 13-16.

17. Winkler M, Akça O, Birkenberg B, Hetz H, Scheck T, et al. (2000) Aggressive Warming Reduces Blood Loss During Hip Arthroplasty. Anesth Analg 91: 978-984.

18. Wei YR (2012) Bair hugger Temperature control instrument in the study on the role of surgery in neonates. National Medical Frontiers of China 7: 81-82.

19. Ng V, Lai A, Ho V (2006) Comparison of forced-air warming and electric heating pad for maintenance of body temperature during total knee replacement. Anaesthesia 61: 1100-1104.

20. Butwick AJ, Lipman SS, Carvalho B (2007) Intraoperative Forced Air-Warming During Cesarean Delivery Under Spinal Anesthesia Does Not Prevent Maternal Hypothermia. Anesth Analg 105: 1413-1419.

21. Leung KK, Lai A, Wu A (2007) A randomised controlled trial of the electric heating pad vs forced-air warming for preventing hypothermia during laparotomy. Anaesthesia 62: 605-608.

22. De Witte JL, Demeyer C, Vandemaele E (2010) Resistive-Heating or Forced-Air Warming for the Prevention of Redistribution Hypothermia. Anesthesia & Analgesia 110: 829-833.

23. Chung SH, Lee BS, Yang HJ, Kweon KS, Kim HH, et al. (2012) Effect of preoperative warming during cesarean section under spinal anesthesia. Korean journal of Anesthesiol 62: 454-460.

24. Song RY (2016) Effect of prewarming combined with intraoperative active warming on early postoperative cognitive function recovery in elderly patients with thoracic surgery. HeBei North University, China.

25. Wang YJ (2016) The effect of forced-air warming blanket on the patients undergoing total hysterectomy during operative procedures, Suzhou university, China.

26. Liu C (2018) Clinical study of the effect of different body temperature on postoperative cognitive function in elderly patients. Xinan medical university, China.

27. Liang H (2016) Effectiveness of forced-air warming system in preventing hypothermia and reducing intraoperative blood loss for patients undergoing hip replacement surgery. HeBei North University, China.

28. Horn EP, Schroeder F, Gottschalk A (2002) Active Warming During Cesarean Delivery. Anesth Analg 94: 409-414.

29. Shin KM, Ahn JH, Kim IS, Lee JY, Kang SS (2015) The efficacy of pre-warming on reducing intraprocedural hypothermia in endovascular coiling of cerebral aneurysms. BMC Anesthesiol 15: 8.

30. Qu DC (2016) Effects of air warming blanket on the recovery period of anesthesia in elderly patients undergoing total knee replacement. Dalian medical university, China.

31. Ng SF, Oo CS, Loh KH, Lim PY, Chan YH, et al. (2003) A Comparative Study of Three Warming Interventions to Determine the Most Effective in Maintaining Perioperative Normothermia. Anesth Analg 96: 171-176.

32. Lai ZY, Li GH, Li K, et al. (2017) Effect of perioperative insulation on patients undergoing total knee arthroplasty. Jiangxi Medical Journal 3: 231-233.

33. Murat I, Bernière J, Constant I (1994) Evaluation of the efficacy of a forced-air warmer (bair hugger) during spinal surgery in children. J Clin Anesth 6: 425-429.

34. Pei L, Huang Y, Xu Y, Zheng Y, Sang X, et al. (2018) Effects of Ambient Temperature and Forced-air Warming on Intraoperative Core Temperature. Anesthesiology 128: 903-911.

35. Onik GM, Chambers N, Chernus SA, Zemel R, Atkinson D, et al. (1993) Hepatic cryosurgery with and without the Bair Hugger. J Surg Oncol 52: 185-187.

36. Yuan GJ (2013) Study on the effect of different thermal insulation measures on the change of body temperature in patients undergoing laparotomy. Tianjin Medical University, China.

37. Hooven K(2011) Preprocedure Warming Maintains Normothermia Throughout the Perioperative Period: A Quality Improvement Project. J Perianesth Nurs 26: 9-14.

38. Xu H, Wang Z, Guan X, Lu Y, Malone DC, et al. (2020) Safety of intraoperative hypothermia for patients: meta-analyses of randomized controlled trials and observational studies. BMC Anesthesiol -20: 202.

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752