Journal of Clinical Anesthesia (2016) **33**, 376–385

Journal of Clinical Anesthesia

Original Contribution

A randomized trial of prewarming on patient satisfaction and thermal comfort in outpatient surgery

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Received 14 August 2015; revised 13 April 2016; accepted 24 April 2016

Keywords:
Thermoregulation;
Normothermia;
Prewarming;
Patient satisfaction;
Outpatient surgery;
Anesthesia

Abstract

Study objective: To test the primary hypothesis that forced-air prewarming improves patient satisfaction after outpatient surgery and to evaluate the effect on core temperature and thermal comfort.

Design: Prospective randomized controlled trial.

Setting: Preoperative area, operating room, and postanesthesia care unit.

Patients: A total of 115 patients aged 18 to 75 years with American Society of Anesthesiologists status <4 and body mass index of 15 to 36 kg/m^2 who were undergoing outpatient surgery (duration <4 hours).

Interventions: Patients were randomized to active prewarming with a Mistral-Air warming system initially set to 43°C or no active prewarming. All patients were warmed intraoperatively.

Measurements: Demographic and morphometric characteristics, perioperative core temperature, ambient temperature, EVAN-G satisfaction score, thermal comfort via visual analog scales.

Main Results: Data from 102 patients were included in the final analysis. Prewarming did not significantly reduce redistribution hypothermia, with prewarmed minus not prewarmed core temperature differing by only 0.18°C (95% confidence interval [CI], −0.001 to 0.37) during the initial hour of anesthesia (P = .052). Prewarming increased the mean EVAN-G satisfaction score, although not significantly, with an overall

Disclosure/Funding: Financial support was provided by the 37Company. Drs Saager, Kurz, and Sessler serve on advisory boards for the 37Company; Drs. Kurz and Sessler serve on advisory boards for 3M. All fees are donated to charity. Dr. Leif Saager is supported by a Mentored Research Training Grant for Health Services Research from the Foundation for Anesthesia Education and Research and the Anesthesia Quality Institute. None of the other authors have a personal financial interest in this research.

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http://dx.doi.org/10.1016/j.jclinane.2016.04.041

difference (prewarmed minus not prewarmed) of 5.6 (95% CI, −0.9 to 12.2; $P = .09$). Prewarming increased thermal comfort, with an overall difference of 6.6 mm (95% CI, 1.0-12.9; $P = .02$).
Conclusion: Active prewarming increased thermal comfort but did not significantly reduce redistribution hypothermia or improve postoperative patient satisfaction.

1. Introduction

Most unwarmed surgical patients become hypothermic [1–4], as defined by core temperature below 36.0°C [5,6]. Randomized trials indicate that perioperative hypothermia causes substantial complications including wound infection, coagulopathy [7], and patient dissatisfaction [8]. There are just a few contraindications for active warming, including tissue ischemia and open wounds. It is thus now standard of care to actively warm surgical patients intraoperatively.

Forced-air remains by far the most common perioperative warming approach. Forced-air markedly reduces cutaneous heat loss [9,10]; consequently, most warmed patients are normothermic by the end of surgery. [11] However, core-to-peripheral redistribution of body heat reduces core temperature in the first hour after induction of anesthesia [12,13], even in actively warmed patients [11,14]. Most patients, therefore, at least initially, experience some intraoperative hypothermia. Hypothermia is especially problematic in patients having short procedures because there is insufficient time for rewarming before the end of surgery. Redistribution hypothermia can be ameliorated by prewarming which increases peripheral tissue temperature, thus reducing the core-to-peripheral tissue-temperature gradient and heat flow after induction of anesthesia [15]. Patients who are prewarmed are therefore more likely to be normothermic at the end of surgery [16], an effect that will be most apparent in shorter operations.

Being normothermic at the end of surgery may improve patient satisfaction and comfort in the postoperative period. Patient satisfaction is not only of interest to patients; hospital reimbursement is also based on patient satisfaction scores. We therefore tested the primary hypothesis that forced-air prewarming improves patient satisfaction in patients having brief outpatient operations. Our secondary hypothesis was that prewarming decreases redistribution hypothermia and increases patient thermal comfort. To put our results into perspective, we included them in a meta-analysis of previous relevant work.

2. Methods

2.1. Prospective randomized prewarming study

With institutional review board approval, we approached patients between 18 and 75 years of age, with an American Society of Anesthesiologists physical status (ASA PS) classification less than 4, with a body mass index between 15 and 36 kg/m^2 who were scheduled for outpatient surgery expected to last 4 hours or less at the Cleveland Clinic Main Campus and Cleveland Clinic Fairview Hospital. Patients were excluded if preoperative sublingual temperature exceeded 38°C, serious skin lesions were present, or any factors barring prewarming existed (such as surgeon request for immediate transfer to the operating room upon arrival).

