

AORN Guideline for Patient Temperature Management
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
1	Clinical Practice Guideline The Management of Inadvertent Perioperative Hypothermia in Adults. NICE Clinical Guidelines, No. 65. http://www.ncbi.nlm.nih.gov/books/NBK53797/ ; https://www.nice.org.uk/guidance/cg65 ed. ; 2016. .	Guideline	N/A	N/A	N/A	N/A	Provides recommendations for preventing hypothermia.	IVB
2	Akers JL, Dupnick AC, Hillman EL, Bauer AG, Kinker LM, Hagedorn Wonder A. Inadvertent Perioperative Hypothermia Risks and Postoperative Complications: A Retrospective Study. AORN J. 2019;109(6):741–747.	Nonexperimental	298 adult surgical patients at a single hospital	n/a	n/a	Perioperative hypothermia, postoperative complications (eg, low hemoglobin/hematocrit, need for blood transfusion, sepsis, SSI, pneumonia, mortality)	Found that older adults were at increased risk for perioperative hypothermia and that postoperative complications of anemia, sepsis, and mortality were significantly associated with perioperative hypothermia. Recommended development of policies and procedures that help RNs identify patients at risk of hypothermia, assess and document temperatures, and implement warming practices.	IIIB
3	Choi J, Kim D, Kim J, Lee E, Kim J. A retrospective analysis on the relationship between intraoperative hypothermia and postoperative ileus after laparoscopic colorectal surgery. PLoS One. 2018;13(1):e0190711.	Nonexperimental	637 adult laparoscopic colorectal surgery patients	n/a	n/a	Core temperature and incidence of postoperative ileus	Intraoperative hypothermia was common and associated with longer hospital stay.	IIIA
4	Sessler DI. Thermoregulatory defense mechanisms. Crit Care Med. 2009;37(7 Suppl):S203-S210.	Expert opinion	N/A	N/A	N/A	N/A	Describes mechanisms of thermoregulation.	VA
5	Frequently Asked Questions: MHAUS. Malignant Hyperthermia (MHAUS) Web site. https://www.mhaus.org/faqs/	Expert Opinion	n/a	n/a	n/a	n/a	Answers to frequently asked questions related to malignant hyperthermia.	VB
6	Lu Z, Rosenberg H, Li G. Prevalence of malignant hyperthermia diagnosis in hospital discharge records in California, Florida, New York, and Wisconsin. J Clin Anesth. 2017;39:10–14.	Nonexperimental	9,745,539 inpatient discharge records from California, Florida, New York, and Wisconsin, including 164 with MH diagnosis	n/a	n/a	Prevalence of MH	There is modest variation in the prevalence of MH diagnosis among hospital discharges in California, Florida, New York, and Wisconsin, but epidemiologic patterns are similar across the four states.	IIIB
7	Rosenberg H, Pollock N, Schiemann A, Bulger T, Stowell K. Malignant hyperthermia: a review. Orphanet J Rare Dis. 2015;10:93–1.	Literature Review	n/a	n/a	n/a	n/a	Summary of diagnostic, management, and treatment practices for malignant hyperthermia.	VA
8	Spruce L. Guideline for Implementation of Enhanced Recovery After Surgery. Kyle E, ed.; 2024:339–374.	Guideline	n/a	n/a	n/a	n/a	Provides guidance for implementation of enhanced recovery after surgery.	IVA

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9	Cahn J. Guideline for Medication Safety. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for medication safety in the perioperative setting.	IVA
10	Kyle E, Spruce L. Guideline for Medical Device and Product Evaluation. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for medical device and product evaluation.	IVA
11	Birch DW, Dang JT, Switzer NJ, et al. Heated insufflation with or without humidification for laparoscopic abdominal surgery. <i>Cochrane Database Syst Rev</i> . 2016;10:CD007821.	Systematic Review w/ Meta-Analysis	1428 adults and children undergoing abdominal laparoscopic surgery; 22 RCTs	Heated, with or without humidification, CO2 insufflation	Cold CO2 insufflation	Primary: core temperature; secondary: postoperative pain, morphine consumption, hospital stay, PACU stay, lens fogging, operative time, major adverse events	The clinical significance of heated, humidified CO2 insufflation is unclear in patients undergoing laparoscopic abdominal surgery. There were no significant differences in serious adverse events and no reductions in length of PACU or hospital stay, lens fogging, or operating time. Results should be interpreted with caution due to study design limitations. Recommend use of external warming devices and warmed irrigation over this intervention, which adds cost to cases.	IA
12	Shaw CA, Steelman VM, DeBerg J, Schweizer ML. Effectiveness of active and passive warming for the prevention of inadvertent hypothermia in patients receiving neuraxial anesthesia: A systematic review and meta-analysis of randomized controlled trials. <i>J Clin Anesth</i> . 2017;38:93-104.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Active warming is more effective against inadvertent hypothermia than passive warming in patients receiving neuraxial anesthesia. Additional research comparing the effectiveness of different active warming methods is needed.	IB
13	Sessler DI, Pei L, Li K, et al. Aggressive intraoperative warming versus routine thermal management during non-cardiac surgery (PROTECT): a multicentre, parallel group, superiority trial. <i>Lancet</i> . 2022;399(10337):1799.	Quasi-experimental	5013 non-cardiac surgical patients > 45 years old	Aggressive warming (forced air 30 minute prewarming at 43, intraoperative forced air warming with two units, warmed IV fluids)	Routine thermal management (no prewarming, only rescue forced air warming if 35.5 C intraoperatively)	Myocardial injury, non-fatal arrest, mortality; infection, transfusion, length of stay, readmission	The incidence of myocardial injury, surgical site infection, and the need for transfusion did not differ significantly between surgical patients randomized to aggressive warming to 37 C versus routine thermal management to 35.5 C. Patients in the aggressive warming group had a mean final core temperature of 37.1 C vs. 35.6 C in the routine care group. Maintaining core temperature of at least 35.5 C in surgical patients appears adequate to prevent major complications.	IIA
14	Luo J, Zhou L, Lin S, Yan W, Huang L, Liang S. Beneficial effect of fluid warming in elderly patients with bladder cancer undergoing Da Vinci robotic-assisted laparoscopic radical cystectomy. <i>Clinics (Sao Paulo, Brazil)</i> . 2020;75:e1639.	RCT	108 older adults undergoing robotic-assisted laparoscopic radical cystectomy	Warmed fluids at 41 C	Warming blanket at 43 C	Body temperature, EBL, operative characteristics, complications, shivering, laboratory results	Fluid warming effectively reduces the need to transfuse and length of hospitalization, maintains intraoperative normothermia, and supports postoperative coagulation function in older adults undergoing robotic-assisted laparoscopic radical cystectomy.	IB

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15	Erdogan H, Isil CT, Turk HS, Ergen G, Oba S. Comparison of forced-air warming systems and intravenous fluid warmers in the prevention of pediatric perioperative hypothermia. Haseki tip bulteni. 2019;57(3):225.	Quasi-experimental	200 elective surgery patients between 0 to 6 years old	IV fluid warming	Forced air warming underbody blanket	Body temperature, need for rescue warming for intraoperative temperatures < 36 C	Intravenous fluid warming is as effective as forced air warming against perioperative hypothermia in pediatric elective surgery patients. Procedure duration and ambient OR temperature were associated with incidence of hypothermia.	IIA
16	Thapa HP, Kerton AJ, Peyton PJ. Comparison of the EasyWarm® self-heating blanket with the Cocoon forced-air warming blanket in preventing intraoperative hypothermia. Anaesthesia and intensive care. 2019;47(2):169.	RCT	39 patients undergoing elective surgery	Self-heating blanket	Forced-air warming blanket	Nasopharyngeal temperature at end of procedure	The self-heating blanket was as effective as forced-air warming in preventing intraoperative hypothermia in patients undergoing elective surgery > 1 hour in the supine position. The self-heating blanket could also be used for preoperative warming.	IB
17	Gulia A, Gupta N, Kumar V, et al. Comparison of two forced air warming systems for prevention of intraoperative hypothermia in carcinoma colon patients: a prospective randomized study. Journal of clinical monitoring and computing. 2022;36(1):215.	RCT	60 adult patients undergoing laparoscopic colon surgery	Underbody forced-air warming blanket at 44 C	Over body forced-air warming blanket at 44 C	Core body temperature by nasopharyngeal probe; time to reach Aldrete score of 10, side effects (eg, shivering, sweating)	Underbody and over body forced air warming blankets are comparably effective in maintenance of core temperature of patients undergoing laparoscopic colon surgery.	IB
18	Del Vecchio JJ, Chemes LN, Ghioldi ME, Dealbera ED, Daniel Morgillo P. Comparison of two forced-air warming devices during foot and ankle surgery: a randomised controlled trial. Journal of perioperative practice. 2020;30(11):340.	RCT	35 patients undergoing foot and ankle surgery	Underbody forced air warming blanket at 43 C	Over body forced air warming blanket at 43 C	Temperature measured by self-adhesive electrode; side effects and complications	Findings support use of under body forced air warming blankets in patients undergoing foot and ankle surgery. Recommend additional intervention (eg, prewarming) in addition to intraoperative active warming to prevent inadvertent perioperative hypothermia.	IB
19	Yoo JH, Ok SY, Kim SH, et al. Comparison of upper and lower body forced air blanket to prevent perioperative hypothermia in patients who underwent spinal surgery in prone position: a randomized controlled trial. Korean journal of anesthesiology. 2022;75(1):37.	RCT	120 elective spine surgery patients	Upper body forced air warming blanket	Lower body forced air warming blanket	Incidence of perioperative hypothermia; temperature changes, postoperative shivering, thermal comfort and satisfaction	An upper body forced-air warming blanket was more effective in preventing perioperative hypothermia than a lower body blanket in patients undergoing spine surgery in the prone position. High ambient temperature could reduce severe hypothermia and additional warming interventions should be implemented if long procedure duration is anticipated.	IA
20	Lee JJ, Choi GJ, Lee WJ, Choi SB, Kang H. Effect of active airway warming with a heated-humidified breathing circuit on core body temperature in patients under general anesthesia: a systematic review and meta-analysis with trial sequential analysis. Korean J Anesth. 2023;76(1):17-33.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	The research suggests that using a heated-humidified breathing circuit device can help mitigate the temperature decline and maintain intraoperative core temperature better than a conventional breathing circuit or a heat and moisture exchanger filter although it doesn't completely prevent hypothermia.	IA

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21	Zhuo Q, Xu J-, Zhang J, Ji B. Effect of active and passive warming on preventing hypothermia and shivering during cesarean delivery: a systematic review and meta-analysis of randomized controlled trials. BMC Pregnancy Childbirth. 2022;22(1):720.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Active warming is superior to passive warming in prevention of hypothermia and shivering in women undergoing cesarean delivery; however, there was no significant difference between active and passive warming on the temperature or incidence of hypothermia in newborns.	IA
22	Hosseini SR, Mohseni MG, Aghamir SMK, Rezaei H. Effect of Irrigation Solution Temperature on Complication of Percutaneous Nephrolithotomy: a Randomized Clinical Trial. Urology journal. 2019;16(6):525.	RCT	60 patients undergoing percutaneous nephrolithotomy (PCNL)	Warm irrigation solution at 37 C; cold solution at 20 C	Room temperature irrigation solution at 24 C	Core temperature by esophageal probe; complications (eg, shivering, postoperative pain)	Warming irrigation solution during percutaneous nephrolithotomy decreases hypothermia, postoperative pain, and shivering. Administration of warmed irrigation fluid is recommended during this procedure.	IB
23	Balki I, Khan JS, Staibano P, et al. Effect of Perioperative Active Body Surface Warming Systems on Analgesic and Clinical Outcomes: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Anesth Analg. 2020;131(5):1430–1443.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Active warming is effective for maintenance of normothermia, reducing surgical site infections, shivering, blood transfusions, and increasing patient satisfaction. It has no significant effect on postoperative pain or opioid use.	IA
24	Jun JH, Chung MH, Kim EM, et al. Effect of pre-warming on perioperative hypothermia during holmium laser enucleation of the prostate under spinal anesthesia: a prospective randomized controlled trial. BMC anesthesiology. 2018;18(1):201.	RCT	50 adult patients undergoing laser enucleation of prostate with spinal anesthesia	Forced air warming at 45 C for 20 minutes before spinal anesthesia	Passive insulation (warmed cotton blanket)	Temperature upon PACU admission; intraoperative temperatures, hypothermia on admission to PACU, perioperative shivering and thermal comfort	Prewarming at 45 C for 20 minutes before surgery significantly increased core temperature at PACU admission and decreased but did not eliminate the occurrence of shivering and hypothermia in patients undergoing laser enucleation of the prostate with spinal anesthesia. Recommended continuing prewarming of patients until immediately before administration of spinal anesthesia and possibly combining prewarming with intraoperative active warming.	IB
25	Fuganti CCT, Martinez EZ, Galvão CM. Effect of preheating on the maintenance of body temperature in surgical patients: a randomized clinical trial. Revista latino-americana de enfermagem. 2018;26:e3057.	RCT	86 adult elective gynecologic surgery patients	Preheating with forced air warming at 38 C for 20 minutes	Standard care (cotton sheets and blankets) for 20 minutes	Variation in body temperature measured by tympanic membrane	The effect of preheating with forced air warming at 38 C for 20 minutes on maintenance of body temperature was similar to standard care passive warming with blankets for elective gynecologic surgery patients.	IA

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26	Becerra A, Valencia L, Saavedra P, Rodríguez-Pérez A, Villar J. Effect of prewarming on body temperature in short-term bladder or prostatic transurethral resection under general anesthesia: a randomized, double-blind, controlled trial. Scientific reports. 2021;11(1):20762.	RCT	297 elective bladder or prostate transurethral resection patients	Prewarming with forced air warming at 43 C for 15, 30, or 45 minutes	No prewarming	Difference in core temperature between treatment groups; postoperative hypothermia, shivering, pain, length of PACU stay, postoperative complications	Prewarming with forced air warming at 43 C for at least 15 minutes decreases hypothermia and reduces the decline of perioperative body temperature. Prewarming for 15, 30, and 45 minutes was comparably effective in raising temperature compared to no prewarming. Prewarming also decreased postoperative shivering, pain, and length of stay in PACU.	IA
27	Sampurno S, Chittleborough T, Dean M, et al. Effect of Surgical Humidification on Inflammation and Peritoneal Trauma in Colorectal Cancer Surgery: a Randomized Controlled Trial. Annals of surgical oncology. 2022;29(12):7911.	RCT	66 laparoscopic colorectal surgery patients; 19 laparotomy colorectal surgery patients	Humidified warm CO2 insufflation	Dry cold CO2 insufflation	Peritoneal tissue damage; core temperature, relationship between humidification and systemic inflammation, length of stay	Use of humidified, warmed CO2 insufflation protects peritoneal tissue, reduces inflammation, and assists in restoration of core body temperature during colorectal cancer surgery, but the effect on core body temperature is observed after surgery duration of 3 hours.	IB
28	He LP, Liu PZ, Wen YM, Wu J. Effect of temperature maintenance by forced-air warming blankets of different temperatures on changes in inflammatory factors in children undergoing congenital hip dislocation surgery. Chinese medical journal. 2020;133(15):1768.	RCT	123 pediatric patients undergoing orthopedic surgery for developmental displacement of the hip (DDH)	Forced air warming at 32 C, 38 C, or 43 C	Forced air warming at 32 C, 38 C, or 43 C	Body temperature, serum levels of inflammatory factors	Forced air warming at 38 C was most effective for maintenance of stable body temperature with fewer adverse outcomes postoperatively compared to warming at 32 C and 43 C in pediatric patients undergoing orthopedic surgery for developmental hip displacement. Forced air warming at 38 C may also inhibit an inflammatory response in this population.	IA
29	Kang S, Park S. Effect of the ASPAN Guideline on Perioperative Hypothermia Among Patients With Upper Extremity Surgery Under General Anesthesia: a Randomized Controlled Trial. Journal of perianesthesia nursing : official journal of the american society of perianesthesia nurses. 2020;35(3):298.	RCT	51 patients undergoing upper extremity surgery with general anesthesia	Active (forced air warming, IV fluid warming) and passive warming (head turban, sleeping socks, warmed regular hospital blanket) during the perioperative period	No warming interventions	Body temperature by tympanic thermometer, shivering, thermal comfort and discomfort	Combining passive and active warming interventions was effective in preventing hypothermia and shivering in patients undergoing upper extremity surgery with general anesthesia. Warming also resulted in greater thermal comfort and less thermal discomfort of the experimental group compared the control group. The ASPAN hypothermia guideline should be used as the basis for development of an evidence-based guideline in South Korea.	IA

