Gynecologic Oncology 154 (2019) 590–594

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

Improving the rate of surgical normothermia in gynecologic surgery

Amanika Kumar [a,*], David P. Martin [b], Sarah R. Dhanorker [c], Sharon R. Brandt [b], Darrell R. Schroeder [d], Andrew C. Hanson [d], Robert R. Cima [e], Sean C. Dowdy [a]

[a] Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Mayo Clinic, Rochester, MN, United States of America
[b] Department of Anesthesiology, Mayo Clinic, Rochester, MN, United States of America
[c] Department of Management Engineering and Internal Consulting, Mayo Clinic, Rochester, MN, United States of America
[d] Division of Biomedical Statistics and Informatics, Mayo Clinic, Rochester, MN, United States of America
[e] Division of Colon and Rectal Surgery, Mayo Clinic, Rochester, MN, United States of America

HIGHLIGHTS

- Intra-operative normothermia is important in maintaining hemodynamic stability, normal clotting, and medication metabolism.
- Quality improvement methods can be used in an operating room setting to improve compliance with intra-operative normothermia.
- A combination of patient warming and room temperature regulation increases rates of intra-operative normothermia.

ARTICLE INFO

Article history:
Received 4 June 2019
Received in revised form 27 June 2019
Accepted 30 June 2019
Available online 5 July 2019

Keywords:
Health care
Hypothermia
Normothermia
Surgical site infections
PACU
Postanesthesia care unit

ABSTRACT

Objective. To increase the rate of normothermia (core temperature ≥ 36 °C) in patients undergoing gynecologic surgery.

Methods. The rate of surgical normothermia was evaluated in a single institution. A two-phase quality improvement project was undertaken; Phase 1 included the use of intra-operative room temperature regulation and intra-operative patient warming and Phase 2 included pre-operative patient warming. Clinical characteristics, median temperatures, and rate of normothermia were abstracted for patients in each phase. Cohorts were compared using chi-square and *t*-tests.

Results. The project was performed in two phases, each with a historic and intervention cohort. There were 503 patients in the historical cohort and 636 patients in the intervention cohort in phase 1; there were 291 patients in the historical cohort and 259 patients in the intervention cohort for Phase 2. Patient characteristics and anesthetic type and duration did not differ between cohorts.

After intra-operative temperature regulation and patient warming in Phase 1, significantly more patients achieved normothermia (79% versus 68%, $P < 0.0001$). However operating room staff were more likely to rate the temperature as very hot in 40% of cases post-intervention, compared to only 2% historically.

In Phase 2, after the intervention of pre-warming patients, there was no difference in achieving normothermia, 78% versus 83%, $P = 0.09$. Staff had no statistical difference in personal comfort with the temperature, however did feel efforts were very effective more frequently, 7.7% historic versus 32.7% post-intervention, $P < 0.0001$.

Conclusions. Quality improvement methodology can be applied to pre- and intra-operative decision making to improve rates of surgical patient normothermia.

1. Introduction

Core body temperature is tightly regulated by the hypothalamus between 36.5 and 37.5 degrees Celsius (°C). Deviation from this narrow range frequently signals thermoregulation failure or an extreme thermal environment. In the operating room setting, hypothermia occurs in the majority of patients undergoing major thoracic or abdominal surgery [1,2]. Contributors to intraoperative hypothermia are multifactorial. High-volume room temperature intravascular fluid administration and generally cooler operating room ambient temperatures contribute to heat loss. Additionally, open body cavities, such as the abdomen and thorax, accelerate conductive loss to the environment. All these factors, and others, contribute to patient hypothermia [3]. Normally, the hypothalamus will react to these factors and regulate core

* Corresponding author at: Department of Obstetrics and Gynecology, Mayo Clinic, 200 First Street, SW, Rochester, MN 55905, United States of America.
E-mail address: Kumar.amanika@mayo.edu (A. Kumar).

https://doi.org/10.1016/j.ygyno.2019.06.027
0090-8258/

temperature by shivering and vasoconstriction. However, impairment of thermoregulation by anesthetic agents leads to unchecked and uncorrected hypothermia. Reflexive vasoconstriction is blunted, allowing core heat to redistribute to the extremities, thereby increasing heat loss. Resulting intraoperative hypothermia augments anesthetic potency, increases the duration of neuromuscular blockade, delays drug metabolism, and contributes to hemodynamic instability due to failure of the thermoregulatory response [4].