2.1.1. Protocol

Upon arrival to the preoperative area, consenting patients changed into a Mistral-Air (The 37Company, Amersfoort, the Netherlands) Warming Suit. The double-layered Mistral-Air Warming Suit insulates the patient with full coverage of arms and legs and consists of upper and lower portions which are connected at the waist by Velcro. Each section has an air inlet port that can be attached to the Mistral-Air warmer.

Preoperative thermal management was randomized, via a Web-based system using computer-generated codes on an unstratified 1:1 basis. Randomization was to preoperative forced-air warming with a Mistral-Air blower and Suit or preoperative passive insulation with an un-inflated Mistral-Air Suit. Patients randomized to passive insulation wore the Mistral-Air Suit in place of a standard patient gown. In patients assigned to prewarming, a Mistral-Air forced-air warming device set to 43°C was connected to the lower-body segment of the Suit; thereafter, blower temperature was adjusted to patient comfort. Warming continued until patient was ready for transfer to the operating room.

All patients were warmed intraoperatively after induction of anesthesia with a single Mistral-Air system set at 43°C, using the upper or lower portion of the warming Suit as appropriate for the surgery. Previous work indicates that heat transfer is similar with upper- and lower-body forced-air warming [10]. Active intraoperative warming continued until the end of surgery. Ambient operating room temperature was maintained near 20°C.

Anesthesia was induced with propofol and fentanyl, and maintained with either a volatile anesthetic or a combination of propofol and opioid. Patients were either intubated or an i-gel supraglottic airway (Intersurgical Inc, Liverpool, NY) was inserted. Ventilation was controlled mechanically, or spontaneous ventilation was assisted to maintain an end-tidal PCO_2 near 35 mm Hg.

2.1.2. Measurements

Preoperatively, demographic and morphometric characteristics were recorded, including age, sex, type of surgery, duration of surgery, ASA PS classification, body mass index, and type of airway. The duration of active prewarming was

recorded, along with preoperative administration of benzodiazepines and/or opioids.

Core temperature was measured orally with an electronic thermometer in the preoperative and postoperative period, whereas core temperature was measured from a distal esophageal thermistor in the intraoperative period. The esophageal temperature probe was inserted after securing the airway and was removed upon emergence from anesthesia. In patients ventilated with a laryngeal mask airway, the esophageal temperature probe was inserted through the gastric suction channel. Ambient temperatures in the operating rooms were measured from a thermocouple placed at patient level. Insertion of the esophageal probe was considered as time zero for intraoperative temperature readings, and subsequent readings were recorded at 15-minute increments.

We assessed patient satisfaction using the Evaluation du Vécu de l'Anesthésie Générale (EVAN-G). [17] The EVAN-G questionnaire is among the best-validated methods for evaluating perioperative patient satisfaction, especially in ambulatory general anesthesia. [18] The questionnaire includes the following domains: attention, privacy, information, pain, discomfort, and waiting. However, we considered only the "discomfort" domain, as it was most pertinent to prewarming (Appendix 1). EVAN-G comfort domain was evaluated on a Likert scale of satisfaction, which was linearly transformed to a 0-100 scale, with 100 indicating the best possible level of satisfaction and 0 indicating the worst. Satisfaction was considered high with scores above 80 (scaled to a score indicating that satisfaction was more than expected). [17].

Thermal comfort scores were assessed with a visual analog scale where patients were asked to mark their subjective thermal status on a 100-mm image line (Appendix 2). A score of 0 mm was designed as extreme cold and 100 mm as extreme heat; 50 mm was considered thermally neutral, neither warm nor cold. [19].

Patient satisfaction, thermal comfort, and oral temperature measurements were assessed at the following 4 points: patient arrival at preoperative holding area, prior to anesthesia induction, 15 minutes postoperatively in recovery area, and prior to discharge from recovery unit.

2.1.3. Statistical analysis

Randomized groups were descriptively compared on potentially confounding baseline variables using the standardized difference (ie, the difference in means or proportions divided by standard deviation). Any imbalanced variables, defined by an absolute standardized difference of > 0.39 ($1.96 \times \sqrt{\frac{(n1+n2)}{n1 \times n2}} = 0.39$), would be adjusted for in the models below.

A linear mixed-effects model was used to compare prewarmed and control groups on mean recovery room patient satisfaction (primary outcome, EVAN-G score) and thermal comfort across repeated measurements (15 minutes after recovery room arrival and upon home discharge), with each model adjusting for the baseline value of the outcome and adjusting for within-subject correlation assuming an unstructured correlation matrix. Similarly, a linear mixed-effects model was used to compare treatment groups on mean temperature in the first hour (esophageal core temperatures, from induction through 60 minutes of surgery) assuming an autoregressive correlation matrix. For each model, if no treatment group-by-time interaction was detected ($P < .15$), we assessed the overall effect of treatment collapsing over time as the primary analysis; otherwise, differences at each time point would be primary, with Bonferroni correction.