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30	Cotoia A, Mariotti PS, Ferialdi C, et al. Effectiveness of Combined Strategies for the Prevention of Hypothermia Measured by Noninvasive Zero-Heat Flux Thermometer During Cesarean Section. <i>Front Med (Lausanne)</i> . 2021;8:734768.	RCT	78 patients undergoing cesarean delivery with spinal anesthesia	Warmed IV fluids only or warmed IV fluids with forced air warming at 43 C	Room temperature IV fluids, no warming	Maternal core temperature measured by zero-heat-flux thermometry; shivering, thermal comfort, blood loss; Apgar scores, neonatal axillary temperatures	Combining active warming methods prevented perioperative hypothermia, increased maternal core temperature, reduced shivering, and decreased the overall decline in core temperature throughout the perioperative period in patients undergoing elective cesarean delivery under spinal anesthesia compared to use of warmed fluids alone or no warming at all.	IA
31	Pei L, Huang Y, Xu Y, et al. Effects of Ambient Temperature and Forced-air Warming on Intraoperative Core Temperature: a Factorial Randomized Trial. <i>Anesthesiology</i> . 2018;128(5):903.	RCT	292 adult patients undergoing major noncardiac surgery with general anesthesia	Ambient OR temperature at 19 C, 21 C, or 23 C with forced air warming	Ambient OR temperature at 19 C, 21 C, or 23 C with out forced air warming at 43 C	Rate of core temperature change after induction and core temperature change; final intraoperative core temperature	Ambient OR temperature has a negligible effect on core temperature when forced air warming is used and only a small effect on passively insulated patients. Therefore, ambient OR temperature can be set to the comfort of the perioperative team when patients are actively warmed.	IB
32	Ni TT, Zhou ZF, He B, Zhou QH. Effects of combined warmed preoperative forced-air and warmed perioperative intravenous fluids on maternal temperature during cesarean section: a prospective, randomized, controlled clinical trial. <i>BMC anesthesiology</i> . 2020;20(1):48.	RCT	135 patients undergoing cesarean delivery with spinal anesthesia	30 min prewarming with forced air warming at 43 C and IV fluids warmed to 37 C until end of procedure	No prewarming or warmed IV fluids	Core temperature; thermal comfort, shivering, hypothermia incidence, neonatal axillary temperature, Apgar scores	Prewarming with forced air warming and administering warmed IV fluids decreased overall core temperature decline, reduced the incidence of perioperative hypothermia and shivering, and increased thermal comfort in patients undergoing cesarean delivery with spinal anesthesia compared to patients who did not receive any warming interventions.	IA
33	He Y, Feng YG, He J, et al. Effects of irrigation fluid temperature during flexible ureteroscopic holmium laser lithotripsy on postoperative fever and shivering: a randomized controlled trial. <i>BMC urology</i> . 2021;21(1):72.	RCT	108 patients undergoing ureteroscopic holmium laser lithotripsy	Irrigation fluid at 37 C; irrigation fluid at 17 C	Irrigation fluid at 27 C	Postoperative fever > 37.5 C; core body temperature by tympanic thermometer, shivering, WBC count, serum procalcitonin level, incidence of suspected infection, duration of hospital stay	Warming irrigation fluid during flexible ureteroscopic lithotripsy can reduce postoperative fever and shivering, but further research is needed to determine the optimal irrigation fluid temperature. Core temperature at the end of the procedure was significantly lower in the 17 C group than the other two groups. Decisions about irrigation fluid temperature should consider the patient's individual cardiac risk and the anticipated duration of surgery.	IB
34	Canturk M, Hakki M, Kocaoglu N. Effects of Isothermic Irrigation on Core Body Temperature During Endoscopic Urethral Stone Treatment Surgery Under Spinal Anesthesia: a Randomized Controlled Trial. <i>Urology journal</i> . 2020;17(1):1.	RCT	60 patients undergoing endoscopic urethral stone surgery with spinal anesthesia	Irrigation fluids warmed to 37 C	Room temperature irrigation fluids	Core temperature, shivering, surgeon comfort	Warming irrigation fluid during endoscopic urethral stone surgery done under spinal anesthesia decreased intraoperative hypothermia and shivering and increased surgeon comfort.	IA

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35	Bayter-Marín JE, Cárdenas-Camarena L, Durán H, Valedon A, Rubio J, Macías AA. Effects of Thermal Protection in Patients Undergoing Body Contouring Procedures: a Controlled Clinical Trial. <i>Aesthet surg J</i> . 2018;38(4):448.	RCT	122 plastic surgery patients undergoing procedures > 3.5 hours	Maintenance of OR temperature between 20 to 22 C during surgery, warmed IV fluids (37.5 C) and irrigation (37 C) or same OR temperature and warmed fluids in addition to prewarming for 1 hour at 39 C with forced air warming	No thermal protection measures (standard care)	Core temperature measured by esophageal probe, degree of hypothermia; recovery time, shivering, pain, cold perception, opioids administered, nausea	Hypothermia is common in patients undergoing major plastic surgery > 3.5 hours, especially when no thermal protection measures are implemented. A combination of interventions that included maintaining the OR temperature between 20 to 22 C, warming IV fluids and irrigation solutions, and prewarming patients for 1 hour before surgery was found to be most effective against intraoperative hypothermia.	IB
36	Jun JH, Chung MH, Jun JJ, et al. Efficacy of forced-air warming and warmed intravenous fluid for prevention of hypothermia and shivering during caesarean delivery under spinal anaesthesia: a randomised controlled trial. <i>European journal of anaesthesiology</i> . 2019;36(6):442.	RCT	50 patients undergoing cesarean delivery with spinal anesthesia	Active warming (15 minute prewarming with forced air warming at 41 C and intraoperative IV fluids prewarmed to 41 C)	No active warming or warmed fluids	Incidence of hypothermia based on tympanic membrane temperature, shivering severity, thermal comfort; neonatal temperature, Apgar scores	Combining whole body forced air prewarming and intraoperative warmed IV fluids effectively prevented hypothermia and reduced the incidence of shivering in patients undergoing cesarean delivery with spinal anesthesia.	IA
37	Baradaranfard F, Jabalameli M, Ghadami A, Aarabi A. Evaluation of Warming Effectiveness on Physiological Indices of Patients Undergoing Laparoscopic Cholecystectomy Surgery: a Randomized Controlled Clinical Trial. <i>Journal of perianesthesia nursing</i> . 2019;34(5):1016.	RCT	96 laparoscopic cholecystectomy patients	Forced air warming at 42 C on lower limbs intraoperatively and whole body after surgery or IV fluids prewarmed to 38 C with routine intraoperative drapes	Routine care (routine drapes intraoperatively and blankets in PACU)	Physiological indices (tympanic temperature, blood pressure, heart rate), postoperative shivering	The effects of forced air warming, warmed IV fluids, and routine care were all similar in preventing hypothermia in laparoscopic cholecystectomy patients. Using an underbody warming blanket or covering a larger area of the body may be more effective over use of routine blankets, and additional research investigating the effectiveness of warming methods in this patient population is needed.	IA
38	Nieh HS, Shu-Fen. Forced-Air Warming for Rewarming and Comfort Following Laparoscopy: A Randomized Controlled Trail. <i>Clin Nurs Res</i> . 2018;27(5):540-559. doi:10.1177/1054773817708082.	RCT	127 patients undergoing laparoscopic thoracic or abdominal surgery	Lower body forced air warming at 43 C applied intraoperatively and postoperatively	Standard care of heated cotton blankets to lower body intraoperatively, radiant warming to chest and lower body in PACU	Change in core temperature and thermal comfort	Forced air warming more effectively and quickly rewarmed patients in PACU compared to a heated blanket with radiant warming system. Forced air warming also had a greater effect on thermal comfort compared to standard care.	IA

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39	Kaufner, L., Niggemann, P., Baum, T., et al. Impact of brief prewarming on anesthesia-related core-temperature drop, hemodynamics, microperfusion and postoperative ventilation in cytoreductive surgery of ovarian cancer: a randomized trial 2019	RCT	47 women undergoing surgery for ovarian cancer	Forced air prewarming at 43 C for 30 minutes during epidural catheter insertion	Passive insulation (cotton blanket) during epidural catheter insertion	Core body temperature changes between groups at established points	Forced air prewarming at 43 C during placement of epidural catheter and induction of general anesthesia was found to decrease the drop in core temperature and help maintain intraoperative normothermia at the end of surgery and at two hours post-ICU admit. Patients receiving forced-air warming had no shivering or mechanical ventilation related to hypothermia postoperatively.	IB
40	de Brito Poveda, Vanessa, Oliveira, Ramon A. and Galvao, Cristina M. Perioperative body temperature maintenance and occurrence of surgical site infection: A systematic review with meta-analysis 2020	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	The evidence associating active warming methods with surgical site infection remains unclear and more research is needed to determine the effect of active warming method on the occurrence of surgical site infection.	IIIA
41	Tyvold, S. S. Preventing hypothermia in outpatient plastic surgery by self-warming or forced-air-warming blanket: a randomised controlled trial 2019	RCT	112 plastic surgery patients	Self-warming blanket	Forced air warming blanket	Core temperature measured by zero-heat-flux sensor	Forced air underbody blanket was more effective in reducing hypothermia incidence than a self-warming blanket, but inadvertent perioperative hypothermia was not completely prevented by either intervention.	IA
42	Ralte P, Mateu-Torres F, Winton J, et al. Prevention of Perioperative Hypothermia: a Prospective, Randomized, Controlled Trial of Bair Hugger Versus Inditherm in Patients Undergoing Elective Arthroscopic Shoulder Surgery. Arthroscopy. 2020;36(2):347.	RCT	102 elective arthroscopic shoulder surgery patients	Inditherm mattress	Bair Hugger blanket	Core body temperature measured by nasopharyngeal probe	Core body temperature was statistically significantly higher in the Bair Hugger group compared to the Inditherm mattress group, but the difference was not clinically significant. Fewer patients in the Bair Hugger group were hypothermic at the end of surgery, however, the study was not powered to measure prevention of hypothermia. The study findings support the use of the Bair Hugger in elective arthroscopic shoulder surgery.	IA
43	Min SH, Yoon S, Yoon SH, Bahk JH, Seo JH. Randomised trial comparing forced-air warming to the upper or lower body to prevent hypothermia during thoracoscopic surgery in the lateral decubitus position. British journal of anaesthesia. 2018;120(3):555.	RCT	123 patients undergoing thoracoscopy under general anesthesia	Upper body forced air warming blanket	Lower body forced air warming blanket	Incidence of intraoperative hypothermia (nasopharyngeal temperature < 36 C); body temperature, hypothermia, need for additional warming, shivering, thermal discomfort, adverse events, recovery time	Upper body forced air warming was more effective in preventing hypothermia compared to lower body forced air warming in patients undergoing thoracoscopy in the lateral position. Upper and lower body warming should be used together for patients at high risk of hypothermia when possible.	IA

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44	da Silva Feu Santos RM, de Fatima Santana Ferreira Boin I, Caruy CAA, Cintra EA, Torres NA, Duarte HN. Randomized clinical study comparing active heating methods for prevention of intraoperative hypothermia in gastroenterology. <i>Revista latino-americana de enfermagem</i> . 2019;27:e3103.	RCT	75 gastroenterological surgery patients	Thermal mattress at 38 C; heated infusions at 41 C	Forced air warming underbody blanket at 40-43 C	Core temperature	There was no significant difference between the tested active warming methods (ie, thermal mattress, heated infusions, forced air warming) and none were effective in preventing hypothermia (< 36 C) in patients undergoing open gastroenterological surgery.	IB
45	Kumin M, Jones CI, Woods A, et al. Resistant fabric warming is a viable alternative to forced-air warming to prevent inadvertent perioperative hypothermia during hemiarthroplasty in the elderly. <i>Journal of hospital infection</i> . 2021;118:79.	RCT	257 older adults undergoing non-elective hemiarthroplasty	Resistive fabric warming	Forced air warming	Core temperature measured by zero-heat-flux sensor, incidence of hypothermia < 36.5 C and < 36 C, cumulative hypothermia duration	Resistive fabric warming was as effective as forced air warming in preventing inadvertent perioperative hypothermia in older adults undergoing non-elective hemiarthroplasty. Additional research is needed to determine the best method of warming patients to prevent SSI and a standard definition for perioperative hypothermia.	IB
46	Lauronen SL, Kalliovalkama J, Aho A, et al. Self-warming blanket versus forced-air warming blanket during total knee arthroplasty under spinal anaesthesia: a randomised non-inferiority trial. <i>Acta anaesthesiologica Scandinavica</i> . 2023;67(8):1102.	RCT	150 patients undergoing primary unilateral total knee arthroplasty with spinal anesthesia	Self-warming blanket	Forced air warming	Core temperature on admission to PACU; temperature changes, usability/convenience of warming methods, costs, postoperative complications	Both interventions increased mean body temperature preoperatively. Intraoperative hypothermia was common for both groups and rescue warming was needed. Core temperature upon admission to PACU did not vary significantly between groups.	IA
47	Verra WC, Beekhuizen SR, van Kampen PM, de Jager MC, Deijkers RLM, Tordoir RL. Self-Warming Blanket Versus Forced-Air Warming in Primary Knee or Hip Replacement: a Randomized Controlled Non-Inferiority Study. <i>Asian Journal of Anesthesiology</i> . 2018;56(4):128.	RCT	86 patients undergoing primary total hip or knee arthroplasty	Self-warming blanket for prewarming and intraoperative warming	Forced air warming	Lowest measured intraoperative temperature via zero-heat-flux sensor with tympanic temperature at end of surgery; core temperature, thermal comfort, complications	Both interventions were unable to prevent inadvertent perioperative hypothermia, with higher incidence of hypothermia in the self-warming blanket group. The 0.2 C statistically significant difference in core temperature between the two groups at the end of procedure was likely not clinically significant, leading to conclusion that the self-warming blanket was non-inferior to forced air warming.	IB
48	Ózsaban A, Acaro&gbreve, lu R. The Effect of Active Warming on Postoperative Hypothermia on Body Temperature and Thermal Comfort: a Randomized Controlled Trial. <i>Journal of perianesthesia nursing</i> . 2020;35(4):423.	RCT	64 PACU and ICU neurosurgery postoperative patients	Forced air warming at 43 C	Routine care with cotton blankets	Body temperature by axillary probe and tympanic probe; shivering, thermal comfort	Patients were more rapidly rewarmed and thermal comfort was increased with forced air warming compared to routine care with cotton blankets.	IA

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REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
49	Wittenborn J, Mathei D, van Waesberghe J, et al. The effect of warm and humidified gas insufflation in gynecological laparoscopy on maintenance of body temperature: a prospective randomized controlled multi-arm trial. Archives of gynecology and obstetrics. 2022;306(3):753.	RCT	150 patients undergoing gynecologic laparoscopic surgery	Warmed, humidified CO2 only (no forced air warming); warmed, humidified CO2 with forced air warming blanket	Forced air warming blanket with cold, dry CO2 insufflation gas	Incidence of hypothermia (< 36 C); body temperature by esophageal probe, duration of hypothermia, duration of recovery	Warmed, humidified CO2 insufflation on its own is not effective in preventing hypothermia. Combining warmed, humidified CO2 insufflation with forced air warming is the best option for optimizing temperature management of patients undergoing laparoscopic gynecologic surgery.	IB
50	Gunusen I, Akdemir A, Sarg&inodot, n A, Karaman S. The effects of CO2 pneumoperitoneum at different temperature and humidity on hemodynamic and respiratory parameters and postoperative pain in gynecological laparoscopic surgery: a prospective randomized controlled study. Asian journal of surgery / Asian Surgical Association. 2022;45(1):154.	RCT	100 ASA I-II patients 40-65 who underwent laparoscopic hysterectomy for benign pathology; 4 excluded intraoperatively for malignancy	Heated, humidified CO2 insufflation	Cold, dry CO2 insufflation with external forced air warming	Primary: hemodynamic and respiratory parameters (blood pressure, heart rate, pulse oximetry, end tidal Co2, temperature, peak pressure); secondary: pain scores, analgesic consumption, blood gas values, inflammation markers (leukocytes, neutrophils, NLR).	Heated, humidified CO2 insufflation produced a significantly increased inflammatory response and statistically significantly higher body temperature (although not clinically significant) in healthy patients compared to standard cold, dry CO2. Considering the cost of the heat/humidification device, heating and humidifying CO2 may not be necessary for healthy patients.	IB
51	Yan Y, Geng J, Cui X, Lei G, Wu L, Wang G. Thoracic Paravertebral Block Decreased Body Temperature in Thoracoscopic Lobectomy Patients: a Randomized Controlled Trial. Therapeutics and clinical risk management. 2023;19:67. ndomized Controlled Trial 2023	RCT	48 adults undergoing elective thoracoscopic lobectomy	General anesthesia with thoracic paravertebral block	General anesthesia	Primary outcome: core temperature at end of procedure; secondary outcomes: core temperature during surgery, intraoperative peripheral temperature	Thoracic paravertebral block raises the risk of hypothermia during thoracoscopic lobectomy. Monitoring core (esophageal) temperature is better than peripheral because changes in peripheral (axillary) temperature coincide with but lag changes in core (esophageal) temperature.	IA
52	Hara K, Kuroda H, Matsuura E, et al. Underbody blankets have a higher heating effect than overbody blankets in lithotomy position endoscopic surgery under general anesthesia: a randomized trial. Surgical endoscopy. 2022;36(1):670.	RCT	99 patients undergoing laparoscopic colon surgery in lithotomy	Forced air underbody blanket	Forced air overbody blanket	Intraoperative core temperature; peripheral temperature, blood loss, shivering, complications, length of stay	Using an underbody blanket was superior to an overbody blanket in raising core temperature and reducing shivering in patients undergoing colon surgery in the lithotomy position.	IB