Prospective randomized controlled trials have demonstrated that maintaining normothermia during surgery provides multiple clinical benefits to patients, including decreased surgical site infections, reduced blood loss, fewer cardiac complications, improved recovery time, and increased comfort [5–13]. In ovarian cancer, hypothermia has been associated with poor outcomes at our own institution [5]. As a result of these reports, the Centers for Medicare and Medicaid Services designated either the achievement of normothermia (36 °C) during surgery or the application of an active warming device to the patient as a best practice. In 2017, the Centers for Disease Control guidelines on preventing surgical site infection included maintaining peri-operative normothermia as a Category IA recommendation [2]. The reporting metric was tightened to exclude the option to report only application of a warming device, but as a compromise the definition of normothermia was relaxed to 35.5 °C. Despite these proven benefits, hypothermia remains a common occurrence in the perioperative setting.

To address these shortcomings, we initiated a two-phase quality improvement project to lower patient hypothermia rates in the gynecologic surgery division. During the course of the investigation, we evaluated the efficacy of the intervention, its associated cost, and staff satisfaction.

2. Methods

This was a quality improvement project in the Division of Gynecologic Surgery and the Department of Anesthesiology. At the time of the study, the division was comprised of 7 gynecologic oncologists and 4 urogynecologists. The Institutional Review Board approved this study.

The quality improvement initiative was performed in two phases. A multidisciplinary team was assembled to retrospectively evaluate baseline normothermia rates and then design and implement interventions to maintain normothermia as a prospective practice change using Define, Measure, Analyze, Improve, and Control approach. Phase 1 focused on equipping operating rooms in the surgical gynecology division with digital thermostats to enable precise temperature control (thermostat part number AP-TMZ1600-0; Johnson Controls). Room temperature was set using decision algorithms based on whether or not the patient was normothermic at the time of operating room entry and whether or not the patient was covered (Fig. 1). An appropriate room temperature was assured before the patient was brought into the operating room. An upper body forced-air warming blanket (Bair Hugger; 3M) was applied to all patients in this group regardless of operating room entry patient temperature. Phase 1 included a counterbalance measure designed to assess staff comfort and satisfaction. For Phase 1, normothermia rates within the intervention group were compared to the rate of normothermia in a historical control group including patients undergoing surgery on the gynecologic service between April 2011 and September 2011. Phase I took place from December 2011 and April 2012.

Phase II adopted the effective interventions from Phase I with alternative interventions aimed to maintain normothermia without compromising staff satisfaction. Phase II investigated the combination of algorithm-based operating room temperature control via digital thermostats (from Phase I) and pre-warming with Bair Paws Flex gowns (models 81001 and 81003; 3M) in gynecologic surgery patients between June 10, 2013, and August 2, 2013. These patients were compared to a historical control group of gynecologic surgery patients in the same operating rooms between April 15, 2013, and June 7, 2013, when algorithm-based operating room temperature control was used.

In both Phases I and II, the majority of patients underwent general anesthesia and had esophageal temperature probes placed. Anesthesia providers were instructed to leave the probes in place until the end of the case when possible. When esophageal temperature probes were not placed for patients undergoing regional anesthesia, oral temperatures were measured. Tympanic and nasal temperature measurements were discouraged, but these measurements were used if they were the only ones available. Temperature was recorded continuously during surgery and documented in the anesthesia information management system (Pices Chart+).