Secondarily, analysis of covariance adjusting for baseline was used to compare the treatment groups on EVAN-G satisfaction score and thermal comfort at discharge to the surgical suite. The overall significance level was .05 for each of the primary and secondary outcomes. Bonferroni correction was used for multiple comparisons. SAS software version 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses.

2.2. Meta-analysis

Using the criteria set forth by the PRISMA Group [20], we conducted a systematic review to identify studies to be included in our meta-analysis. We searched in MEDLINE via PubMed, the Cochrane Central Register of Controlled Trials, and Excerpta Medica Database. The terms searched were "prewarming," "pre-warming," "preoperative warming," "pre-operative warming," "forced air warming," "forced-air-warming," "redistribution hypothermia," "thermal redistribution," "pre-induction warming," "perioperative normothermia," "core temperature + intraoperative," and "perioperative temperature management" without language restriction up through March 2014. Additional studies were identified from the bibliographies of retrieved articles. We excluded studies not written in English, animal studies, volunteer studies, and pediatric studies.

Two authors (Z.A. and A.F.) screened the abstracts of retrieved articles and removed review articles, abstracts without full articles, and studies that did not include intraoperative core temperature readings. Full articles of all remaining abstracts were retrieved. Full articles with forced-air prewarming and intraoperative core temperature readings were included in the final meta-analysis.

To assess the quality of the selected studies we used the 5-point "Jadad Score." [21]. The scoring is based on 3 questions that are answered "yes" or "no": (1) randomization, (2) blinding, and (3) description of withdrawals/dropouts with up to 2 additional points being awarded for appropriateness of method of randomization and blinding. Scores of 1 or 2 are traditionally considered lower quality. In addition, we evaluated concealed allocation in our quality measure. Therefore, we used a Jadad score of 0 to 5 with the addition of plus 1 if concealed allocation was noted.

After finalizing the articles, information on the demographic and morphometric measurements from each article was extracted. This information included sample size, types of surgery, height, weight, length of procedure, temperature readings, duration of prewarming, randomization, ASA PS classification, age,

sex, and other available data. The accuracy and completeness of extracted results were confirmed by another investigator. If questions remained, attempts were made to contact the original authors for further clarification and data. Data from our current study were added to the 7 studies that were selected for the meta-analysis. We included only patients with full intraoperative temperature data for at least 60 minutes.

A meta-analysis was conducted to assess the effect of prewarming (vs not) on the lowest mean temperature achieved for a group between start of prewarming through 60 minutes. Data from our current study were added to the 7 studies that were selected for the meta-analysis. We included only patients with full intraoperative temperature data for at least 60 minutes to be consistent with the other studies. We conducted a random-effects meta-analysis on the difference in mean temperature between the randomized groups. Quality of studies was assessed with the Jadad score. Heterogeneity of the treatment effect across studies was assessed with the Q statistic and I^2 measures. A funnel plot of observed treatment effect vs inverse of sample size was used to assess publication bias.

3. Results

A total of 115 patients were enrolled, 58 assigned to prewarming group and 57 to the control group. Seven patients elected to discontinue the study (3 in prewarming group and 4 in non-prewarming group). Because of surgeon preference and surgical procedure requirements, 6 patients (4 prewarming and 2 non-prewarming) were unable to receive intraoperative warming and were therefore excluded from the analysis. The final analysis thus included 102 patients (Fig. 1).

Baseline and intraoperative factors were balanced between the randomized groups (ie, absolute standardized difference <0.39), except that prewarmed patients were more likely to have been intubated (Table 1).