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53	Steelman VM, Chae S, Duff J, Anderson MJ, Zaidi A. Warming of Irrigation Fluids for Prevention of Perioperative Hypothermia During Arthroscopy: A Systematic Review and Meta-analysis. <i>Arthroscopy J Arthroscopic Relat Surg.</i> 2018;34(3):930–942.e2.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Warming irrigation fluids for shoulder and hip arthroscopy reduces hypothermia risk, lessens the drop in intraoperative temperature, raises the lowest body temperature, and reduces postoperative shivering. There was insufficient data to determine the benefits during knee arthroscopy.	IIA
54	Zaman SS, Rahmani F, Majedi MA, Roshani D, Valiee S. A Clinical Trial of the Effect of Warm Intravenous Fluids on Core Temperature and Shivering in Patients Undergoing Abdominal Surgery. <i>J Perianesth Nurs.</i> 2018;33(5):616–625.	RCT	70 patients undergoing nonemergent abdominal surgery	IV fluid warmed to 38 C	IV fluids at room temperature	Core temperature, shivering, surgeon comfort	Warming solutions for infusion may prevent hypothermia and tachycardia and reduce postoperative shivering in patients undergoing abdominal surgery.	IB
55	Smith N, Abernethy C, Allgar V, Foster L, Martinson V, Stones E. An open-label, randomised controlled trial on the effectiveness of the Orve + wrap® versus Forced Air Warming in restoring normothermia in the postanesthetic care unit. <i>Journal of Clinical Nursing (John Wiley & Sons, Inc.).</i> 2020;29(7):1085–1093.	RCT	129 postsurgical patients with temperatures between 35 to 35.9 in PACU	Orve + wrap warmed to 50 C	Forced air warming	Mean temperature difference at 60-minutes post PACU admission, patient body temperature; length of stay, adverse events, shivering	The Orve + wrap was found to be noninferior to forced air warming in the postoperative phase for patients who arrived to PACU with temperature between 35.0 - 35.9 C.	IB
56	Tubog TD, Kane TD, Ericksen AM. Combined Forced Air Warming and Warm Intravenous Fluid Strategy for Perioperative Hypothermia in Cesarean Delivery: A Systematic Review and Meta-Analysis. <i>J Perianesth Nurs.</i> 2023;38(1):21–32.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Combining forced air warming with warmed IV fluids is effective in preventing perioperative hypothermia of patients undergoing cesarean delivery with neuraxial anesthesia.	IA
57	Lupo BL, Collins SB, Hewer I, Hooper VD. Comparing Forced-Air to Resistive-Polymer Warming for Perioperative Temperature Management: A Retrospective Study. <i>J Perianesth Nurs.</i> 2020;35(2):178–184.	Quasi-experimental	426 patients undergoing non-spine orthopedic surgery	Forced air warming device	Resistive-polymer heating device	Final intraoperative temperature, incidence of inadvertent perioperative hypothermia	Forced air warming was associated with higher final temperatures and more normothermic patients than resistive-polymer heating blankets, but no causal relationship between type of warming device and hypothermia can be made.	IIA
58	Moheb M, Rezaei M, Azizi-Fini I, Atoof F, Saadati MA. Comparison of the Effect of Forced-air Warming and Warmed Intravenous Fluid on the Comfort and Prevention of Shivering After Spinal Anesthesia in Patients Undergoing Orthopedic Surgery. <i>J Perianesth Nurs.</i> 2022;37(6):865–871.	RCT	120 adult patients undergoing lower extremity surgery with spinal anesthesia	Forced air warming at 38 C or warmed IV fluids at 37 C	No forced air warming or warmed IV fluids	Thermal comfort, shivering	Forced air warming and warmed IV fluids reduce shivering and improve thermal comfort of patients undergoing orthopedic lower extremity surgery with spinal anesthesia; forced air warming is most effective of the two interventions.	IA

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59	Wang J, Fang P, Sun G, Li M. Effect of active forced air warming during the first hour after anesthesia induction and intraoperation avoids hypothermia in elderly patients. <i>BMC ANESTHESIOLOGY</i> . 2022;22(1):1–9.	RCT	218 patients > 65 years old undergoing major laparoscopic abdominal surgery	Forced air warming at 42 C; forced air warming at 42 C for one hour, then 38 C until PACU	Forced air warming at 38 C	Core temperature by nasopharyngeal probe; recovery time, adverse effects, patient satisfaction and thermal comfort	Recommended intraoperative use of forced air warming at 42 C for the first hour, then 38 C for the remainder of surgery in elderly patients undergoing major laparoscopic abdominal surgery > 2 hours.	IA
60	Yang G, Zhu Z, Zheng H, He S, Zhang W, Sun Z. Effects of different thermal insulation methods on the nasopharyngeal temperature in patients undergoing laparoscopic hysterectomy: a prospective randomized controlled trial. <i>BMC ANESTHESIOLOGY</i> . 2021;21(1):1–5.	RCT	75 laparoscopic hysterectomy patients	Warming blanket at 38 C with IV fluid infusion thermometer at 37 C or incubator	Warming blanket at 38 C	Nasopharyngeal temperature; wake up time	Using a warming blanket at 38 C with an infusion thermometer at 37 C is more effective than a warming blanket with infusion incubator or warming blanket alone in maintaining perioperative thermal insulation in patients undergoing laparoscopic hysterectomy.	IB
61	Yarbrough A, Godsey J, Whitacre K, Waite C. Hypothermia in the Postoperative Patient: Implications and Opportunities for Medical-Surgical Nurses. <i>Medsurg Nurs</i> . 2021;30(1):14–19.	Nonexperimental	206 patients undergoing spinal fusion, open abdominal, or hip revision procedures	n/a	n/a	Temperature as indicator of hypothermia	Hypothermia was frequently documented in the OR. Variance in temperature measurement methods affected comparison of temperatures between perioperative areas. Recommended that med-surg RNs advocate for standardization of temperature devices for accurate, consistent measurement of temps across perioperative areas.	IIIB
62	Nordgren M, Hernborg O, Hamberg Å, Sandström E, Larsson G, Söderström L. The Effectiveness of Four Intervention Methods for Preventing Inadvertent Perioperative Hypothermia During Total Knee or Total Hip Arthroplasty. <i>AORN J</i> . 2020;111(3):303–312.	Quasi-experimental	120 adults undergoing primary elective unilateral total knee or total hip arthroplasty	Convective warming with prewarming, conductive warming with prewarming, reflective and convective warming without prewarming	Convective warming without prewarming	Incidence of inadvertent perioperative hypothermia; correlation between actual and experienced core temperature	Prewarming with a convective device was more effective at reducing inadvertent perioperative hypothermia in patients undergoing total hip or knee arthroplasty than a conductive self-warming blanket. Health care providers should measure the patient's core temperature instead of relying on the patient's perceptions of warmth or cold.	IIB
63	Yilmaz H, Khorshid L. The Effects of Active Warming on Core Body Temperature and Thermal Comfort in Patients After Transurethral Resection of the Prostate: A Randomized Clinical Trial. <i>Clin Nurs Res</i> . 2023;32(2):313–322.	RCT	105 male patients undergoing transurethral resection of the prostate with bladder irrigation	Warmed IV fluids at 36 C	Standard care with room temperature IV fluids and cotton blankets	Core body temperature, thermal comfort	Warmed IV fluids raised body temperature and increased thermal comfort in transurethral resection of the prostate patients postoperatively.	IA

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64	Brodshaug I, Tettum B, Raeder J. Thermal Suit or Forced Air Warming in Prevention of Perioperative Hypothermia: A Randomized Controlled Trial. <i>J Perianesth Nurs</i> . 2019;34(5):1006–1015.	RCT	30 spinal surgery patients	Full-body passive thermal suit during perioperative period (pre-, intra-, and postoperatively)	Intraoperative forced air warming with underbody, upper body, or lower body blanket at 43 or 44 C	Mean core temperature difference at 30 minutes after induction; incidence and duration of hypothermia, core temperature changes, thermal comfort, shivering, comparison between temperature measurement methods	Use of a passive thermal suit did not prevent unintended hypothermia at 30 minutes after anesthesia induction in patients undergoing spinal surgery. Forced air warming was significantly more effective at re-establishing normothermia.	IB
65	Cho S, Yoon S, Lee S, Jee Y, Cho C, Sung T. Clinical efficacy of short-term prewarming in elderly and adult patients: A prospective observational study. <i>Int J Med Sci</i> . 2022;19(10):1548–1556.	Nonexperimental	25 adult (20 - 50 yo) and 25 older adult (> 65 yo) patients undergoing ureteroscopic stone surgery under general anesthesia	n/a	n/a	Incidence and severity of intraoperative hypothermia; thermal comfort, shivering, need for active warming in PACU, changes in temperature	Short-term prewarming is less effective in preventing inadvertent hypothermia in elderly patients and additional interventions should be implemented to prevent inadvertent hypothermia in this population.	IIIB
66	Sari S, Aksoy SM, But A. The incidence of inadvertent perioperative hypothermia in patients undergoing general anesthesia and an examination of risk factors. <i>Int J Clin Pract</i> . 2021;75(6):e14103.	Nonexperimental	2015 surgical patients undergoing general anesthesia	n/a	n/a	Tympanic temperature before anesthesia induction, every 30 minutes intraoperatively, and 15 minutes postoperatively	Identified age > 65 years, BMI > 25, higher ASA scores, major surgery, endoscopic procedures, presence of comorbidities, anesthesia > 2 hours, and use of unwarmed fluids as risk factors for perioperative hypothermia. Recommended following published hypothermia prevention guidelines, routine monitoring of body temperature, increasing awareness of perioperative hypothermia through education, training in the use of active warming methods, and implementing active warming.	IIIA
67	Monteiro FLJ, Halpern H, Bortoli F, et al. Forced-Air Warming in Patients Undergoing Endovascular Procedures: Comparison between 2 Thermal Blanket Models. <i>Ann Vasc Surg</i> . 2019;47:98–103.	Quasi-experimental	50 patients undergoing endovascular surgery	Underbody forced air warming blanket	Upper body forced air warming blanket	Body temperature, incidence of hypothermia; variables affecting patient heating	The upper body forced air warming blanket was more effective than an underbody blanket in warming and prevention of hypothermia of patients undergoing endovascular surgery. Underbody blankets should be used only when upper body blankets are not feasible. Upper body blankets are preferred over underbody for medium length and longer procedures.	IIA

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68	Lee Y, Kim K. Optimal Application of Forced Air Warming to Prevent Peri-Operative Hypothermia during Abdominal Surgery: A Systematic Review and Meta-Analysis. <i>Int J Environ Res Public Health</i> . 2021;18(5):2517.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Forced air warming effectively prevents perioperative hypothermia in patients undergoing open and laparoscopic abdominal surgery. The upper body is the preferred site compared to the lower or full body.	IB
69	Mullhi R, Ewington I, Chipp E, Torlinski T. A descriptive survey of operating theatre and intensive care unit temperature management of burn patients in the United Kingdom. <i>Int J Burns Trauma</i> . 2021;11(3):136–144.	Qualitative	74 responses from health professionals working in UK burn services	n/a	n/a	Perceptions of hypo/hyperthermia, temperature monitoring and management strategies	Differences in perception between professional groups did not reach clinical or statistical significance. Hypothermia was most frequently managed by raising the room temperature and hyperthermia was most frequently managed by administering paracetamol.	IIIB
70	Koleini E, Cohen JS, Darwish OM, Pourafkari L, Rein L, Nader ND. Perioperative Hypothermia after Transurethral Surgeries: Is it Necessary to Heat the Irrigation Fluids? <i>Turk J Anaesthesiol Reanim</i> . 2020;48(5):391–398.	Nonexperimental	1632 male endoscopic urology procedure patients	Warmed irrigation	Room temperature irrigation	Incidence of hypothermia (< 36 C) on arrival to PACU; postoperative complications	Warming irrigation solutions during endoscopic urology procedures resulted in increased body temperature and reduced the risk of perioperative hypothermia but did not affect the incidence of postoperative complications.	IIIA
71	Grote R, Wetz A, Bräuer A, Menzel M. Short interruptions between pre-warming and intraoperative warming are associated with low intraoperative hypothermia rates. <i>Acta Anaesthesiol Scand</i> . 2020;64(4):489–493.	Nonexperimental	5084 adults undergoing general anesthesia	n/a	n/a	Incidence of intraoperative hypothermia	Short interruptions between pre- and intraoperative warming are associated with lower intraoperative hypothermia.	IIIB
72	Cho C, Chang M, Sung T, Jee YS. Incidence of postoperative hypothermia and its risk factors in adults undergoing orthopedic surgery under brachial plexus block: A retrospective cohort study. <i>Int J Med Sci</i> . 2021;18(10):2197–2203.	Nonexperimental	660 adults undergoing orthopedic surgery with brachial plexus block	n/a	n/a	Comparison of preoperative and postoperative tympanic membrane temperatures	40.6% of patients undergoing orthopedic surgery with brachial plexus block were hypothermic (< 36 C) upon arrival to PACU. Factors associated with postoperative hypothermia included lower preoperative baseline core temperature, alcohol abuse (> 3-4 drinks per day at least four times/wk), fentanyl use, arthroscopic shoulder surgery, use of midazolam with dexmedetomidine, greater volume of infusions, and longer surgery length. Recommended intraoperative body temperature monitoring and implementing strategies to mitigate the identified risks.	IIIA

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73	Jiang R, Sun Y, Wang H, Liang M, Xie X. Effect of different carbon dioxide (CO2) insufflation for laparoscopic colorectal surgery in elderly patients: A randomized controlled trial. <i>Medicine (Baltimore)</i> . 2019;98(41):e17520.	RCT	150 older adults undergoing laparoscopic colorectal surgery	Warmed 37 C, humidified CO2 insufflation only	Standard CO2 insufflation with electric warming blanket at 38 C or forced air warming at 38 C	Pain, sufentanil consumption; quality of visual image, hemodynamic and heart rate changes, esophageal/skin/body temperature, recovery time, shivering, time to flatus and food intake, complications	Warmed, humidified CO2 and standard insufflation with forced air warming at 38C effectively reduced intraoperative hypothermia, coagulation dysfunction, early postoperative cough pain, sufentanil consumption, days to first flatus and solid food intake, and length of hospital stay.	IB
74	Gabriel P, Höcker J, Steinfath M, Kutschick KR, Lubinska J, Horn E. Prevention of inadvertent perioperative hypothermia - Guideline compliance in German hospitals. <i>Ger Med Sci</i> . 2019;17:Doc07.	Nonexperimental	431 surgical patients	n/a	n/a	Sublingual temperature; frequency of warming device use, temperature measurement, occurrence of hypothermia	There is widespread acceptance of German S3 Guideline since no postoperative hypothermia was reported in the study sample. Prewarming may not be necessary since 70% of patients were normothermic postoperatively without prewarming. but further study is needed to confirm this.	IIIB
75	Buraimoh MA, Nash A, Howard B, et al. Effect of forced-air warming blanket position in elective lumbar spine surgery: Intraoperative body temperature and postoperative complications. <i>Surg Neurol Int</i> . 2019;10:229.	RCT	74 adult elective lumbar spine surgery patients	Lower body Bair Hugger placed under torso and legs	Upper body Bair Hugger placed on top of upper back and arms	Intraoperative body temperature, hypothermia incidence, postoperative complications, postoperative infection; blood loss, length of stay	Standard placement of the upper body Bair Hugger across the upper back and arms was associated with increased surgical site infection in patients undergoing lumbar spine surgery. Since placement of the Bair Hugger had no effect on hypothermia incidence, recommend placing a lower body Bair Hugger under the torso and legs to reduce the risk of infection.	IB
76	Alfonsi P, Bekka S, Aegerter P, SFAR Research Network investigators. Prevalence of hypothermia on admission to recovery room remains high despite a large use of forced-air warming devices: Findings of a non-randomized observational multicenter and pragmatic study on perioperative hypothermia prevalence in France. <i>PLoS One</i> . 2019;14(12):e0226038.	Nonexperimental	893 surgical patients over the age of 45 in France	n/a	n/a	Hypothermia (< 36 C) on admission to recovery room	The incidence of perioperative hypothermia is high in patients after surgery. Study results suggest that pre-warming with intraoperative forced-air warming can reduce perioperative hypothermia.	IIIA

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77	Lai L, See M, Rampal S, Ng K, Chan L. Significant factors influencing inadvertent hypothermia in pediatric anesthesia. J Clin Monit Comput. 2019;33(6):1105–1112.	Nonexperimental	502 pediatric surgical cases	n/a	n/a	Core temperature measured by nasopharyngeal probe	Despite implementing active and passive warming methods, intraoperative hypothermia was still common in pediatric surgery. Identified risk factors that contributed to intraoperative hypothermia included patient age, weight, surgery duration, surgery type, anesthesia type, and OR temperature. Using forced air warming, a warming blanket, and fluid warmer together were most effective in maintaining core temperature.	IIIA
78	Sutton E, Bellini G, Grieco MJ, et al. Warm and humidified versus cold and dry CO2 pneumoperitoneum in minimally invasive colon resection: A randomized controlled trial. Surg Innov. 2017;24(5):471-482.	RCT	101 adults with benign colorectal conditions undergoing elective minimally invasive colon resection	Warmed, humidified CO2 insufflation	Cold, dry CO2 insufflation	Primary: postoperative pain and analgesia requirements, core body temperature, length of stay, time to first flatus, bowel movement, tolerated solid meal; Secondary: peritoneal injury, systemic cytokine response	Unable to make firm conclusions about warmed, humidified CO2 insufflation. No significant difference in core temperatures between groups.	IA
79	Balayssac D, Pereira B, Bazin J, LeRoy B, Pezet D, Gagniere J. Warmed and humidified carbon dioxide for abdominal laparoscopic surgery: Meta-analysis of the current literature. Surg Endosc. 2017;31(1):1-12.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Analysis of the studies showed only a small beneficial effect of warmed, humidified CO2 insufflation compared to standard insufflation on immediate postoperative pain and intraoperative hypothermia. No significant effect on later postoperative pain, analgesic requirements, postop body core temperature, length of stay, lens fogging, or procedure duration.	IA
80	Yoo JH, Ok SY, Kim SH, et al. Efficacy of active forced air warming during induction of anesthesia to prevent inadvertent perioperative hypothermia in intraoperative warming patients: Comparison with passive warming, a randomized controlled trial. Medicine (Baltimore). 2021;100(12):e25235. doi:10.1097/MD.00000000000025235	RCT	130 major elective surgery patients with general anesthesia > 120 minutes	Peri-induction warming (forced air warming at 47 C during induction) with warming at 40 C during surgery or 45 C if temperature < 36.5 C	No warming during induction (cotton blanket) with forced air warming at 40 C or 45 C if temperature < 36.5 c applied during surgery	Incidence of perioperative hypothermia; shivering, thermal comfort, satisfaction in PACU	Peri-induction active forced air warming is an effective and convenient method to prevent intraoperative inadvertent perioperative hypothermia in intraoperatively warmed patients undergoing major surgery > 2 hours.	IA