The primary outcome was the normothermia rate, defined as a median temperature ≥36 °C recorded between 30 min prior to leaving the operating room and 15 min after admission to the postanesthesia care unit (PACU), as defined by Centers for Medicare and Medicaid Services Surgical Care Improvement Project (SCIP) measure, SCIP-Inf-10 – Surgery Patients with Perioperative Temperature Management. Other patient factors were collected from the chart, such as age, sex, type of anesthesia, and length of PACU stay. Additional data were obtained via staff satisfaction surveys administered before and after each phase. Cost analysis was obtained from institutional supply chain management. Secondary outcomes included PACU length of stay, rates of staff satisfaction, and costs of interventions.

Patient and procedural characteristics were summarized separately for each study using mean (SD) and median (25th, 75th percentile) for continuous variables and frequency percentages for nominal variables. For each phase, the primary outcome was the percentage of patients who met criteria for normothermia (temperature ≥36 °C), based on the median temperature recorded between 30 min prior to leaving the operating room and 15 min after admission to the PACU. The χ^2-test was used to compare the frequency of normothermia between the historical control group and the intervention group. For these comparisons, the decision was made a priori that a two-tailed P value less than or equal to 0.10 would be used to conclude that an experimental intervention was effective and worthy of further investigation.

OR Thermostat Settings

	Patient temp ≥ 36 C	Patient temp < 36 C
Before and after draping	72 F	74 F
Patient covered with drapes	70 F	74 F

Thermostat should not be set less than 70 F between cases or overnight.

Fig. 1. Algorithm used for operating room temperature.

3. Results

3.1. Phase I

Table 1 summarizes case volume and patient characteristics in the Phase I study. There were no differences between cases and historical controls.

In Phase I, gynecologic operating rooms followed the room temperature algorithm shown in Fig. 1. The proportion of patients with normothermia (temperature ˃36.0 °C) increased significantly from 68% to 79%

Table 1
Patient demographics and rates of normothermia by phase and intervention stage[a].

	Phase I			Phase II		
	Pre-intervention (N = 503)	Post-intervention (N = 636)	P-value	Pre-intervention (N = 291)	Post-intervention (N = 259)	P-value
Age (y)			0.4308[1]			0.8836[1]
Mean (SD)	54.1 (15.47)	53.4 (14.43)		54.7 (15.61)	54.5 (15.90)	
Type of anesthesia (n = 1688)			0.5099[2]			0.1896[2]
General	500 (99.4%)	629 (99.1%)		267 (91.8%)	245 (94.6%)	
Regional or MAC	3 (0.6%)	6 (0.9%)		24 (8.2%)	14 (5.4%)	
Duration of anesthesia (h; n = 1687)			0.3937[1]			0.4803[1]
Mean (SD)	3.5 (1.91)	3.4 (1.86)		3.3 (1.75)	3.5 (2.00)	
ASA PS (n = 1688)			0.0647[2]			0.3378[2]
1–2	389 (77.3%)	520 (81.8%)		223 (76.9%)	190 (73.4%)	
3–4	114 (22.7%)	116 (18.2%)		67 (23.1%)	69 (26.6%)	
Emergency surgery (n = 1688)			0.3110[2]			
No	497 (98.8%)	632 (99.4%)		290 (100.0%)	259 (100.0%)	
Yes	6 (1.2%)	4 (0.6%)		0 (0.0%)	0 (0.0%)	
Median temperature ≥ 36 °C			<0.0001[2]			0.0911[2]
No	160 (31.8%)	133 (20.9%)		65 (22.3%)	43 (16.6%)	
Yes	343 (68.2%)	503 (79.1%)		226 (77.7%)	216 (83.4%)	
Temperature (°C)			<0.0001[1]			0.3147[1]
Mean (SD)	36.3 (0.61)	36.4 (0.71)		36.4 (0.65)	36.4 (0.62)	
PACU length of stay (h; n = 1674)			0.0648[1]			0.3303[1]
Mean (SD)	2.3 (1.15)	2.2 (1.12)		2.0 (0.95)	2.0 (1.07)	
Post-operative ICU admission			0.3877[2]			0.6234[2]
No	488 (97.0%)	611 (96.1%)		284 (97.6%)	251 (96.9%)	
Yes	15 (3.0%)	25 (3.9%)		7 (2.4%)	8 (3.1%)	

[a] Values are mean (SD) for continuous variables and n (%) for categorical variables. When not all data are present, numbers of observations with complete data are noted.
[1] Equal variance two sample *t*-test.
[2] Chi-square P-value.