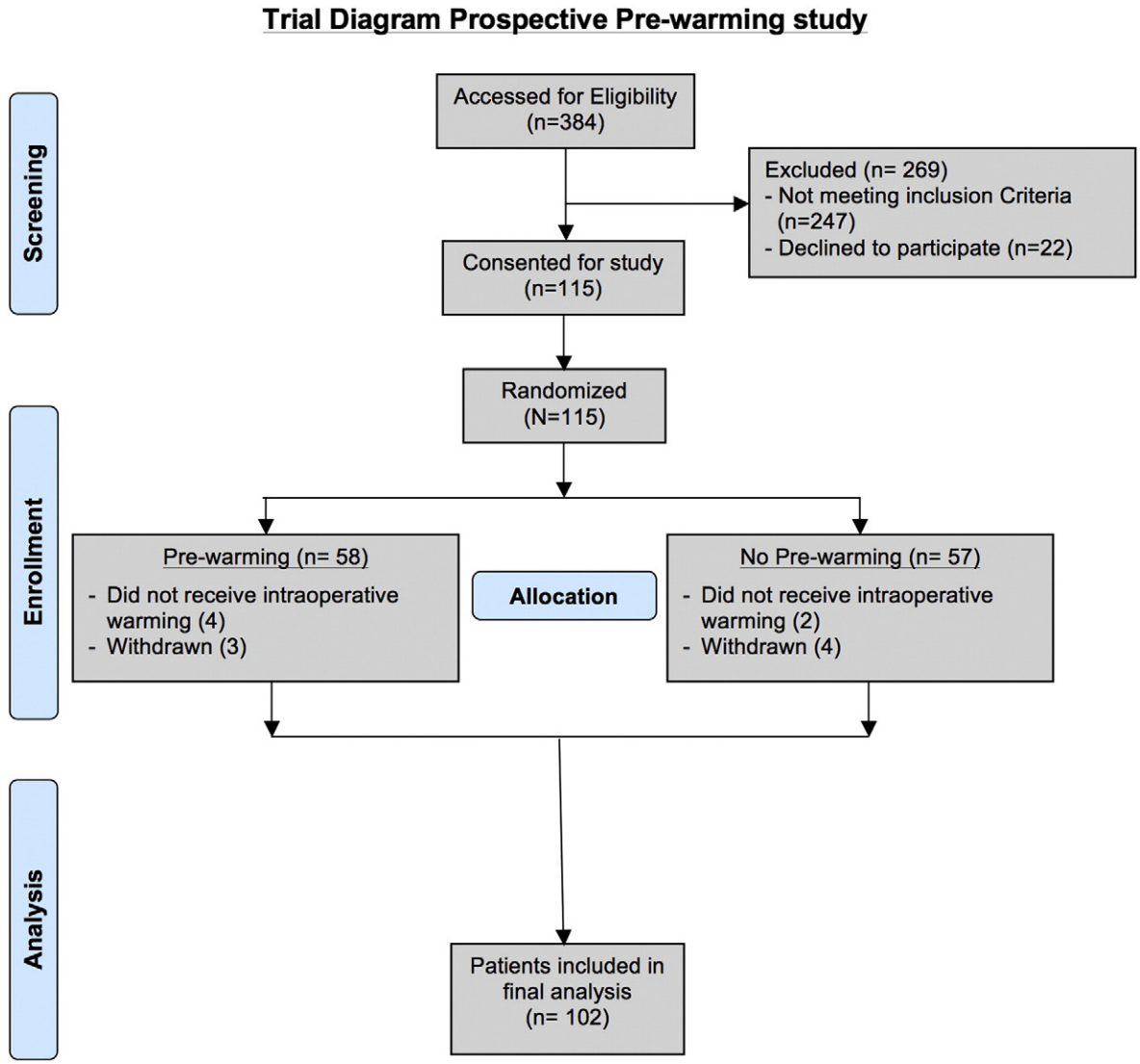


Fig. 1 Trial diagram.

Table 1 Comparing prewarmed vs control on demographics and operation factors

Factor	Prewarming (n = 51)	Control (n = 51)	ASD
Age (y)	52 ± 13	50 ± 13	0.16
Male, no. (%)	9 (18)	14 (27)	0.24
Height (cm)	164 ± 13	168 ± 12	0.34
Weight (kg)	69 ± 12	73 ± 12	0.35
BMI (kg/m^2)	25 ± 4	25 ± 3	0.04
ASA PS classification, no. (%)			0.28
I	9 (18)	11 (22)	
II	27 (53)	31 (61)	
III	15 (29)	9 (18)	
Sublingual (oral) temperature (°C)	36.5 ± 0.4	36.5 ± 0.3	0.09
Ambient room temperature (°C)	22.3 ± 1.3	22.0 ± 1.1	0.24
Prewarming time (min)	60 [50, 85]	NA	NA
Duration of anesthesia (min)	112 [87, 152]	133 [93, 165]	0.26
Opioids prior to OR, no. (%)	0 (0)	0 (0)	0.00
Benzodiazepine prior to OR, no. (%)	4 (8)	2 (4)	0.17
Type of warming (Suit vs Upper), no. (%)	5 (10)	5 (10)	0.00
Airway insertion (min)	11 [8,12]	10 [8,13]	0.17
Airway (ETT vs LMA), no. (%)	45 (88)	37 (73)	0.40

Data are presented as mean ± SD or n (%). STD = standardized difference, difference in means or proportions divided by pooled standard deviation, with imbalance defined as an absolute STD (ASD) ≥ 0.39 (ie, $1.96\times\sqrt{\frac{(n1+n2)}{n1\times n2}}=0.39$); BMI = body mass index; ASA PS = American Society of Anesthesiologists physical status; OR = operating room; ETT = endotracheal tube; LMA = laryngeal mask airway.