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81	Su S, Nieh H. Efficacy of forced-air warming for preventing perioperative hypothermia and related complications in patients undergoing laparoscopic surgery: A randomized controlled trial. <i>Int J Nurs Pract.</i> doi:10.1111/ijn.12660.	RCT	127 patients having laparoscopic thoracic or abdominal surgery (64 intervention group, 63 control)	Forced air warming device	Passive insulation	Patient temperature	Forced air warming reduces complications associated with hypothermia.	IA
82	Ryan-Wenger N, Sims MA, Patton RA, Williamson J. Selection of the Most Accurate Thermometer Devices for Clinical Practice: Part 1: Meta-Analysis of the Accuracy of Non-Core Thermometer Devices Compared to Core Body Temperature. <i>Pediatr Nurs.</i> 2018;44(3):116–133.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Oral and rectal electronic thermometers demonstrate the most accurate approximation of core body temperature and should be used to measure patient temperatures for screening, monitoring, diagnostic, and treatment purposes. Clinicians must meticulously follow manufacturer's directions for use every time. Temporal, tympanic, and axillary chemical and electronic thermometers demonstrated less accuracy in comparison to oral and rectal devices and should not be used in clinical practice. When evaluating evidence on the accuracy of thermometer devices, only studies comparing core to non-core devices are appropriate.	IIIA
83	Sims, M.A., Patton, R.A., Williamson, J., & Ryan-Wenger, J. (2018). Selection of the most accurate thermometer devices for clinical practice: Part 2. Nursing practice and policy change in the use of non-core thermometer devices. <i>Pediatric Nursing</i> , 44(3), 134-140, 154.	Organizational Experience	n/a	n/a	n/a	n/a	Describes implementation of a revised temperature policy based on a systematic review and meta-analysis of the evidence. Post-implementation evaluation showed mixed adherence to the revised policy with other types of thermometers (eg, oral chemical, axillary chemical, rectal chemical, temporal artery) available in many of the audited areas in addition to the permitted devices (ie, electronic oral or rectal thermometers). The policy did not address the use of these other types of devices, and future policy recommendations will state to avoid axillary temperatures.	VA
84	Hooper VD, Chard R, Clifford T, et al. ASPAN's evidence-based clinical practice guideline for the promotion of perioperative normothermia: second edition. <i>Journal of PeriAnesthesia Nursing.</i> 2010;25(6):346-365.	Guideline	N/A	N/A	N/A	N/A	Summarizes measures to take to prevent hypothermia throughout the entire perioperative time frame.	IVA

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85	Torossian A, Brauer A, Hocker J, Bein B, Wulf H, Horn EP. Preventing inadvertent perioperative hypothermia. Dtsch Arztebl Int. 2015;112(10):166-172.	Guideline	N/A	N/A	N/A	N/A	Multisociety European guideline for prevention of intraoperative hypothermia	IVA
86	Brozanski BS, Piazza AJ, Chuo J, et al. STEPP IN: Working Together to Keep Infants Warm in the Perioperative Period. Pediatrics. 2020;145(4).	Organizational Experience	> 13000 monitored surgeries on neonates	n/a	n/a	Postoperative hypothermia (< 36 C within 30 minutes return to NICU)	Described multi-center quality improvement project to develop, implement, and sustain a standardized process to reduce perioperative hypothermia in neonatal intensive care unit patients. A multi-pronged approach to maintaining eutheria reduced perioperative hypothermia in NICU patients.	VA
87	Şenkal S, Kara U. Guideline implementation and raising awareness for unintended perioperative hypothermia: Single-group "before and after" study. ULUS TRAVMA ACIL CER. 2020;26(5):719–727.	Organizational Experience	669 surgical patients	Evidence-based protocol to prevent unintended perioperative hypothermia	No evidence-based protocol	Body temperature by tympanic membrane upon arrival to PACU; adverse effects, correlated risk factors	Implementation of an evidence-based protocol reduced the incidence of unintended perioperative hypothermia. Risk factors associated with hypothermia included older age, male gender, and high BMI.	VB
88	Russell K, Ostendorf M, Welden LMS, Stallings JD. Using a Normothermia Bundle With Perioperative Prewarming to Reduce Patient Hypothermia. J Perianesth Nurs. 2022;37(1):114–121.	Organizational Experience	200 adult same day surgery patients	n/a	n/a	Incidence of inadvertent perioperative hypothermia	Implementation of a normothermia bundle that included forced air prewarming was followed by decreased incidence of IPH, however, adherence to intraoperative monitoring decreased.	VB
89	Mutchnick I, Thatikunta M, Braun J, et al. Protocol-driven prevention of perioperative hypothermia in the pediatric neurosurgical population. J Neurosurg Pediatr. 2020:1–7.	Organizational Experience	120 pediatric patients	Normothermia protocol (forced air prewarming, ambient OR temperature 75 F, radiant warming light in OR until draped, forced air intraoperative warming, blankets and radiant light postop until transfer to PACU)	Standard care (intermittent radiant warming light, forced air intraoperative warming before draping)	n/a	Prewarming reduces the risk of perioperative hypothermia and insulates against the initial core temperature drop all patients experience. Successful implementation of an evidence-based normothermia protocol that standardized warming and temperature monitoring practices at one hospital reduced perioperative hypothermia in pediatric neurosurgical patients.	VB
90	Simpson JB, Thomas VS, Ismaili SK, Muradov PI, Noble PC, Incavo SJ. Hypothermia in Total Joint Arthroplasty: A Wake-Up Call. J Arthroplasty. 2018;33(4):1012–1018.	Organizational Experience	383 total joint patients (204 total hip, 179 total knee)	n/a	n/a	Body temperature	Perioperative hypothermia is common among patients undergoing total joint arthroplasty and may be avoidable. Recommend focusing on preoperative holding, minimizing time to incision, and raising ambient OR temperature to reduce heat loss. Implemented change in institutional practice to increase ambient OR temperature to 21 C.	VA

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REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
91	Kay AB, Klavas DM, Hirase T, Cotton MO, Lambert BS, Incavo SJ. Preoperative Warming Reduces Intraoperative Hypothermia in Total Joint Arthroplasty Patients. <i>J Am Acad Orthop Surg.</i> 2020;28(6):e255–e262.	Organizational Experience	672 total joint patients (194 total hip, 478 total knee)	n/a	n/a	n/a	Addition of preoperative forced-air warming reduced perioperative hypothermia in total joint patients.	VB
92	Engorn BM, Kahntroff SL, Frank KM, et al. Perioperative hypothermia in neonatal intensive care unit patients: effectiveness of a thermoregulation intervention and associated risk factors. <i>Paediatr Anaesth.</i> 2017;27(2):196–204.	Organizational Experience	515 noncardiac operative neonatal cases	n/a	n/a	n/a	Describes implementation of a quality improvement project that included a transport protocol, education, and ongoing monitoring to reduce the incidence of perioperative hypothermia in noncardiac neonatal intensive care unit patients. The focused intervention reduced perioperative hypothermia with sustained results.	VA
93	Duff J, Walker K, Edward K, et al. Effect of a thermal care bundle on the prevention, detection and treatment of perioperative inadvertent hypothermia. <i>J Clin Nurs.</i> 2018;27(5-6):1239–1249.	Organizational Experience	729 surgical adult patient charts audited	n/a	n/a	n/a	Describes the implementation of a thermal care bundle intended to prevent, detect, and treat perioperative inadvertent hypothermia and subsequent evaluation to determine its impact. The bundle included assessment, temperature documentation, and active warming components. Found mild improvements in risk assessment, documented temperatures, and active warming. Reported a significant increase in intraoperative hypothermia incidence, which was attributed to improved detection. Although there were statistically significant improvements in some components of bundle implementation, overall, patient outcomes did not improve after bundle implementation.	VC
94	Pedersen C, Munch P, Kjaergaard J, Grønlykke L, Bräuer A. Accuracy of a zero-heat-flux thermometer in cardiac surgery, a prospective, multicentre, method comparison study. <i>Scientific Reports.</i> 2024;14(1):3169.	Nonexperimental	100 patients undergoing cardiac surgery	n/a	Zero-heat-flux thermometers (two SpotOn devices), bladder thermometer, pulmonary artery catheter	Core temperature	Zero heat flux thermometer devices are accurate and reliable and can provide continuous, non-invasive measurements of core temperature in normothermic and mild hypothermic temperature ranges. Bladder temperature provided a significantly less accurate measurement of core temperature. Concluded the tested ZHF device is suitable for clinical use.	IIIB

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95	Gómez-Romero FJ, Fernández-Prada M, Fernández-Suárez FE, et al. Intra-operative temperature monitoring with two non-invasive devices (3M Spoton® and Dräger Tcore®) in comparison with the Swan-Ganz catheter. <i>Cirugía Cardiovascular</i> . 2019;26(4):191–196.	Nonexperimental	41 patients undergoing cardiac valve surgery	n/a	Pulmonary artery catheter, two non-invasive temperature measurement devices (ie, Tcore, SpotOn)	Core temperature	Both the Tcore and SpotOn devices demonstrate an acceptable level of accuracy, precision, and sensitivity in measuring core temperature compared to core temperature measured by pulmonary artery catheter, and they are non-invasive and easy to use. These devices are suitable for clinical use in patients undergoing cardiac surgery.	IIIA
96	Verheyden C, Neyrinck A, Laenen A, Rex S, Van Gerven E. Clinical evaluation of a cutaneous zero-heat-flux thermometer during cardiac surgery. <i>J Clin Monit Comput</i> . 2022;36(5):1279–1287.	Nonexperimental	40 patients undergoing cardiac surgery	n/a	Zero-heat-flux thermometer, pulmonary artery catheter, nasopharyngeal, bladder, and rectal thermometers	Core temperature	The non-invasive zero-heat-flux thermometer was more accurate than nasopharyngeal, bladder, and rectal thermometers, although the differences were small. The ZHF device could be considered as an alternative to these thermometers in measuring core temperature during cardiac surgery. Reliability during deep hypothermia and impact on clinical outcomes need further study.	IIIB
97	Bräuer A, Fazliu A, Perl T, Heise D, Meissner K, Brandes IF. Accuracy of zero-heat-flux thermometry and bladder temperature measurement in critically ill patients. <i>Scientific Reports</i> . 2020;10(1):21746.	Nonexperimental	50 critically ill adult patients	n/a	Zero-heat-flux thermometer, bladder catheter temperature probe, arterial catheter temperature probe (iliac or pulmonary artery)	Core temperature	Although temperature measurements from the bladder probe were slightly more accurate than the zero-heat-flux device, either device is suitable for clinical use in critically ill patients.	IIIB
98	Soehle M, Dehne H, Hoefft A, Zenker S. Accuracy of the non-invasive Tcore™ temperature monitoring system to measure body core temperature in abdominal surgery. <i>J Clin Monit Comput</i> . 2020;34(6):1361–1367.	Nonexperimental	22 female patients undergoing surgery for ovarian cancer	n/a	Tcore thermometer, femoro-iliacal artery catheter temperature probe	Core temperature	The Tcore thermometer was found to provide an accurate measurement of core body temperature when compared to measurements from a femoro-iliacal artery catheter temperature probe in female patients undergoing surgery for ovarian cancer.	IIIB
99	Cutuli SL, See EJ, Osawa EA, et al. Accuracy of non-invasive body temperature measurement methods in adult patients admitted to the intensive care unit: a systematic review and meta-analysis. <i>Crit Care Resusc</i> . 2023;23(1):6–13.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	In ICU patients, non-invasive peripheral thermometers inaccurately estimate core temperature compared to invasive temperature measurement methods. Esophageal probes most closely approximated invasive intravascular temperature measurements and were found to be clinically acceptable.	IIIA

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100	Conway A, Bittner M, Phan D, et al. Accuracy and precision of zero-heat-flux temperature measurements with the 3M™ Bair Hugger™ Temperature Monitoring System: a systematic review and meta-analysis. <i>J Clin Monit Comput.</i> 2021;35(1):39–49.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	The 3M Bair Hugger Temperature Monitoring System was determined to be as much as 1 C higher or lower than core temperature. Therefore, clinicians should take this uncertainty in accuracy into account when deciding to use this device, as it may not be appropriate in situations when a difference in temperature of less than 1 C is of clinical significance.	IIIA
101	Ekers T, Adamson N, Wells A, Presneill J. A pilot study of agreement between noninvasive thermometers and the core temperature of postoperative cardiothoracic surgical patients. <i>Aust Crit Care.</i> 2023;36(5):782–786.	Nonexperimental	100 postoperative adult cardiothoracic surgery patients with pulmonary artery catheter	Noninvasive thermometers: temporal artery, axillary, tympanic, NexTemp	Core temperature measured by pulmonary artery catheter	Temperature measurement	Tympanic thermometer was closest in agreement to the core temperature readings of the pulmonary artery catheter. The study results align with previous research findings that noninvasive temperature measurement methods might not be adequate when precise measurement of core temperature is clinically important.	IIIB
102	Simpson G, Rodseth RN. A prospective observational study testing liquid crystal phase change type thermometer placed on skin against oesophageal/pharyngeal placed thermometers in participants undergoing general anesthesia. <i>BMC ANESTHESIOLOG.</i> 2019;19(1):N.PAG.	Nonexperimental	100 adult elective surgery patients receiving general anesthesia	Traxit wearable thermometer	Esophageal/pharyngeal core temperature	Intraoperative temperature	Temperature readings from four different sites (ie, behind the ear, axilla, sternum, forehead) were found to be outside of the clinically acceptable range of agreement with the standard of care (ie, esophageal/pharyngeal probe). Therefore, the Traxit thermometer was determined to be not clinically valuable and the standard of care esophageal monitor should continue to be used in patients under general anesthesia.	IIIB
103	Paik GJ, Henker H, Sereika S, et al. Accuracy of Temporal Artery Thermometry as an Indicator of Core Body Temperature in Patients Receiving General Anesthesia. <i>J Perianesth Nurs.</i> 2019;34(2):330–337.	Nonexperimental	54 adult patients undergoing general anesthesia procedures with planned esophageal temperature monitoring	Temporal artery temperature	Esophageal core intraoperative temperature, oral postanesthesia temperature	Temperature	Although convenient, the use of temporal artery thermometers is not recommended in the perioperative setting because it was shown to inaccurately estimate core temperature.	IIIB
104	Yang S, Cho H, Kim H. Comparison of tracheal temperature and core temperature measurement in living donor liver transplant recipients: a clinical comparative study. <i>BMC ANESTHESIOLOG.</i> 2022;22(1):1–7.	Nonexperimental	22 living donor liver transplant recipients	Tracheal temperature monitoring	Esophageal and pulmonary artery temperature monitoring	Core temperature	Monitoring core temperature via tracheal temperature is a viable alternative to esophageal and pulmonary artery temperature monitoring during living donor liver transplantation.	IIIB

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105	Ji Y, Han D, Han L, Xie S, Pan S. The Accuracy of a Wireless Axillary Thermometer for Core Temperature Monitoring in Pediatric Patients Having Noncardiac Surgery: An Observational Study. <i>J Perianesth Nurs.</i> 2021;36(6):685–689.	Nonexperimental	70 children undergoing elective surgery with general anesthesia and endotracheal intubation	Wearable, wireless axillary thermometer (iThermometer); rectal temperature probe	Esophageal temperature probe	Agreement between axillary and rectal temperatures compared to esophageal temperatures	The wearable axillary thermometer was found to accurately represent core body temperature during non-cardiac surgery on pediatric patients and could be an alternative to monitoring esophageal temperature.	IIIB
106	Cutuli SL, Osawa EA, Eyeington CT, et al. Accuracy of non-invasive body temperature measurement methods in critically ill patients: a prospective, bicentric, observational study. <i>Crit Care Resusc.</i> 2023;23(3):346–353.	Nonexperimental	50 critically ill adult ICU patients	Non-invasive temperature measurement (axillary chemical dot, temporal scanner, tympanic infrared)	Invasive temperature measurement (intravascular or intra-urinary bladder catheter)	Clinical accuracy and adequacy between invasive and non-invasive temperature measurement methods	Non-invasive body temperature measurement methods (ie, tympanic infrared, temporal scanner, and axillary chemical dot) are unreliable for measuring core temperature of ICU patients compared to invasive methods (ie, intravascular and intra-bladder catheters).	IIIB
107	Jack JM, Ellicott H, Jones CI, Bremner SA, Densham I, Harper CM. Determining the accuracy of zero-flux and ingestible thermometers in the peri-operative setting. <i>J Clin Monit Comput.</i> 2019;33(6):1113–1118.	Nonexperimental	30 elective surgery patients	CorTemp wireless ingestible temperature monitoring system; 3M zero flux thermometer	Esophageal temperature probe	Limits of agreement	Interference from the energy device and fluoroscopy unit made 39% of ingestible sensor's readings unusable. Comparison of the two intervention devices to the esophageal probe showed that the zero flux thermometer was significantly more accurate with device malfunction affecting only 1.2% of readings. The zero flux thermometer is sufficiently accurate for clinical use and the ingestible sensor is not.	IIIB
108	Boisson, M.; Alaux, A.; Kerforne, T.; Mimos, O.; Debaene, B.; Dahyot-Fizelier, C.; Frasca, D. Intra-operative cutaneous temperature monitoring with zero-heat-flux technique (3M SpotOn) in comparison with oesophageal and arterial temperature: A prospective observational study. <i>Eur. J. Anaesthesiol.</i> 2018, 35, 825–830.	Nonexperimental	49 major abdominal surgery patients	SpotOn zero-heat-flux temperature monitoring device	Esophageal probe or arterial catheter	Core temperature	The SpotOn sensor appeared reliable for core temperature monitoring in patients undergoing major abdominal surgery during slow changes in core temperature. It was less reliable during rapid variations in temperature.	IIIB
109	Eshraghi Y, Nasr V, Parra-Sanchez I, et al. An evaluation of a zero-heat-flux cutaneous thermometer in cardiac surgical patients. <i>Anesth Analg.</i> 2014;119(3):543-549.	Nonexperimental	105 patients having nonemergent cardiac surgery	N/A	N/A	Patient temperature	Zero-heat-flux temperature probes are an effective means for measuring core temperature	IIIB
110	Schell-Chaple HM, Liu KD, Matthay MA, Puntillo KA. Rectal and bladder temperatures vs forehead core temperatures measured with SpotOn monitoring system. <i>Am J Crit Care.</i> 2018;27(1):43-50.	Nonexperimental	748 paired temperature measurements from 38 ICU patients	N/A	N/A	Patient temperature	Zero-heat-flux temperatures closely correlate to rectal and bladder temperatures	IIIB

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111	Dahyot-Fizelier C, Lamarche S, Kerforne T, et al. Accuracy of zero-heat-flux cutaneous temperature in intensive care adults. <i>Crit Care Med.</i> 2017;45(7):e715-e717.	Nonexperimental	52 ICU patients	n/a	Esophageal temperature and arterial temperature to zero-heat-flux thermometry	Patient temperature variance	Zero-heat-flux thermometry is comparable to esophageal or iliac arterial temperature measurements.	IIIB
112	Drake-Brockman TFE, Hegarty M, Chambers NA, Von Ungernsternberg BS. Monitoring temperature in children undergoing anaesthesia: a comparison of methods. <i>Anaesth Intensive Care.</i> 2014;42(3):315-320.	Nonexperimental	200 children having elective non-cardiac surgery	N/A	Temperature recorded at tympanic membrane, temporal artery, axilla, skin on the chest, nasopharyngeal	Patient temperature	Temperatures varied between sites.	IIIA
113	Minzola DJ, Keele R. Relationship of tympanic and temporal temperature modalities to core temperature in pediatric surgical patients. <i>AANA J.</i> 2018;86(1):19-26.	Nonexperimental	106 pediatric surgical	N/A	N/A	Patient rectal, tympanic and temporal temperatures	Tympanic temperature correlates closer to rectal than temporal temperatures.	IIIB
114	Zeiner S, Zadrazil M, Willschke H, et al. Accuracy of a Dual-Sensor Heat-Flux (DHF) Non-Invasive Core Temperature Sensor in Pediatric Patients Undergoing Surgery. <i>J Clin Med.</i> 2023;12(22):7018. doi: 10.3390/jcm12227018.	Nonexperimental	57 pediatric patients undergoing elective surgery	n/a	n/a	Agreement between the dual-sensor heat flux thermometer and rectal probe	The temperature measurements from the dual-sensor heat flux thermometer overestimated core temperature when compared to rectal probe measurements. However, none of the measurements would have lead to harmful treatment and the non-invasive sensors are acceptable for continuous temperature monitoring when more invasive methods are contraindicated or unavailable in toddlers and small children undergoing surgery.	IIIB
115	Munday J, Delaforce A, Forbes G, Keogh S. Barriers and enablers to the implementation of perioperative hypothermia prevention practices from the perspectives of the multidisciplinary team: a qualitative study using the theoretical domains framework. <i>J Multidiscip Healthc.</i> 2019;12:395-417. https://doi.org/10.2147/jmdh.s209687	Qualitative	12 members of the perioperative team (RNs, surgeons, anesthetists)	n/a	n/a	Barriers and enablers to perioperative hypothermia practices	Identified 11 theoretical domains influencing the uptake of perioperative hypothermia practices and recommended strategies to address, including training, reminders, audits and feedback, organizational support ameliorate lack of ambient temperature control, and accessible accurate temperature measurement devices.	IIIA

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116	Cutler HS, Romero JA, Minor D, Huo MH. Sources of contamination in the operating room: A fluorescent particle powder study. <i>Am J Infect Control.</i> 2020;48(8):948–950. doi:10.1016/j.ajic.2019.12.027	Nonexperimental	n/a	n/a	n/a	Contaminated areas of the surgical field	The forced-air warming blanket contributed to surgical field contamination when activated before draping. Moving the OR lights, especially overhead collisions, contributed to surgical field contamination. Recommend activating forced air warming after draping, applying light handles away from the sterile field, minimizing OR light movement, and educating personnel on these practices.	IIIB
117	He X, Karra S, Pakseresht P, Apte SV, Elghobashi S. Effect of heated-air blanket on the dispersion of squames in an operating room. <i>Int J Numer Method Biomed Eng.</i> 2018;34(5):e2960.	Nonexperimental	Simulation	N/A	Blower off to blower on	Skin squame cell counts	When the forced air warmer was turned on there were more skin squames in the four locations than with it turned off.	IIIB
118	Reed M, Kimberger O, McGovern PD, Albrecht MC. Forced-air warming design: evaluation of intake filtration, internal microbial buildup, and airborne-contamination emissions. <i>AANA J.</i> 2013;81(4):275-280.	Nonexperimental	23 FAW device blowers	N/A	N/A	Microbial and particle counts	Forced-air warming devices emit significant levels of airborne particles which may or may not end up on the surgical site.	IIIB
119	Dasari KB, Albrecht M, Harper M. Effect of forced-air warming on the performance of operating theatre laminar flow ventilation. <i>Anaesthesia.</i> 2012;67(3):244-249.	Quasi-experimental	Simulation	Forced-air warming blanket	Under-body resistive mattress; over-body conductive blanket	Air-temperature at surgical site	Forced-air warming produces the greatest release of excessive heat near the surgical site compared to conductive warming systems. Study findings indicate that hot air pockets move upward against downward laminar airflow currents, resulting in convection current activity; however, the effect of this on clinical outcomes is unknown.	IIB
120	Albrecht M, Gauthier R, Leaper D. Forced-air warming: a source of airborne contamination in the operating room? <i>Orthop Rev (Pavia).</i> 2009;1(2):e28.	Nonexperimental	25 blowers	N/A	N/A	Microbial counts	Forced-air warming blowers emit airborne contaminants. Alternative technologies to prevent inadvertent hypothermia should be considered.	IIIB
121	Albrecht M, Gauthier RL, Belani K, Litchy M, Leaper D. Forced-air warming blowers: an evaluation of filtration adequacy and airborne contamination emissions in the operating room. <i>Am J Infect Control.</i> 2011;39(4):321-328.	Nonexperimental	52 blowers	N/A	N/A	Microbial counts	Forced-air warming blowers emit airborne contaminants. Alternative technologies to prevent inadvertent hypothermia should be considered.	IIIB
122	Sessler DI, Olmsted RN, Kuelpmann R. Forced-air warming does not worsen air quality in laminar flow operating rooms. <i>Anesth Analg.</i> 2011;113(6):1416-1421.	Quasi-experimental	Volunteer and manikins	FAW unit on	FAW unit off	Tracer background particle counts	Forced-air warming does not negatively effect laminar airflow.	IIB

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123	Haeberle HS, Navarro SM, Samuel LT, et al. No evidence of increased infection risk with forced-air warming devices: a systematic review. <i>Surg Technol Int.</i> 2017;31:295-301.	Systematic Review	N/A	N/A	N/A	N/A	Forced-air warming devices should be used for orthopedic surgery.	IIIC
124	Kellam MD, Dieckmann LS, Austin PN. Forced-air warming devices and the risk of surgical site infections. <i>AORN J.</i> 2013;98(4):354-9.	Systematic Review	15 articles	N/A	N/A	N/A	The evidence did not clearly indicate that forced-air warming increased the risk of SSI.	IIIB
125	Shirozu K, Kai T, Setoguchi H, Ayagaki N, Hoka S. Effects of Forced Air Warming on Airflow around the Operating Table. <i>Anesthesiology.</i> 2018;128(1):79-84.	Nonexperimental	n/a	n/a	n/a	Direction and speed of airflow	Downward laminar airflow from the ceiling effectively counteracts the airflow caused by forced-air warming. In the presence of sufficient laminar airflow, forced-air warming is unlikely to cause contamination of the surgical field.	IIIA
126	Oguz R, Diab-Elschahawi M, Berger J, et al. Airborne bacterial contamination during orthopedic surgery: A randomized controlled pilot trial. <i>J Clin Anesth.</i> 2017;38:160-164. doi:10.1016/j.jclinane.2017.02.008	RCT	80 patients undergoing minor orthopedic surgery	Resistive polymer warming blanket	Forced air warming	Bacterial counts	The type of warming system had no significant influence on bacterial counts at any sampling site. The absence of unidirectional turbulent free laminar airflow and longer surgery duration significantly increased bacterial counts.	IB
127	Aalirezaie A, Akkaya M, Barnes CL, et al. General Assembly, Prevention, Operating Room Environment: Proceedings of International Consensus on Orthopedic Infections. <i>J Arthroplasty.</i> 2019;34(2S):S105-S115. doi:10.1016/j.arth.2018.09.060	Consensus	n/a	n/a	n/a	n/a	The literature associating the use of forced-air warming with increased risk of surgical site infections or periprosthetic joint infections conflicts and does not definitively link the two. Recommends following device manufacturer instructions for use, maintenance, and cleaning. Alternative warming methods can be effective and may be used.	IVB
128	Warming Units, Patient, Forced-Air. Emergency Care Research Institute (ECRI) Web site. https://www.ecri.org/components/HPCS/Pages/Warming-Units,-Patient,-Forced-Air.aspx . Updated 2023.	Expert Opinion	n/a	n/a	n/a	n/a	Describes forced air warming devices that are commercially available in the United States.	VB
129	Warming Units, Blood/Solution. Emergency Care Research Institute (ECRI); 2023.	Expert Opinion	n/a	n/a	n/a	n/a	Describes commonly used blood/solution warmers.	VB
130	Warming Units, Patient, Conductive Layer. Emergency Care Research Institute (ECRI) Web site. https://www.ecri.org/components/HPCS/Pages/Warming-Units,-Patient,-Conductive-Layer.aspx . Updated 2023.	Expert Opinion	n/a	n/a	n/a	n/a	Compares conductive warming devices, describes potential for injury, and recommends considerations for purchase.	VB

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131	Benze C, Spruce L, Groah L. Perioperative Nursing: Scope and Standards of Practice. Denver, CO: AORN, Inc; 2021. https://www.aorn.org/guidelines-resources/clinical-resources/standards-of-practice .	Consensus	n/a	n/a	n/a	n/a	Perioperative nursing standards of practice.	IVA
132	Chen HY, Su LJ, Wu HZ, Zou H, Yang R, Zhu YX. Risk factors for inadvertent intraoperative hypothermia in patients undergoing laparoscopic surgery: A prospective cohort study. PLoS One. 2021;16(9):e0257816.	Nonexperimental	690 laparoscopic surgery patients	n/a	n/a	Core body temperature (baseline tympanic, intraoperative nasopharyngeal)	Found that age, BMI, baseline body temperature, irrigation volume, and length of surgery were significantly associated with intraoperative hypothermia in patients undergoing laparoscopic abdominal surgery. Did not observe significant associations between hypothermia and systolic blood pressure, heart rate before induction, ASA score, CO2 insufflation volume, total IV fluid volume, and blood loss.	IIIB
133	Zhang H, Wang J, Zhu S, Li J. Full title: The prevalence of and predictors for perioperative hypothermia in postanesthesia care unit. Journal of Clinical Nursing (John Wiley & Sons, Inc.). 2022;31(17):2584–2592.	Nonexperimental	7216 elective surgery patients	n/a	n/a	Tympanic temperature in PACU; intraoperative core temperature via nasopharyngeal probe	Identified significant risk factors for postoperative hypothermia in patients undergoing elective procedures, including age > 65, non-supine position during surgery (ie, lateral or lithotomy), minimally invasive surgery (ie, laparoscopic or endoscopic), non-superficial surgery, IV infusion > 1000 ml, use of dexmedetomidine, blood transfusion, and surgeries performed in summer and fall. Found that BMI > 25, higher baseline body temperature, and fasting > 18 hours were associated with lower risk of hypothermia. Concluded that a predictive score could help identify patients at high risk of postoperative hypothermia so that appropriate warming interventions could be implemented.	IIIB

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134	Sagioglu G, Ozturk GA, Baysal A, Turan FN. Inadvertent Perioperative Hypothermia and Important Risk Factors during Major Abdominal Surgeries. <i>J Coll Physicians Surg Pak</i> . 2020;30(2):123–128.	Nonexperimental	529 elective abdominal surgery patients	n/a	n/a	Correlation between inadvertent hypothermia and potential risk factors (eg, demographic characteristics, surgery duration and type, OR temperature, intraoperative characteristics [eg, hemodynamic parameters, diuresis, bleeding, fluid needs, blood transfusions, lab values], postoperative complications).	Inadvertent hypothermia was common in patients undergoing major abdominal surgery. Risk factors for inadvertent hypothermia in patients undergoing major abdominal surgery included advanced age, male gender, smoking, ASA III, longer surgery duration, and transfusion of fluids/blood.	IIIA
135	Li C, Zhao B, Li L, Na G, Lin C. Analysis of the Risk Factors for the Onset of Postoperative Hypothermia in the Postanesthesia Care Unit. <i>J Perianesth Nurs</i> . 2021;36(3):238–242.	Nonexperimental	1,788 surgical patients	n/a	n/a	Preoperative and postoperative tympanic temperature	Identified significant risk factors for postoperative hypothermia were general anesthesia, preoperative hypothermia, and ASA above II. Found that epidural anesthesia was associated with lower risk of hypothermia. Also found that gender, procedure type, and BMI did not increase risk of hypothermia.	IIIB
136	Li L, Lu Y, Yang LL, Xu W, Yu JK. Construction and validation of postoperative hypothermia prediction model for patients undergoing joint replacement surgery. <i>Journal of Clinical Nursing (John Wiley & Sons, Inc.)</i> . 2023;32(13):3831–3839.	Nonexperimental	503 hip and knee arthroplasty patients	n/a	n/a	Preoperative, intraoperative, postprocedure tympanic temperature	Using risk factors identified in the literature, developed and validated an equation to predict the risk of postoperative hypothermia for patients undergoing total hip or knee arthroplasty.	IIIB
137	Li Y, Liang H, Feng Y. Prevalence and multivariable factors associated with inadvertent intraoperative hypothermia in video-assisted thoracoscopic surgery: a single-center retrospective study. <i>BMC ANESTHESIOLOGY</i> . 2020;20(1):1–6.	Nonexperimental	1467 adult elective video-assisted thoracoscopic surgery patients	n/a	n/a	Intraoperative hypothermia	Inadvertent intraoperative hypothermia was common in adult patients undergoing elective video-assisted thoracoscopic surgery. Risk factors identified included older age, longer preparation time and procedure duration > 2 hours, lower OR temperature, having surgery in the morning, and general anesthesia with paravertebral block after induction. Obesity was found to be protective against hypothermia.	IIIA

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138	Pu J, Zhao W, Xie X, Huang H. A Systematic Review and Meta-Analysis of Risk Factors for Unplanned Intraoperative Hypothermia Among Adult Surgical Patients. <i>J Perianesth Nurs</i> . 2022;37(3):333–338.	Systematic Review w/ Meta-Analysis	15, 010 adult surgical patients	n/a	n/a	n/a	Risk factors for unplanned intraoperative hypothermia included increased age, lower BMI, ambient temperature, preoperative heart rate, longer duration of anesthesia, and fluid infusion volume > 1000 mL. These risk factors can help the development of new assessment tools to identify patients at high risk of unplanned intraoperative hypothermia.	IIIA
139	Öner Cengiz H, Uçar S, Yılmaz M. The Role of Perioperative Hypothermia in the Development of Surgical Site Infection: A Systematic Review. <i>AORN J</i> . 2021;113(3):265–275.	Systematic Review	n/a	n/a	n/a	n/a	Hypothermia may contribute to the development of surgical site infection, depending on its severity, surgery type and duration, type of anesthesia, and patient characteristics. Identification of risks for hypothermia, including male gender, low BMI, diabetes mellitus, and history of tobacco use. Interpretation of the results was limited by heterogeneous data and a lack of prospective studies.	IIIA
140	Kleimeyer JP, Harris AHS, Sanford J, Maloney WJ, Kadry B, Bishop JA. Incidence and Risk Factors for Postoperative Hypothermia After Orthopaedic Surgery. <i>J Am Acad Orthop Surg</i> . 2018;26(24):e497–e503.	Nonexperimental	3822 orthopedic surgery patients	n/a	n/a	Postoperative hypothermia (< 36 C on arrival to PACU or ICU)	Intraoperative and postoperative hypothermia is common in patients undergoing orthopedic surgery. Recommend prewarming due to correlation between lower preoperative temperature and postoperative hypothermia. Risk factors associated with postoperative hypothermia included female gender, lower BMI, older age, lower preoperative temperature, and intraoperative hypothermia.	IIIA
141	Scholten R, Leijtens B, Kremers K, Snoeck M, Koëter S. The incidence of mild hypothermia after total knee or hip arthroplasty: A study of 2600 patients. <i>J Orthop</i> . 2018;15(2):408–411.	Nonexperimental	2600 total joint patients (1473 total hip, 1127 total knee)	n/a	n/a	Incidence of hypothermia	Although inadvertent hypothermia improved compared to a previous report, likely due to increased awareness as hypothermia still occurs after total joint arthroplasty. Female gender and spinal anesthesia were identified as risk factors for hypothermia. Higher BMI was associated with lower risk of hypothermia.	IIIA