Baseline temperatures were similar. After prewarming, mean core temperature was an estimated 0.13 (0.02°C, 0.24°C) higher in the prewarmed patients compared with the not prewarmed group (P = .03); temperature in patients who were not prewarmed remained unchanged. Core temperature decreased in both groups over the initial 30 minutes of anesthesia. Thereafter, core temperature increased in both groups, with both averaging more than 36°C after 1.5 hours of anesthesia (Fig. 2). The treatment-by-time interaction was not significant for temperature in the first hour (P = .72). Consequently, the effect of prewarming on mean temperature was tested by collapsing across the 5 time points. The overall effect of prewarming was nonsignificant, estimated (prewarmed minus not prewarmed) at 0.18°C (95% confidence interval [CI], −0.001 to 0.37; P = .052; Table 2).

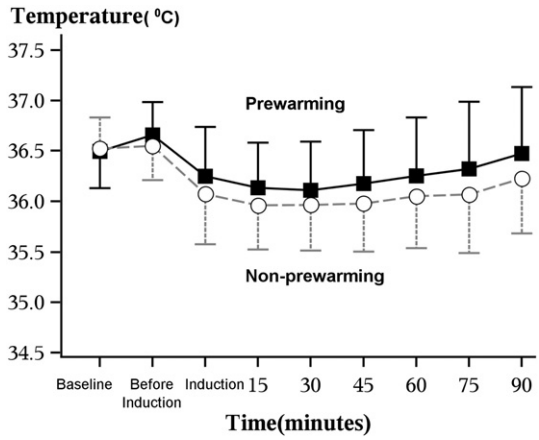


Fig. 2 Comparison on baseline, preinduction, induction, and intraoperative hypothermia (distal esophageal temperature) between prewarming and non-prewarming group (n = 102). Primary analysis compared randomized groups on mean temperature from induction through 60 minutes, with mean difference (95% CI) of 0.18 (−0.001 to 0.37; P = .052). There was no treatment-by-time interaction on mean temperature between induction and 60 minutes (P = .72). CI = confidence interval.

Prewarmed patients had higher mean EVAN-G satisfaction and thermal comfort scores upon transfer from the holding area to the operating room (P < .001; Table 2). The treatment-by-time interaction was not significant for EVAN-G satisfaction score (P = .24). Consequently, the effect of prewarming on the primary outcome was summarized by collapsing across 2 time points, with an estimated effect (prewarmed minus control) of 5.6 (95% CI, −0.9 to 12.2; P = .09).

No treatment-by-time interaction on thermal comfort score was detected (P = .65). Collapsing over time, prewarming increased mean thermal comfort score, with an overall difference (prewarmed minus not prewarmed) of 6.6 (95% CI, 1.0-12.9; P = .02).

For the meta-analysis, initial literature search identified 1474 articles. After screening for exclusion criteria, the remaining 585 were assessed for eligibility. A total of 7 previous studies used prewarming with forced air and recorded consistent intraoperative core temperatures (Fig. 3). Among our current 102 patients, 7 had operations lasting less than an hour; thus, data from 95 were included in the meta-analysis to be consistent with the other included studies. The meta-analysis showed that prewarming reduced redistribution hypothermia by an estimated 0.42°C (95% CI, 0.27-0.57) across all studies (Fig. 4). Heterogeneity was found across studies using either the Q statistic (P < .001) or I^2, with I^2 of 76%. However, estimated treatment effects for all studies were in the same

Table 2 Association between prewarming and primary and secondary outcomes

Outcomes	Prewarming (n = 51), mean (SE)	Control (n = 51), mean (SE)	Mean difference (CI) * (prewarming − control)	*P* *
Primary outcome: EVAN-G satisfaction score				
Baseline	89 [75, 96]	90 [75, 100]		
Discharge to OR [a] PACU [b]	89.7 (1.5)	82.3 (1.5)	7.4 (3.2 to 11.7)	<.001
Treatment × time				.24
Overall			5.6 (−0.9 to 12.2) [c]	.09
15 min	86.7 (2.8)	78.5 (2.8)	8.1 (−0.8 to 17.1) [c,] X **	.04
Discharge	88.1 (2.6)	84.4 (2.6)	3.7 (−4.7 to 12.1) [c,**]	.32
Secondary outcome				
1. Thermal comfort				
Baseline	50.1 ± 14.4	49.7 ± 14.6		
Discharge to OR [a] PACU [b]	60.9 (2.1)	50.4 (2.1)	10.6 (4.8 to 16.3)	<.001
Treatment × time				0.65
Overall			6.6 (1.0 to 12.2) [c]	.02
15 min	57.5 (2.5)	52.0 (2.5)	5.6 (−2.5 to 13.6) [c,**]	.12
Discharge	58.3 (2.2)	51.1 (2.2)	7.2 (0.1 to 14.3) [c,**]	0.024
2. Temperature				
Baseline	36.49 ± 0.36	36.52 ± 0.31		
Preinduction [a] Intraoperative [b]	36.67 (0.04)	36.54 (0.04)	0.13 (0.02 to 0.24)	.03
Treatment × time				.72
Overall			0.18 (−0.001 to 0.37) [c]	.052
Induction	36.25 (0.07)	36.07 (0.07)	0.18 (−0.08 to 0.43) [c,†]	.08
15 min	36.14 (0.07)	35.96 (0.07)	0.17 (−0.08 to 0.43) [c,†]	.08
30 min	36.11 (0.07)	35.97 (0.07)	0.14 (−0.11 to 0.40) [c,†]	.15
45 min	36.18 (0.07)	35.98 (0.07)	0.20 (−0.06 to 0.46) [c,†]	.05
60 minutes	36.25 (0.07)	36.05 (0.07)	0.19 (−0.07 to 0.45) [c,†]	0.05