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142	Vural F, Çelik B, Deveci Z, Yasak K. Investigation of inadvertent hypothermia incidence and risk factors. Turk J Surg. 2018;34(4):300–305.	Nonexperimental	144 adult surgical patients	n/a	n/a	Body temperature; correlation between hypothermia and patient characteristics, patient-related factors, and surgery-related factors	Found a high incidence of intraoperative and postoperative hypothermia in patients undergoing a variety of types of surgeries. Identified factors that influenced development of inadvertent hypothermia included preoperative body temperature, OR temperature, and intraoperative warming.	IIIB
143	Yan L, Tan J, Chen H, et al. A Nomogram for Predicting Unplanned Intraoperative Hypothermia in Patients With Colorectal Cancer Undergoing Laparoscopic Colorectal Procedures. AORN J. 2023;117(1):e1–e12.	Nonexperimental	765 patients with colorectal cancer undergoing laparoscopic colorectal procedures	n/a	n/a	Intraoperative core body (nasopharyngeal) temperature	A nomogram was developed to assist clinicians in predicting risk of hypothermia in patients with colorectal cancer undergoing laparoscopic colorectal surgery. The nomogram predicted intraoperative hypothermia risk based on body mass index, diabetes diagnosis, ambient temperature and humidity, anticipated length of surgery, and expected use of forced-air warming.	IIIB
144	Emmert, Alexander, Gries, Gereon, Wand, Saskia, et al. Association between perioperative hypothermia and patient outcomes after thoracic surgery: A single center retrospective analysis 2018	Nonexperimental	339 thoracic surgery patients	n/a	n/a	Hypothermia and association with risk factors	Perioperative hypothermia was common in thoracic surgery patients with a long induction time, small body surface area, and large intraoperative fluid volume identified as independent risk factors.	IIIB
145	Groene P, Zeuzem C, Baasner S, Hofmann-Kiefer K. The influence of body mass index on temperature management during general anaesthesia—A prospective observational study. J Eval Clin Pract. 2019;25(2):340–345.	Nonexperimental	206 patients undergoing lower limb surgery (104) or abdominal surgery (102)	n/a	n/a	Sublingual body temperature after 60 minutes of anesthesia	German guidelines for hypothermia prevention provide protection against perioperative hypothermia for normal weight and obese patients undergoing lower limb or abdominal surgery. There were no relevant differences in sublingual temperatures among the body weight subgroups after 60 minutes of anesthesia.	IIIB
146	Lee C, Park S, Kim B, et al. Effects of Female Reproductive Hormone Levels on Inadvertent Intraoperative Hypothermia during Laparoscopic Gynecologic Surgery: A Retrospective Study. Medicina (Kaunas). 2021;57(11):1255.	Nonexperimental	660 menstruating and menopausal female patients who underwent laparoscopic gynecologic surgery	n/a	n/a	Level of female reproductive hormones as potential predictor of inadvertent intraoperative hypothermia; incidence of shivering and treatment in PACU, risk factors associated with inadvertent intraoperative hypothermia	Estradiol and progesterone were associated with inadvertent intraoperative hypothermia but might not be a risk factor for hypothermia in patients undergoing gynecologic surgery with general anesthesia. Other risk factors associated with increased risk of inadvertent intraoperative hypothermia included low nasopharyngeal temperature before general anesthesia induction, low BMI, high fresh air flow rate, and longer duration of anesthesia.	IIIB

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147	Williams M, El-Houdiri Y. Inadvertent hypothermia in hip and knee total joint arthroplasty. <i>J Orthop.</i> 2018;15(1):151–158.	Nonexperimental	2431 total joint arthroplasty patients (primary and revision total hip and knee)	n/a	n/a	Inadvertent hypothermia (< 36 C core temperature after closure) via tympanic membrane	Reported a rate of 3.9% to 13.2% for inadvertent hypothermia in total joint arthroplasty. Identified lower BMI and primary total joint arthroplasty, especially total hip arthroplasty, as risk factors for inadvertent hypothermia.	IIIA
148	Mahmoud WI, Abd El-Naby AG, Deif HIA, EL-Hadia H. Predictors of Intraoperative Hypothermia among Patients Undergoing Major Abdominal Surgeries. <i>International Journal of Novel Research in Healthcare and Nursing.</i> 2019;6(3):1158–1168.	Nonexperimental	100 adult patients undergoing major abdominal surgery	n/a	n/a	Incidence of intraoperative hypothermia; predictors of intraoperative hypothermia	Identified prolonged preoperative fasting, anesthesia duration, lower preoperative temperature, OR temperature, and increased intraoperative blood loss as predictors of intraoperative hypothermia.	IIIB
149	McCann ME, Lee JK, Inder T. Beyond Anesthesia Toxicity: Anesthetic Considerations to Lessen the Risk of Neonatal Neurological Injury. <i>Anesth Analg.</i> 2019;129(5):1354–1364.	Literature Review	n/a	n/a	n/a	n/a	Summarizes the pathophysiology of brain injuries associated with surgery in infants and recommendations to mitigate risk.	VA
150	Wallisch C, Zeiner S, Scholten P, Dibiasi C, Kimberger O. Development and internal validation of an algorithm to predict intraoperative risk of inadvertent hypothermia based on preoperative data. <i>Scientific Reports.</i> 2021;11(1):22296.	Nonexperimental	36,371 surgical cases	n/a	n/a	Minimum intraoperative temperature	Inadvertent intraoperative hypothermia occurs despite implementing active warming. The prediction models that were tested were accurate in identifying patients at risk for mild and moderate inadvertent intraoperative hypothermia. A web-based version of the algorithm could make implementation of the prediction model clinically convenient. The model identified patient weight, urgency, preoperative heart rate, and surgery type as predictors for hypothermia.	IIIA
151	Ahmed U, Ullah H, Samad K. Mean Temperature Loss During General Anesthesia for Laparoscopic Cholecystectomy: Comparison of Males and Females. <i>Cureus.</i> 2021;13(8):e17128.	Nonexperimental	97 adult elective laparoscopic cholecystectomy patients	n/a	n/a	Mean core temperature loss	Males undergoing laparoscopic cholecystectomy are at higher risk for hypothermia than females.	IIIB
152	Garceau C, Cosgrove MS, Gonzalez K. Inadvertent Perioperative Hypothermia. <i>AANA J.</i> 2023;91(4):303–309.	Expert Opinion	n/a	n/a	n/a	n/a	Describes concepts, causative factors, and complications related to inadvertent perioperative hypothermia (IPH). Recommends identification of preoperative risk factors and contributing factors, monitoring temperature, and using warming devices to prevent IPH.	VA

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153	AST Guidelines for Best Practice in Maintaining Normothermia in the Perioperative Patient. Association of Surgical Technologists; 2019.	Guideline	n/a	n/a	n/a	n/a	Provides guidance for maintaining normothermia in perioperative patients.	IVB
154	MHAUS Recommendations. Malignant Hyperthermia Association of the United States (MHAUS). https://www.mhaus.org/healthcare-professionals/mhaus-recommendations/	Consensus	n/a	n/a	n/a	n/a	Clinical guidance for the care of patients with malignant hyperthermia from MHAUS.	IVB
155	Yukse A, Talih G. The Truth We Cannot See; Hypothermia in Patients Under Spinal Anesthesia. MED J BAKIRKOY. 2020;16(2):108–113.	Nonexperimental	113 patients older than 65 who underwent orthopedic surgery with spinal anesthesia	Tympanic membrane temperature and axillary skin temperature measured by infrared thermometer	Core temperature measured at the tympanic membrane by thermocouple probe	Incidence of hypothermia; comparison of measurement techniques	Infrared tympanic temperature monitoring is acceptable if unable to monitor core temperature in patients undergoing orthopedic surgery under spinal anesthesia. The incidence of hypothermia was not associated with duration of surgery.	IIIB
156	Erdling A, Johansson A. Core temperature—the intraoperative difference between esophageal versus nasopharyngeal temperatures and the impact of prewarming, age, and weight: a randomized clinical trial. AANA J. 2015;83(2):99-105.	RCT	52 patients having colorectal surgery (26 each group)	Pre and intraoperative warming	Intraoperative warming	Esophageal and nasopharyngeal temperatures	Prewarming decreases the risk of hypothermia	IB
157	Counts D, Acosta M, Holbrook H, et al. Evaluation of temporal artery and disposable digital oral thermometers in acutely ill patients. Medsurg Nurs. 2014;23(4):239-250.	Nonexperimental	48 acutely ill patients	N/A	N/A	Oral, temporal artery and axillary temperatures	The digital disposable oral and temporal artery thermometers had precision values of $\leq 0.5^{\circ}\text{C}$ but should not replace electronic oral nondisposable thermometers.	IIIA
158	Larach MG, Gronert GA, Allen GC, Brandom BW, Lehman EB. Clinical presentation, treatment, and complications of malignant hyperthermia in North America from 1987 to 2006. Anesthesia and Analgesia. 2010 Feb;110(2):498-507.	Nonexperimental	286 reported MH cases	n/a	n/a	Clinical characteristics, treatment, complications	Hyperthermia may be an early sign of MH, and accurate temperature monitoring that avoids the use of skin liquid crystal temperature monitors can facilitate detection of MH. The researchers also recommended avoiding the use of MH-triggers for any patient who experienced an unusual metabolic response during prior anesthetization unless a thorough evaluation rules out MH as the cause.	IIIA
159	Standards for Basic Anesthetic Monitoring. American Society of Anesthesiologists (ASA) Web site. https://www.asahq.org/standards-and-practice-parameters/standards-for-basic-anesthetic-monitoring . Updated 2020.	Consensus	n/a	n/a	n/a	n/a	Provides guidance for temperature monitoring from the perspective of the anesthesia professional.	IVC

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160	<i>Standards for Nurse Anesthesia Practice. American Association of Nurse Anesthesiology (AANA); 2019.</i>	Consensus	N/A	N/A	N/A	N/A	Articulates certified registered nurse anesthetist standards of patient care including temperature monitoring and documentation.	IVB
161	Munday J, Sturgess D, Oishi S, Bendeich J, Kearney A, Douglas C. Implementation of continuous temperature monitoring during perioperative care: a feasibility study. <i>PATIENT SAF SURG.</i> 2022;16(1):1–9.	Nonexperimental	82 adult elective surgery patients (42 pre-, 40 post-intervention)	Zero-heat-flux temperature monitoring device	Standard care (no zero-heat-flux temperature monitoring device)	Number of patients screened and recruited with consent rate > 50%, retention and treatment adherence > 80% and missing data < 10%; intervention feasibility and acceptability rated by staff; care process outcomes: temperature documentation, use and appropriateness of active warming, hypothermia	Although some improvement in temperature monitoring in PACU was noted, the researchers concluded that design-enhancements to the zero heat-flux device that improve data transfer and retention, as well as reduced time to reach equilibrium, would be needed before attempting to evaluate implementation of the device on a larger scale.	IIIB
162	Anderson MA, Giarrizzo-Wilson S. Guideline for Patient Information Management. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for the management and documentation of patient information.	IVA
163	<i>State Operations Manual Appendix L: Guidance for Surveyors: Ambulatory Surgical Centers.</i> Rev. 215, 07-21-23 ed. Centers for Medicare & Medicaid Services; 2023.	Regulatory	n/a	n/a	n/a	n/a	CMS conditions of coverage for ambulatory centers.	n/a
164	<i>State Operations Manual Appendix A: Survey Protocol, Regulations and Interpretive Guidelines for Hospitals.</i> Rev. 220; 04-19-24 ed. Centers for Medicare & Medicaid Services (CMS); 2024.	Regulatory	n/a	n/a	n/a	n/a	CMS conditions of participation for hospitals.	n/a
165	Spruce L, Fearon MC. Guideline for team communication. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for team communication.	IVA
166	Kadam VR, Moyes D, Moran JL. Relative efficiency of two warming devices during laparoscopic cholecystectomy. <i>Anaesth Intensive Care.</i> 2009;37(3):464-468.	RCT	29 patients having elective laparoscopic cholecystectomy (15 FAW group, 14 radiant group)	Radiant warming device	Forced air warming device	Patient temperature	No difference in the efficacy of radiant warming compared to forced-air warming.	IB

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167	Yang HL, Lee HF, Chu TL, Su YY, Ho LH, Fan JY. The comparison of two recovery room warming methods for hypothermia patients who had undergone spinal surgery. <i>J Nurs Scholarsh.</i> 2012;44(1):2-10.	Quasi-experimental	65 post-operative spinal surgery patients with hypothermia	Radiant warming device	Warm cotton blankets	Patient temperature	Radiant warming devices rewarmed patients faster than warm cotton blankets.	IIB
168	Madrid E, Urrútia G, Roqué i Figuls M, et al. Active body surface warming systems for preventing complications caused by inadvertent perioperative hypothermia in adults. <i>Cochrane Database Syst Rev.</i> 2016;4: CD009016.	Systematic Review	N/A	N/A	N/A	N/A	Active warming is beneficial to patients and reduces the risk of heart and circulatory complications. Prewarming is beneficial in abdominal surgery.	IA
169	Warttig S, Alderson P, Campbell G, Smith AF. Interventions for treating inadvertent postoperative hypothermia. <i>Cochrane Database of Syst Rev.</i> 2014;11:CD009892.	Systematic Review w/ Meta-Analysis	N/A	N/A	N/A	N/A	Mean time taken to achieve normothermia was less when forced air warming was applied compared to warm or room temperature blankets, and circulating hot water devices. No statistically significant difference in rewarming time between thermal insulation and cotton blankets.	IA
170	Campbell G, Alderson P, Smith AF, et al. Warming of intravenous and irrigation fluids for preventing inadvertent perioperative hypothermia. <i>Cochrane Database Syst Rev.</i> 2015;(4):CD009891.	Systematic Review w/ Meta-Analysis	N/A	N/A	N/A	N/A	Warm IV fluids appear to keep patients warmer during surgery than room temperature fluids. Unable to determine if the actual differences in temperature are clinically meaningful, if there are other benefits or harms associated with the use of warmed IV fluids, and if using fluid warming in addition to other warming methods increases the benefits because a ceiling effect may occur with the use of multiple warming methods.	IIA
171	Nieh HC, Su FS. Meta-analysis: effectiveness of forced-air warming for prevention of perioperative hypothermia in surgical patients. <i>J Adv Nurs.</i> 2016;72(10):2294-2314.	Systematic Review w/ Meta-Analysis	N/A	N/A	N/A	N/A	Forced air warming is more effective at reducing perioperative hypothermia than passive insulation and circulating water mattresses, but is equally effective as circulating water garments, resistive heating blankets, and radiant warming systems.	IA
172	Perl T, Peichl LH, Reyntjens K, Deblaere I, Zaballos JM, Bräuer A. Efficacy of a novel prewarming system in the prevention of perioperative hypothermia. A prospective, randomized, multicenter study. <i>Minerva Anesthesiol.</i> 2014;80(4):436-443.	RCT	90 patients having surgery lasting 30-120 minutes. (30 in each group)	Active preoperative prewarming with a forced-air warmer connected to a prewarming suit	Standard preoperative insulation, passive preoperative insulation with a commercial prewarming suit	Patient temperature	Active prewarming with a forced-air warmer and an insulating prewarming suit achieves significantly higher core temperatures during anesthesia and at the end of surgery when compared to commercial or conventional insulation without active warming.	IA

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173	Shin KM, Ahn JH, Kim IS, et al. The efficacy of pre-warming on reducing intraoperative hypothermia in endovascular coiling of cerebral aneurysms. BMC Anesthesiol. 2015;15:8.	RCT	72 patients having endovascular treatment of cerebral aneurysms. (36 in each group)	Prewarming forced air at 38, 30 min	No prewarming	Patient temperature	Prewarming significantly reduced the rate of intraoperative hypothermia.	IA
174	Horn EP, Bein B, Broch O, et al. Warming before and after epidural block before general anaesthesia for major abdominal surgery prevents perioperative hypothermia: a randomised controlled trial. Eur J Anaesthesiol. 2016;33(5):334-340.	RCT	99 patients having major abdominal surgery and combined epidural and general anesthesia divided into three groups (32 no warming, 33 warming after epidural, 34 warming before and after epidural)	15 minutes prewarming after epidural insertion, 15 minutes prewarming before and after epidural insertion. Used FAW	Warm blankets	Patient temperature	Prewarming before or before and after the administration of epidural anesthesia assists with preventing hypothermia.	IB
175	Wasfie TJ, Barber KR. Value of extended warming in patients undergoing elective surgery. Int Surg. 2015;100(1):105-108.	RCT	94 (46 warming group, 48 control group)	Portable warming gown applied preoperatively (Bair paws = FAW)	Standard warming procedures	Patient temperature	The incidence of hypothermia is decreased when patients are prewarmed.	IB
176	Akhtar Z, Hesler BD, Fiffick AN, et al. A randomized trial of prewarming on patient satisfaction and thermal comfort in outpatient surgery. J Clin Anesth. 2016;33:376-385.	RCT	51 who received no prewarming and 51 who received 60 minutes of prewarming.	Prewarming	No prewarming	Patient temperature, EVAN-G satisfaction score, thermal comfort	Forced-air prewarming increased the sensation of warmth preoperatively and postoperatively but did not significantly reduce redistribution hypothermia; and the mean postoperative core temperatures were not significantly different between groups.	IA
177	Rosenkilde C, Vamosi M, Lauridsen J, Hasfeldt D. Efficacy of prewarming with a self-warming blanket for the prevention of unintended perioperative hypothermia in patients undergoing hip or knee arthroplasty. J Perianesth Nurs. 2017;32(5):419-428.	Quasi-experimental	30 patients having elective primary hip or knee arthroplasty (15 in each group).	Prewarming using self-warming blanket	No prewarming	Patient temperature	Prewarming with a self-warming blanket reduces unintentional perioperative hypothermia.	IIB
178	Munday J, Osborne S, Yates P, Sturgess D, Jones L, Gosden E. Preoperative warming versus no preoperative warming for maintenance of normothermia in women receiving intrathecal morphine for cesarean delivery: a single-blinded, randomized controlled trial. Anesth Analg. 2018;126(1):183-189.	RCT	50 C-section patients. (25 each group)	Prewarming	No prewarming	Patient temperature	Prewarming for 20 minutes did not prevent an intraoperative temperature drop in women who received intrathecal morphine.	IB

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179	Recio-Pérez J, Miró Murillo M, Martín Mesa M, et al. Effect of Prewarming on Perioperative Hypothermia in Patients Undergoing Loco-Regional or General Anesthesia: A Randomized Clinical Trial. <i>Medicina (Kaunas)</i> . 2023;59(12):2082. doi: 10.3390/medicina59122082.	RCT	197 adults undergoing non-cardiac surgery	Prewarming with forced air warming for at least 10 minutes	No prewarming	Incidence, magnitude, and duration of hypothermia; core temperature at OR arrival, SSI, blood loss, transfusion, discomfort, reintervention, hospital stay	Preoperative forced-air warming for at least 10 minutes did not affect the incidence, duration, or magnitude of hypothermia compared to no prewarming, likely related to implementation of a strict protocol for perioperative temperature management that was already in place.	IB
180	Jo YY, Chang YJ, Kim YB, Lee S, Kwak HJ, eds. Effect of preoperative forced-air warming on hypothermia in elderly patients undergoing transurethral resection of the prostate. <i>Urol J</i> . 2015;12(5):2366-2370.	RCT	50 patients having TURP (25 each group)	Prewarming	No prewarming	patient temperature	Prewarming reduced the incidence of moderate and profound hypothermia but did not eliminate hypothermia completely.	IB
181	Connelly L, Cramer E, DeMott Q, et al. The optimal time and method for surgical prewarming: a comprehensive review of the literature. <i>J Perianesth Nurs</i> . 2017;32(3):199-209.	Systematic Review	N/A	N/A	N/A	N/A	Patients should be prewarmed for at least 10 minutes and 30 minutes ideally. Forced air warming was the best method for prewarming.	IIIA
182	Sessler DI. Perioperative thermoregulation and heat balance. <i>Lancet</i> . 2016;387(10038):2655-2664.	Literature Review	N/A	N/A	N/A	N/A	Explains the mechanism of anesthesia-induced hypothermia and recommends keeping all perioperative patients normothermic.	VA
183	Munday J, Hines S, Wallace K, Chang AM, Gibbons K, Yates P. A systematic review of the effectiveness of warming interventions for women undergoing cesarean section. <i>Worldviews Evid Based Nurs</i> . 2014;11(6):383-393.	Systematic Review	N/A	N/A	N/A	N/A	IV fluid warming, forced air warming, and under-body carbon polymer mattresses were effective at preventing intraoperative hypothermia.	IB
184	Alderson P, Campbell G, Smith AF, Warttig S, Nicholson A, Lewis SR. Thermal insulation for preventing inadvertent perioperative hypothermia. [Review]. <i>Cochrane Database of Systematic Reviews</i> . 2014;(6)-2014 Jun 04.	Systematic Review w/ Meta-Analysis	N/A	N/A	N/A	N/A	Forced air warming is more effective at maintaining normothermia than reflective blankets or clothing, and there was no clear evidence indicating that reflective blankets or clothing increased a person's temperature.	IA
185	Horn EP, Bein B, Steinfath M, Ramaker K, Buchloh B, Hocker J. The incidence and prevention of hypothermia in newborn bonding after cesarean delivery: a randomized controlled trial. <i>Anesth Analg</i> . 2014;118(5):997-1002.	RCT	40 patients have C-sections, (21 in warming group, 19 in passive warming only group).	Warming with a forced air device	Passive warming	Mother and neonate temperature, maternal shivering and comfort.	Use of a forced air warming device for both mother and infant during bonding reduced the incidence of hypothermia, decreased maternal shivering, and increased maternal comfort.	IB

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186	de Bernardis RC, Siaulyis MM, Vieira JE, Mathias LA, eds. Perioperative warming with a thermal gown prevents maternal temperature loss during elective cesarean section. A randomized clinical trial. <i>Braz J Anesthesiol.</i> 2016;66(5):451-455.	RCT	40 patients having C-section (20 in each group).	Warmed with forced air warming gown and blanket	No active warming	Patient temperature	Thirty minutes of active warming before spinal anesthesia and intraoperatively prevented hypothermia.	IB
187	Pu Y, Cen G, Sun J, et al. Warming with an underbody warming system reduces intraoperative hypothermia in patients undergoing laparoscopic gastrointestinal surgery: a randomized controlled study. <i>Int J Nurs Stud.</i> 2014;51(2):181-189.	RCT	110 patients undergoing laparoscopic surgery for GI cancer; (55 in each group)	No warming device	Underbody warming device	Patient temperature	Use of an underbody warming system decreased intraoperative hypothermia during laparoscopic gastrointestinal surgery.	IA
188	Moysés AM, dos Santos Trettene A, Navarro LH, Ayres JA. Hypothermia prevention during surgery: Comparison between thermal mattress and thermal blanket. <i>Rev Esc Enfermagem USP.</i> 2014;48(2):226-252.	RCT	38 patients having Open GI tract surgery (19 in each group)	Thermal blanket	Thermal mattress	Patient temperature	The thermal mattress was more effective in preventing hypothermia during surgery than a forced air warming blanket.	IB
189	Ackermann W, Fan Q, Parekh AJ, Stoicea N, Ryan J, Bergese SD. Forced-Air Warming and Resistive Heating Devices. Updated Perspectives on Safety and Surgical Site Infections. <i>Front Surg.</i> 2018;5:64.	Literature Review	n/a	n/a	n/a	n/a	Summarizes literature on forced-air warming and resistive heating and identifies a need for additional research to inform practice.	VB
190	Nemeth M, Miller C, Brauer A. Perioperative Hypothermia in Children. <i>Int J Environ Res Public Health.</i> 2021;18(14).	Literature Review	n/a	n/a	n/a	n/a	Perioperative hypothermia is still a concern for pediatric patients. Identifies effective strategies to avoid hypothermia.	VA
191	Wright R. Guideline for a Safe Environment of Care. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for a safe environment of care.	IVA
192	Chapp K, Lange L. Warming blanket head drapes and trapped anesthetic gases: understanding the fire risk. <i>AORN J.</i> 2011;93(6):749-760.	Organizational Experience	N/A	N/A	N/A	N/A	The forced air warming blanket head drape should be tented and the blower should be on whenever the drape is in place.	VB
193	Torossian A, Van Gerven E, Geertsens K, Horn B, Van de Velde M, Raeder J. Active perioperative patient warming using a self-warming blanket (BARRIER EasyWarm) is superior to passive thermal insulation: a multinational, multicenter, randomized trial. <i>J Clin Anesth.</i> 2016;34:547-554.	RCT	277 patients having elective orthopedic; gynecologic; or ear, nose, and throat surgery with a scheduled time of 30 to 120 minutes. (122 in the warmed group and 124 in the control group)	Warmed using a conductive self warming blanket	Warmed using a cotton blanket	Patient temperature; patients' thermal comfort	Use of a self-warming blanket reduced the rate of perioperative hypothermia and improved patients' thermal comfort.	IA

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194	Chakladar A, Dixon MJ, Crook D, Harper CM. The effects of a resistive warming mattress during caesarean section: a randomised, controlled trial. <i>Int J Obstet Anesth.</i> 2014;23(4):309-316.	RCT	116 patients having cesarean birth	Use of resistive warming mattress	No warming mattress	Presence of inadvertent perioperative hypothermia	Use of a resistive warming mattress decreased the rate of perioperative hypothermia in patients having cesarean delivery.	IA
195	Sharma M, Dixon M, Eljelani F, Crook D, Harper M. A randomised controlled trial to determine the influence of carbon-polymer warming blankets on the incidence of perioperative hypothermia during and after short, day-case operations. <i>J One Day Surg.</i> 2014;24(4):92-99.	RCT	70 surgical patients	Standard care plus an electric warming blanket	Standard care	Patient temperature	Use of an electric blanket during short surgeries may reduce the incidence of hypothermia.	IB
196	Paris LG, Seitz M, McElroy KG, Regan M. A randomized controlled trial to improve outcomes utilizing various warming techniques during cesarean birth. <i>J Obstet Gynecol Neonatal Nurs.</i> 2014;43(6):719-728.	RCT	226 women having cesarean birth divided into three groups; routine Care (n = 76), warmed IV Fluids (n = 73), warmed Under Body Pad (n = 77)	Application of warmed under body pad or warmed IV fluids.	Routine care	Patient temperature	Those receiving warmed fluids had a higher intraoperative temperature and those warmed with the underbody pad had a higher temperature in PACU.	IA
197	Galvão CM, Marck PB, Sawada NO, Clark AM. A systematic review of the effectiveness of cutaneous warming systems to prevent hypothermia. <i>J Clin Nurs.</i> 2009;18(5):627-636.	Systematic Review	N/A	N/A	N/A	N/A	Carbon-fiber blankets and forced-air warming systems are effective at preventing hypothermia but circulating- water garments may be more effective	IA
198	Ruetzler K, Kovaci B, Guloglu E, et al. Forced-air and a novel patient-warming system (vitalHEAT vH2) comparably maintain normothermia during open abdominal surgery. <i>Anesth Analg.</i> 2011;112(3):608-614.	Quasi-experimental	71 Patients having elective major open abdominal surgery. (37 sleeve, 34 FAW)	Circulating-water sleeve	Forced air warming device	Patient temperature	Upper body forced-air warming and a circulating-water sleeve device were equally effective in maintaining normothermia.	IIB
199	Hasegawa K, Nakagawa F, Negishi C, Ozaki M. Core temperatures during major abdominal surgery in patients warmed with new circulating-water garment, forced-air warming, or carbon-fiber resistive-heating system. <i>J Anesth.</i> 2012;26(2):168-173.	Quasi-experimental	36 patients undergoing open abdominal surgery	Circulating water garment	Forced air warming device or carbon- fiber resistive heating system	Patient temperature	A circulating water garment was more effective than forced-air warming device or carbon-fiber resistive heating system.	IIA
200	Trentman TL, Weinmeister KP, Hentz JG, Laney MB, Simula DV. Randomized non-inferiority trial of the vitalHEAT temperature management system vs the Bair Hugger warmer during total knee arthroplasty. <i>Can J Anaesth.</i> 2009;56(12):914-920.	RCT	55 patients having unilateral total knee arthroplasty, (30 in water group 25 in FAW group)	Circulating warm water device with vacuum	Forced air warming device	Patient temperature	A conductive warming system using circulating warm water with a vacuum applied to a single extremity underperforms when compared to a forced air warming device.	IB

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201	FDA's Ongoing Evaluation and Continued Monitoring of Reports of Nontuberculous Mycobacteria Infections Associated with Water-Based Heater-Cooler Devices. US Food & Drug Administration (FDA) Web site. https://www.fda.gov/medical-devices/what-heater-cooler-device/fdas-ongoing-evaluation-and-continued-monitoring-reports-nontuberculous-mycobacteria-infections#design . Updated 2022.	Regulatory	n/a	n/a	n/a	n/a	Report from FDA describing ongoing evaluation and monitoring of infections associated with water-based heater cooler devices.	n/a
202	Recommendations for the Use of Water-Based Heater Cooler Devices. US Food & Drug Administration (FDA) Web site. https://www.fda.gov/medical-devices/what-heater-cooler-device/recommendations-use-water-based-heater-cooler-devices . Updated 2022.	Guideline	n/a	n/a	n/a	n/a	Recommendations from FDA for use of water-based heater cooler devices.	IVB
203	Cahn J. Guideline for Sterile Technique. Kyle E, ed. e-Subscription ed. AORN, Inc.; 2024. [IVA].	Guideline	n/a	n/a	n/a	n/a	Provides guidance for sterile technique.	IVA
204	Warming/Cooling Units, Patient, Circulating-Liquid; Pumps, Circulating-Liquid. Emergency Care Research Institute (ECRI); 2023.	Expert Opinion	n/a	n/a	n/a	n/a	Compares circulating-liquid warming/cooling devices and summarizes reported problems.	VB
205	Kim G, Kim MH, Lee SM, Choi SJ, Shin YH, Jeong HJ. Effect of pre-warmed intravenous fluids on perioperative hypothermia and shivering after ambulatory surgery under monitored anesthesia care. J Anesth. 2014;28(6):880–885.	RCT	Females having minor surgery. 27 participants, 26 control	Pre-warmed IV fluids	Room temperature IV fluids	Patient temperature	Use of pre-warmed IV fluids decreased intraoperative hypothermia.	IA
206	Warming Cabinets. https://www.ecri.org/components/HRC/Pages/SurgAn23.aspx# . Updated 2020.	Expert Opinion	n/a	n/a	n/a	n/a	Recommendations for warming cabinets.	VC
207	Tekgul ZT, Pektas S, Yildirim U, et al. A prospective randomized double-blind study on the effects of the temperature of irrigation solutions on thermoregulation and postoperative complications in percutaneous nephrolithotomy. J Anesth. 2015;29(2):165-169.	RCT	60 patients having percutaneous nephrolithotomy (30 in each group)	Warmed irrigation fluids	Room temperature irrigation fluids	Patient temperature	Using room temperature irrigation fluids led to an increased rate of hypothermia and other associated complications.	IA

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208	Oh JH, Kim JY, Chung SW, et al. Warmed irrigation fluid does not decrease perioperative hypothermia during arthroscopic shoulder surgery. <i>Arthroscopy</i> . 2014;30(2):159-164.	RCT	72 patients having arthroscopic shoulder surgery (36 in each group)	Warmed irrigation fluids	Room temperature irrigation fluids	Patient temperature	Warmed irrigation fluid was not superior to room-temperature irrigation fluid in reducing the occurrence of perioperative hypothermia during arthroscopic shoulder surgery.	IA
209	Anaegbu N, Olatosi O, Tobi K. Effectiveness of heat moisture exchangers (hmes) in preventing perioperative hypothermia among adult patients undergoing abdominal surgery under general endotracheal anaesthesia. <i>J West Afr Coll Surg</i> . 2013;3(3):16-32.	RCT	49 surgical patients in heated group; 50 in control group	Heated moisturized anesthesia gases	No warming	Patient temperature	Warmed anesthesia gases did not prevent hypothermia but resulted in a higher core temperature. Warmed anesthesia gases should be part of a multimodal approach to perioperative hypothermia prevention.	IB
210	Lee Y, Kim H. The effects of heated humidified gases on body temperature and shivering in patients under general anesthesia. <i>Int J Biosci Biotechnol</i> . 2013;5(4):61-72.	Quasi-experimental	71 patients having musculoskeletal surgery	Warmed gases	Room temperature gases	Patient temperature	Anesthesia gases should be heated and humidified.	IIB
211	Cassey JG, King RA, Armstrong P. Is there thermal benefit from preoperative warming in children? <i>Paediatr Anaesth</i> . 2010;20(1):63-71.	RCT	60 children having surgery (30 in each group)	Ambient temperature at 26 degrees C.	Ambient temperature at 21 degrees C.	Patient temperature	Prewarming by increasing the ambient temperature increased the core temperature of the participants; however, the increase was not clinically beneficial for most patients.	IB
212	Deren ME, Machan JT, DiGiovanni CW, Ehrlich MG, Gillerman RG. Prewarming operating rooms for prevention of intraoperative hypothermia during total knee and hip arthroplasties. <i>J Arthroplasty</i> . 2011;26(8):1380-1386.	RCT	66 patients undergoing elective knee or minimally invasive hip arthroplasty.	Prewarming the OR	OR was not prewarmed	Patient temperature	Raising the ambient temperature of the OR preoperatively has a minimal effect on preventing intraoperative hypothermia.	IA
213	Ozer AB, Tosun F, Demirel I, Unlu S, Bayar MK, Erhan OL. The effects of anesthetic technique and ambient temperature on thermoregulation in lower extremity surgery. <i>J Anesth</i> . 2013;27(4):528-534.	Quasi-experimental	90 adult males having lower extremity surgery	Room temperature of 20–22 degrees C	Room temperature of 23–25 degrees C.	Mean skin temperature and mean body temperature	In patients having lower extremity surgery the room temperature affected the mean skin temperature. Room temp affected thermoregulation in Group A (gen anesthesia).	IIB
214	Koenen M, Passey M, Rolfe M. "Keeping them warm"—a randomized controlled trial of two passive perioperative warming methods. <i>J Perianesth Nurs</i> . 2017;32(3):188-198.	RCT	Patients having surgery of one hour or less. (179 in reflective blanket group, 141 in cotton blanket group)	Reflective blanket	Cotton blanket	Temporal artery and foot temperature.	Reflective blankets were more effective than cotton blankets for perioperative temperature management.	IB
215	Kurnat-Thoma E, Roberts MM, Corcoran EB. Perioperative heat loss Prevention—a feasibility trial. <i>AORN J</i> . 2016;104(4):307-319.	Quasi-experimental	110 surgical patient warmed with reflective blanket; 114 patients warmed with cotton blankets	Reflective blankets	Cotton blankets	Patient temperature	Use of reflective blankets did not create a cost saving or decreased rate of hypothermia when compared to use of cotton blankets.	IIB