Baseline data are summarized by mean ± SD or median [q1, q3]. The initial intraoperative temperature averaged 10 minutes after induction of anesthesia.
CI = confidence interval; OR = operating room' PACU = postanesthesia care unit.

[a] *P* values and confidence intervals from analysis of covariance (ANCOVA) model adjusting for baseline.

[b] *P* values and confidence intervals from repeated-measures ANCOVA model adjusting for baseline

[c] Means are adjusted for baseline value of the outcome.

* Significance criterion was $P < .05$ for overall effects; 95% CIs.

** Significance criterion was $P < .025$ (ie, 0.05/2, Bonferroni correction); 97.5% CIs.

† Significance criterion was $P < .01$ (ie 0.05/5, Bonferroni correction); 99% CIs.

direction and always favored prewarming. There was little evidence of publication bias in the funnel plots (not shown). The size of all studies were modest (n = 16-200), with a Jadad score most commonly a 2 and no Jadad scores above 3. Concealed allocation was explicitly reported in all but 2 studies (Table 3).

4. Discussion

In prewarmed patients, core-to-peripheral redistribution of body heat decreased core temperature about 0.5°C in the initial 30 minutes after induction which is consistent with previous research [16]. The surprising aspect of our results is that there was also little redistribution hypothermia in patients who were not prewarmed, which is in distinct contrast to numerous previous reports [2,3,8,22].

Why there was so little redistribution in these patients remains unclear. One factor that may have contributed to the lack of thermal redistribution in our patients was use of the 37Company suits in all patients. To the extent that the suits provided effective passive insulation in the control patients, it would diminish the apparent effect of prewarming.

More likely, though, minimal redistribution in patients who were not prewarmed results from changes in clinical routine over the years. Specifically, previous studies were largely conducted at a time when patients were almost uniformly admitted the night before surgery, and when hospitals may have been kept cooler. Patients are now almost always admitted from home and, possibly, arrive at the hospital effectively prewarmed with high body heat content and low core-to-peripheral tissue temperature gradients. Consistent with this theory, older studies in our meta-analysis tended to demonstrate the most benefit, ranging from 0.72°C in 1992 to

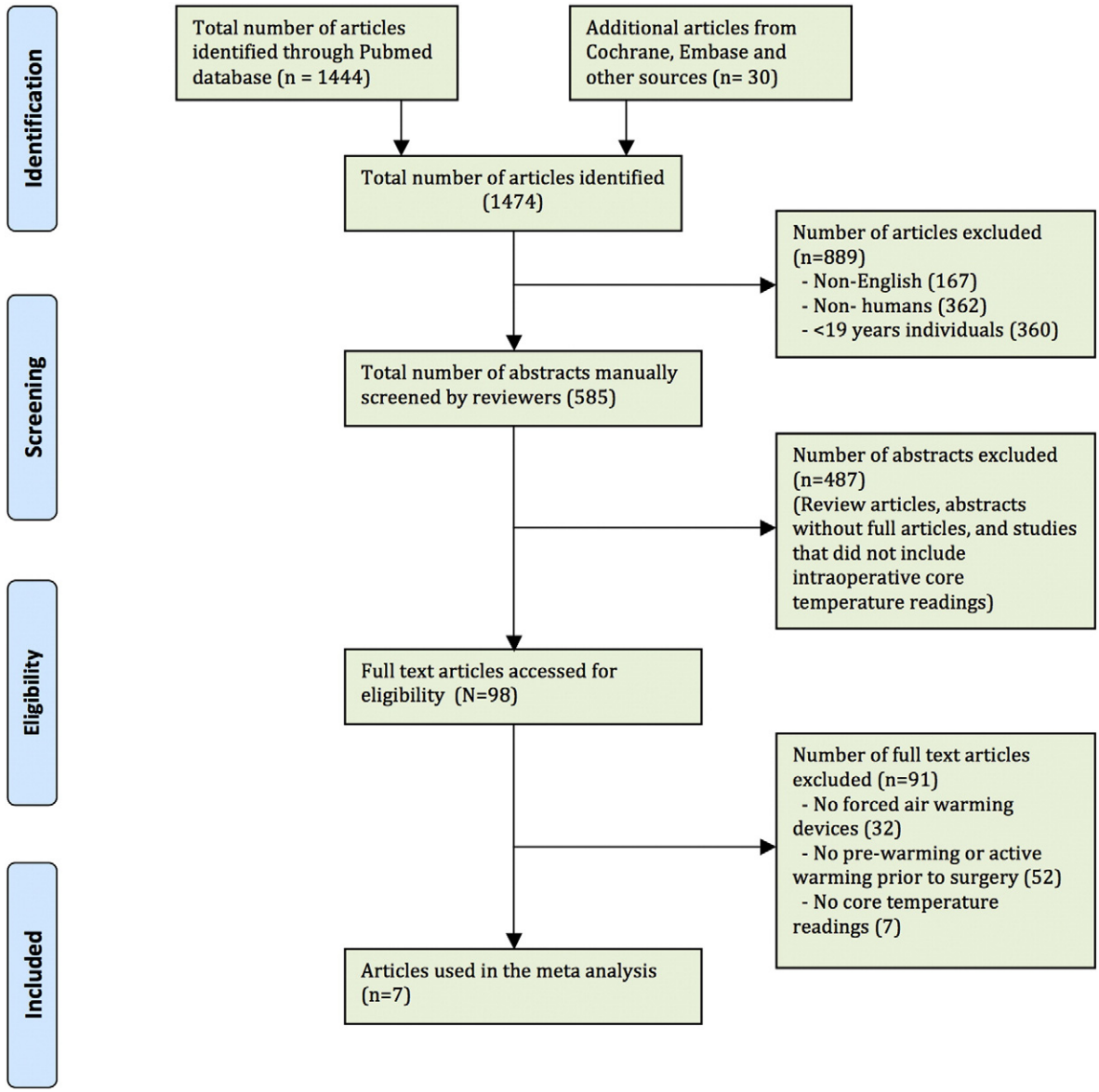


Fig. 3 Identification of published articles used for meta-analysis of intraoperative thermal redistribution.

0.14°C in our current patients. Overall, the meta-analysis shows a highly significant average 0.4°C benefit of prewarming.

Most studies in our meta-analysis were given Jadad scores below 3, traditionally viewed as low-quality studies [21]. However, this study quality indicator may be misleading because the scale emphasizes blinding. It is virtually impossible to blind the study subjects in a prewarming trial; furthermore, core temperature is an objective measure. None of the studies in the meta-analysis (including ours) received credit for double blinding. Given the technical challenges of double-blinding this sort of study, we considered almost all publications included in the meta-analysis to be of good quality.

Autonomic thermoregulatory defenses (ie, sweating and vasoconstriction) are 80% to 90% determined by core temperature with only minimal contribution from the skin [23–25]. In contrast, thermal comfort is 50% determined by mean skin temperature [26]. It is thus unsurprising that cutaneous warming would increase the sensation of warmth, even with little change in core temperature. Thermal comfort in our prewarmed patients increased from 50 mm to 60 mm on a 100-mm scale, whereas core temperature only increased 0.2°C. Previous work has similarly shown that prewarming increases the sensation of warmth and that warming per se does not reduce anxiety [27].

The sensation of warmth was maintained postoperatively, with prewarmed patients feeling significantly warmer after surgery. It is worth noting, though, that patients who were not prewarmed had thermal comfort scores of approximately 50 mm both before and after surgery, a value defined as thermoneutral. That the scores were so high is consistent with the theory postulated above that surgical patients are now kept warmer than in previous years. The Hawthorne effect may also

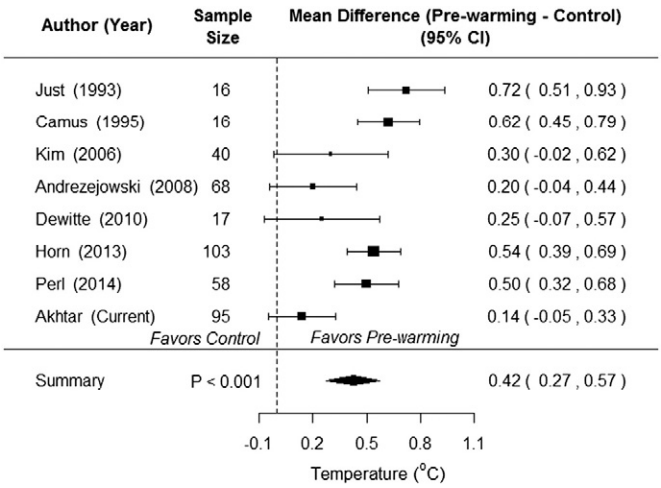


Fig. 4 Meta-analysis comparing prewarming vs control on temperature in first hour. Treatment effect expressed as mean difference in temperature. Overall, prewarming increased temperature by an estimated 0.42°C (95% CI, 0.27-0.57; $P < .001$). Heterogeneity was observed (Q statistic $P < .001$ and $I^2 = 76\%$), but all point estimates of the treatment effect favored prewarming. CI = confidence interval.

have contributed, in that clinicians may have paid particular attention to preoperative thermal comfort in the control patients simply because they were enrolled in a thermoregulatory study.