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216	Lee HY, Kim G, Shin Y. Effects of perioperative warm socks-wearing in maintaining core body temperature of patients undergoing spinal surgery. <i>J Clin Nurs</i> . 2018;27(7):1399-1407.	Quasi-experimental	72 patients having spinal surgery (36 in each group).	Warm socks	No socks	Patient temperature	Wearing warm socks helped decrease the rate of hypothermia	IIC
217	Litman RS, Smith VI, Larach MG, Mayes L, Shukry M, Theroux MC, Watt S, Wong CA. Consensus Statement of the Malignant Hyperthermia Association of the United States on Unresolved Clinical Questions Concerning the Management of Patients With Malignant Hyperthermia. <i>Anesth Analg</i> . 2019;128(4):652-659.	Consensus	n/a	n/a	n/a	n/a	Facilities that stock any MH triggering agents should have a full supply of dantrolene immediately available in the event of an MH crisis. Masseter muscle rigidity (MMR) may not always signal an impending MH crisis. Use nontriggering agents to treat patients who have a history of MMR during anesthesia. There is insufficient evidence to determine whether history of heat/exercise induced rhabdomyolysis is a risk for MH-susceptibility and patients should be evaluated on a case-by-case basis. Hyperthermia resulting from MH should be treated with prompt administration of dantrolene, external cooling, and cooled IV fluids. Care of MH-susceptible patients should not be restricted before formal testing or limited to inpatient hospitals.	IVB
218	Rüffert H, Bastian B, Bendixen D. Consensus guidelines on perioperative management of malignant hyperthermia suspected or susceptible patients from the European Malignant Hyperthermia Group. <i>Br J Anaesth</i> . 2021;126(1):120–130.	Consensus	n/a	n/a	n/a	n/a	Guidance for the care of MH susceptible patients.	IVA
219	Malignant Hyperthermia Association of the United States: MHAUS. Malignant Hyperthermia Association of the United States (MHAUS) Web site. https://www.mhaus.org/	Expert Opinion	n/a	n/a	n/a	n/a	Resources for malignant hyperthermia.	VB
220	Malignant Hyperthermia Crisis Preparedness and Treatment. American Association of Nurse Anesthesiology (AANA); 2018.	Position Statement	n/a	n/a	n/a	n/a	Provides AANA position on MH, dantrolene availability, and considerations for MH policy development.	IVB

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221	Denholm, B.G. (2016), Using Informatics to Improve the Care of Patients Susceptible to Malignant Hyperthermia. AORN Journal, 103: 364-379.e4. https://doi.org/10.1016/j.aorn.2016.02.001	Expert Opinion	n/a	n/a	n/a	n/a	Describes the application of informatics to improve the care of patients susceptible to malignant hyperthermia. Perioperative nurses and leaders should advocate for the reporting of MH-suspected events to national databases to improve data collection and data sharing, which can contribute to the MH knowledge base and advance research to guide clinical practice.	VB
222	Hopkins, P.M., Girard, T., Dalay, S., Jenkins, B., Thacker, A., Patteril, M. and McGrady, E. (2021), Malignant hyperthermia 2020. Anaesthesia, 76: 655-664. https://doi.org/10.1111/anae.15317	Consensus	n/a	n/a	n/a	n/a	Provides guidance on clinical diagnosis of malignant hyperthermia, care and monitoring during and after an MH event, preoperative risk assessment, and precautions to manage patients who are MH-susceptible.	IVB
223	Larach MG, Klumpner TT, Brandom BW, Vaughn MT, Belani KG, Herlich A, Kim TW, Limoncelli J, Riazi S, Sivak EL, Capacchione J, Mashman D, Kheterpal S; on behalf of the Multicenter Perioperative Outcomes Group. Succinylcholine Use and Dantrolene Availability for Malignant Hyperthermia Treatment: Database Analyses and Systematic Review. Anesthesiology. 2019;130(1):41–54.	Systematic Review and Database Analysis	n/a	n/a	n/a	n/a	Succinylcholine can trigger an MH event requiring dantrolene, even without administration of volatile anesthetics. Delaying dantrolene administration increases the probability of MH complications, leading to a recommendation to stock dantrolene wherever succinylcholine or volatile anesthetics may be used.	IIIA
224	Guglielminotti J, Rosenberg H, Li G. Prevalence of malignant hyperthermia diagnosis in obstetric patients in the United States, 2003 to 2014. BMC ANESTHESIOLOG. 2020;20(1):1–9.	Nonexperimental	47,178,322 delivery-related discharges	n/a	n/a	Malignant hyperthermia diagnosis code	The prevalence of MH-susceptibility in maternal patients who had cesarean delivery was found to be similar to the prevalence reported in non-obstetric surgical inpatients. These results support having dantrolene available in maternity units.	IIIA
225	Glahn KPE, Bendixen D, Girard T, et al. Availability of dantrolene for the management of malignant hyperthermia crises: European Malignant Hyperthermia Group guidelines. Br J Anaesth. 2020;125(2):133–140.	Guideline	n/a	n/a	n/a	n/a	Recommendations for availability, dosing, and inventory supply levels of dantrolene in the clinical setting.	IVA
226	Litman RS, Griggs, S.M., Dowling, J.J., Riazi, S.: Malignant Hyperthermia Susceptibility and Related Diseases. Anesthesiology, 1 2018, Vol.128, 159-167	Literature Review	n/a	n/a	n/a	n/a	Summarizes literature linking genetic variants to MH-susceptivity and conditions with MH-like symptoms upon exposure to triggering agents.	VB
227	Gregory H, Weant KA. Pathophysiology and Treatment of Malignant Hyperthermia. Adv emerg nurs j. 2021;43(2):102–110.	Literature Review	n/a	n/a	n/a	n/a	Summarizes the literature on the pathophysiology, recognition, and treatment of malignant hyperthermia.	VC

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228	Otsuki S, Miyoshi H, Mukaida K, Yasuda T, Nakamura R, Tsutsumi YM. Age-Specific Clinical Features of Pediatric Malignant Hyperthermia: A Review of 187 Cases Over 60 Years in Japan. <i>Anesthesia & Analgesia</i> . 2022;135(1).	Nonexperimental	187 pediatric patients from Japanese MH database	n/a	n/a	Clinical symptoms of malignant hyperthermia	The clinical symptoms of malignant hyperthermia vary with age in pediatric patients, and understanding differences in initial MH symptoms among the different age groups could help clinicians with early recognition of MH.	IIIA
229	Toyota Y, Kondo T, Shorin D, et al. Rapid Dantrolene Administration with Body Temperature Monitoring Is Associated with Decreased Mortality in Japanese Malignant Hyperthermia Events. <i>BIOMED RES INT</i> . 2023;1:1–6.	Nonexperimental	128 patients scoring 5 (very likely) or 6 (almost certain) on the MH clinical grading scale	n/a	n/a	First signs of MH, frequency and timing of dantrolene administration; administration of triggering agents, dantrolene dosing, body temperature and rate of increase, end tidal CO ₂	Dantrolene should be administered as quickly as possible once MH is diagnosed. The lower the body temperature is at treatment initiation, the better the prognosis.	IIIA
230	Managing A Crisis. Malignant Hyperthermia Association of the United States (MHAUS) Web site. https://www.mhaus.org/healthcare-professionals/managing-a-crisis/	Expert Opinion	n/a	n/a	n/a	n/a	Recommendations for managing a malignant hyperthermia crisis.	VB
231	Yang L, Tautz T, Zhang S, Fomina A, Liu H. The current status of malignant hyperthermia. <i>The Journal of Biomedical Research</i> . 2020;34(2):75–85.	Literature Review	n/a	n/a	n/a	n/a	Literature review summarizing the epidemiology of MH, clinical symptoms, and diagnosis and treatment of MH.	VB
232	Riazi S, Kraeva N, Hopkins PM. Updated guide for the management of malignant hyperthermia. <i>Canadian Journal of Anesthesia/Journal canadien d'anesthésie</i> . 2018;65(6):709–721.	Expert Opinion	n/a	n/a	n/a	n/a	Early recognition of the signs of malignant hyperthermia and prompt initiation of treatment can reduce the risk of dying from MH.	VB
233	Collins S, Budds M, Raines C, Hooper V. Risk Factors for Perioperative Hypothermia: A Literature Review. <i>J Perianesth Nurs</i> . 2019;34(2):338-346.	Systematic Review	n/a	n/a	n/a	n/a	Further study is needed to definitively identify risk factors for perioperative hypothermia and methods for effectively maintaining perioperative normothermia.	IIIB
234	Oden TN, Doruker NC, Korkmaz FD. Compliance of Health Professionals for Prevention of Inadvertent Perioperative Hypothermia in Adult Patients: A Review. <i>AANA J</i> . 2022;90(4):281–287.	Literature Review	n/a	n/a	n/a	n/a	Summarizes the literature on health care professionals' practice in preventing inadvertent perioperative hypothermia and the application of evidence-based guidelines.	VB

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235	Woretaw AW, Yimer Mekonnen B, Tsegaye N, Dellie E. Knowledge and practice of nurses with respect to perioperative hypothermia prevention in the Northwest Amhara Regional State Referral Hospitals, Ethiopia: a cross-sectional study. <i>BMJ Open</i> . 2023;13(12):e068131-068131. doi:10.1136/bmjopen-2022-068131.	Qualitative	413 RNs from perioperative units	n/a	n/a	Nurses' knowledge and practice related to perioperative hypothermia prevention	Among perioperative nurses in Northwestern Ethiopia, there is a need to improve nurses' knowledge and practice related to prevention of perioperative hypothermia. Recommend education and in-service opportunities.	IIIB
236	Rauch S, Miller C, Brauer A, Wallner B, Bock M, Paal P. Perioperative Hypothermia-A Narrative Review. <i>Int J Environ Res Public Health</i> . 2021;18(16).	Literature Review	n/a	n/a	n/a	n/a	Describes the physiology of thermoregulation and concepts related to perioperative temperature management. Recommends implementing active warming throughout the perioperative period with continual monitoring of body temperature.	VA
237	Hardy, J.-B., Gouin, A., Damm, C., Compère, V., Veber, B., & Dureuil, B. (2018). The use of a checklist improves anaesthesiologists' technical and non-technical performance for simulated malignant hyperthermia management. <i>Anaesthesia Critical Care & Pain Medicine</i> , 37(1), 17–23. doi: 10.1016/j.accpm.2017.07.009	Nonexperimental	24 anesthesiologists	MH checklist	No MH checklist	Checklist task completion; non-technical skill score, participant stress, length of time for completion	MH checklist use led to improved adherence to guidelines and non-technical skills. The findings suggest that using a checklist to support management of an MH emergency is beneficial and that education and training on how to use the checklist could improve usage of the tool.	IIIB
238	Schaad S. Simulation-Based Training: Malignant Hyperthermia. <i>AORN Journal</i> . 2017;106(2):158–161.	Organizational Experience	n/a	n/a	n/a	n/a	Describes one organization's journey toward becoming a high-reliability organization through the use of simulation-based interdisciplinary team training for malignant hyperthermia.	VB
239	Seifert PC, Wahr JA, Pace M, Cochrane AB, Bagnola AJ. Crisis Management of Malignant Hyperthermia in the OR. <i>AORN Journal</i> . 2014;100(2):189–202.e1.	Expert Opinion	n/a	n/a	n/a	n/a	Describes the pathophysiology of malignant hyperthermia, triggers, interventions and treatment, and outlines actions facilities can take to prepare for an MH event, including a list of MH cart supplies.	VB
240	Cain CL, Riess ML, Gettrust L, Novalija J. Malignant Hyperthermia Crisis: Optimizing Patient Outcomes Through Simulation and Interdisciplinary Collaboration. <i>AORN Journal</i> . 2014;99(2):300–311.	Organizational Experience	n/a	n/a	n/a	n/a	Describes one facility's experience in implementing a two-part MH educational intervention consisting of didactic and a high-fidelity simulated OR scenario. The experience allowed personnel to develop their skills, communication, and teamwork as they gained role clarity, learned to anticipate, and improved team cohesion. The project also included MH policy development and updating the MH cart.	VB

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241	Silvana de Oliveira Sene E, Garcia Viana T, Catunda Bettero Valle KA, Bittar E. EDUCATIONAL STRATEGY WITH NURSING PROFESSIONALS ON MALIGNANT HYPERTERMIA IN A CARDIOVASCULAR SURGICAL CENTER. <i>SOBECC REV.</i> 2020;25(1):42–49.	Organizational Experience	43 surgery center professionals (nurses, technicians, assistants)	n/a	n/a	n/a	Pre- and post-test results showed an improvement in knowledge of malignant hyperthermia (MH) after an educational lecture on the topic. An MH treatment kit was developed and implemented.	VC
242	Alidina S, Goldhaber-Fiebert S, Hannenberg AA, et al. Factors associated with the use of cognitive aids in operating room crises: a cross-sectional study of US hospitals and ambulatory surgical centers. <i>Implement Sci.</i> 2018;13(1):50. doi: https://dx.doi.org/10.1186/s13012-018-0739-4	Nonexperimental	368 respondents from US hospitals and ASCs that had implemented OR cognitive aids for crises	n/a	n/a	Regular use of cognitive aids during applicable clinical events	A supportive organizational culture and using a multi-step implementation process was associated with successful implementation of cognitive aids in the OR.	IIIB
243	Hepner DL, Arriaga AF, Cooper JB, et al. Operating Room Crisis Checklists and Emergency Manuals. <i>Anesthesiology.</i> 2017;127(2):384-392. doi: 10.1097/ALN.0000000000001731	Literature Review	n/a	n/a	n/a	n/a	Describes the use of cognitive aids in managing OR emergencies.	VB
244	MH Mock Drill Frequency. Malignant Hyperthermia Association of the United States (MHAUS) Web site. https://www.mhaus.org/cfw/index.cfm?controller=kb&action=view-article&key=BD9B32CE-CB26-4383-82C2-31B52D88AFC9&seoTitle=mh-mock-drill-frequency	Expert Opinion	n/a	n/a	n/a	n/a	Recommendation for MH mock drill frequency.	VB
245	Huang J, Qi H, Lv K, Zhu Y, Wang Y, Jin L. Development and Psychometric Properties of a Scale Measuring Barriers to Perioperative Hypothermia Prevention for Anesthesiologists and Nurses. <i>J Perianesth Nurs.</i> 2023;38(5):703-709.	Nonexperimental	416 anesthesiologists and nurses	n/a	n/a	Validity, reliability	The Barriers to Perioperative Hypothermia Prevention scale met the psychometric criteria for reliability and validity and can help assess quality measures of inadvertent perioperative hypothermia management among anesthesiologists and nurses. Additional research on an optimal protocol for perioperative hypothermia prevention is needed.	IIIA
246	Normothermia Audit Tool. Agency for Healthcare Research and Quality (AHRQ) Web site. https://www.ahrq.gov/hai/tools/surgery/tools/surgical-complication-prevention/normothermia-audit.html . Updated 2017.	Expert Opinion	n/a	n/a	n/a	n/a	Normothermia Audit Tool from the Agency for Healthcare Research and Quality to help evaluate effectiveness of normothermia maintenance interventions.	VB

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247	Fahim M, Dijkstra LM, Biesma DH, Noordzij PG, Smits AB. Effect of Intra-Operative Hypothermia on Post-Operative Morbidity in Patients with Colorectal Cancer. <i>Surg Infect (Larchmt)</i> . 2021;22(8):803–809.	Organizational Experience	1,015 patients undergoing surgery for primary colorectal cancer	n/a	n/a	Core temperature, SSI incidence, 30-day complications, mortality, readmission	In a hospital where temperature management and adherence to normothermia is standard care, intraoperative hypothermia and surgical site infection incidence were found to be low for patients undergoing colorectal cancer surgery.	VA
248	Top 10 Health Technology Hazards for 2023: Expert Insights from ECRI's Device Evaluation Program. ECRI Institute; 2023.	Expert Opinion	n/a	n/a	n/a	n/a	ECRI recommends removing barriers to reporting device-related issues to reduce the chance of recurrence.	VB
249	21 CFR 803: Medical Device Reporting. 2022. https://www.govinfo.gov/app/details/CFR-2022-title21-vol8/CFR-2022-title21-vol8-part803 .	Regulatory	n/a	n/a	n/a	n/a	Requirements for medical device reporting.	n/a
250	MAUDE: Manufacturer and User Facility Device Experience. US Food & Drug Administration (FDA) Web site. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/search.CFM . Updated 2023.	Regulatory	n/a	n/a	n/a	n/a	FDA MAUDE database.	n/a
251	Medical Device Reporting (MDR): How to Report Medical Device Problems. https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems#:~:text=Patients%2C%20healthcare%20professionals%20and%20consumers%20who%20find%20a,FDA%20Safety%20Information%20and%20Adverse%20Event%20Reporting%20Program.?msclkid=b49f593fc0e011ec93feb45aa9414d20 . Updated 2023.	Regulatory	n/a	n/a	n/a	n/a	Requirements for medical device reporting.	n/a