Our primary outcome was postoperative patient satisfaction because we assumed, based on previous work, that active prewarming would increase thermal comfort—as it did. However, we also assumed that prewarming would reduce redistribution hypothermia and thus reduce initial postoperative temperatures. In fact, the amount of redistribution hypothermia was similar in each group, as were postoperative temperatures. Postoperative thermal comfort scores were significantly greater in prewarmed patients, but only slightly so. Postoperative satisfaction as determined by EVAN-G score was similar in patients assigned to passive insulation vs active prewarming, suggesting that feeling slightly warmer had little influence on overall satisfaction. This conclusion is consistent with a previous study that evaluated patient satisfaction on the first postoperative day [28].

Our study differs from most others in being restricted to outpatients, none of whom was having major surgery. Although the amount of redistribution hypothermia probably does not much depend on operation size, temperature changes thereafter are determined by the difference between metabolic heat production and heat loss—which is presumably greater in larger operations [29].

A study dating from 1994 showed that heat transfer with various forced-air warmers available at the time was roughly comparable. [10] In the 2 decades since, many new systems have been developed, and there have been substantial changes

Table 3 Meta-analysis study summaries and quality evaluation

Study	Randomized trial	n	Treatment groups	Anesthesia type	Surgery type	Prewarming time (min)	Warming system	Jadad score + Concealed allocation
Andrzejowski (2008)	Yes	68	Prewarming; Standard of care	General	Spinal surgeries	60	FAW	3 + 1
Camus (1995)	Yes	16	Prewarming; wool blanket	General	Laparoscopic cholecystectomy	60	FAW	2 + 0
De Witte (2009)	Yes	27	No prewarming; prewarming; carbon-fiber prewarming	General	Laparoscopic colorectal surgery	30	FAW	2 + 1
Horn (2012)	Yes	200	No prewarming: 10, 20, 30 min; prewarming: 10, 20, 30 min	General	Laparoscopic cholecystectomy, inguinal hernia repair; breast surgery; minor orthopedic surgery	10, 20, 30	FAW	2 + 1
Just (1993)	Yes	16	Prewarming; no prewarming	General	Orthopedics/ arthroplasty	>90	FAW	1 + 0
Kim (2005)	Yes	40	Prewarming; warmed cotton blanket and warmed mattress	General	Cardiac bypass surgery	60	FAW	2 + 1
Perl (2014)	Yes	58	Prewarming; no prewarming	General	Various elective surgical procedures	30-60	FAW	3 + 1
Akhtar (current)	Yes	95	Prewarming; no prewarming	General	Various elective ambulatory surgical procedures	30-60	FAW	3 + 1

FAW = forced-air warming.

in blower and cover technology. A more recent report by the National Health Service Purchasing and Supply Agency notes that heat delivered to the patient depends on various factors, such as air temperature, air flow, and blanket design. Comparing temperature and air velocity under the blanket, they find similar results for all evaluated devices [30,31]. Curiously, there has not been another quantitative comparison of heat flux among currently available forced-air warmers, much less formal comparison of forced-air to other warming systems that are now available. Heat transfer with modern forced-air system has thus not been formally compared with other available warming systems. Differences in prewarming efficacy may result from differences in warming system efficacy.

In summary, forced-air prewarming increased the sensation of warmth preoperatively and postoperatively. However, prewarming did not significantly reduce redistribution hypothermia; mean postoperative core temperatures were not different in patients randomized to passive insulation or active prewarming. Postoperative patient satisfaction was not significantly different between groups, suggesting that factors other than the modest difference in postoperative thermal comfort dominated patient assessments.

Acknowledgments

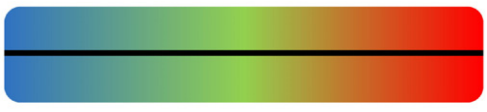
We thank the perioperative nursing personnel at the Cleveland Clinic Main Campus and Cleveland Clinic Fairview Hospital for their support in this study. We also appreciate support from the anesthesia and surgical teams.

Appendix 1

1) Cold, Warm, Posture (position) in your bed (0-100)
2) Feeling of thirst, hunger, nausea, headache (0-100)
(0 = completely unsatisfied, 100 = completely satisfied)

Evaluation du Vécu de l'Anesthésie Générale (EVAN-G) discomfort domain[1]

Appendix 2



Visual Analogue Scale

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