(P < 0.0001) (Table 1). Mean temperature increased slightly in the intervention group (36.4 °C vs 36.3 °C; P < 0.0001). There was no difference in length of PACU (2.3 versus 2.2 h; P = 0.06) or rates of postoperative admission to the intensive care unit. There was 100% compliance with the prescribed room temperature algorithm. The results from staff satisfaction surveys during Phase 1 are shown in Table 2. The intervention was felt to be somewhat or very effective in maintaining normothermia by 66% of gynecologic operating room staff, compared to 46% before room temperature guidelines were implemented. However, there was a significant increase in the number of staff members who found the room to be very hot (2% pre-intervention vs 40% post-intervention) or somewhat hot (34% pre-intervention vs 23% post-intervention), representing increased staff dissatisfaction and discomfort.

3.2. Phase II

In Phase II, interventions from Phase I were combined with prewarming with the Bair Paws Flex gown based on our previous successful experience with thoracic surgery patients (unpublished data), anticipating that increased patient temperature before the operation would allow lower intraoperative room temperatures, as dictated by the algorithm, and improved staff satisfaction. Table 1 summarizes the patient characteristics for the Phase II study. There was no difference between pre-intervention and post-intervention characteristics.

Results for normothermia for Phase II are shown in Table 1. There was no improvement in normothermia rates after the addition of prewarming with Bair Paws Flex gowns in the gynecologic surgery patients

Table 2
Staff satisfaction after intervention[a].

	Phase I			Phase II		
	Pre-intervention (N = 51)	Post-intervention (N = 35)	P-value	Pre-intervention (N = 54)	Post-intervention (N = 49)	P-value
Rate the current process of keeping patients warm:			0.8714[b]			0.2157[b]
Strongly dislike	6 (11.8%)	10 (28.6%)		5 (9.3%)	4 (8.2%)	
Somewhat dislike	13 (25.5%)	6 (17.1%)		16 (29.6%)	7 (14.3%)	
Neutral	15 (29.4%)	2 (5.7%)		11 (20.4%)	11 (22.4%)	
Somewhat like	14 (27.5%)	13 (37.1%)		13 (24.1%)	20 (40.8%)	
Strongly like	3 (5.9%)	4 (11.4%)		9 (16.7%)	7 (14.3%)	
How effective are our efforts to keep patients warm? (n = 186)			0.0893[b]			<0.0001[b]
Grossly inadequate	3 (6.0%)	2 (5.7%)		4 (7.7%)	0 (0.0%)	
Somewhat inadequate	18 (36.0%)	6 (17.1%)		11 (21.2%)	1 (2.0%)	
Neutral	6 (12.0%)	4 (11.4%)		15 (28.8%)	6 (12.2%)	
Somewhat effective	18 (36.0%)	18 (51.4%)		18 (34.6%)	26 (53.1%)	
Very effective	5 (10.0%)	5 (14.3%)		4 (7.7%)	16 (32.7%)	
My personal comfort level with the temperature in the OR is: (n = 187)			<0.0001[b]			0.7533[b]
Very cold	5 (10.0%)	0 (0.0%)		2 (3.8%)	2 (4.1%)	
Somewhat cold	16 (32.0%)	2 (5.7%)		10 (18.9%)	9 (18.4%)	
Just right	11 (22.0%)	11 (31.4%)		14 (26.4%)	17 (34.7%)	
Somewhat hot	17 (34.0%)	8 (22.9%)		18 (34.0%)	12 (24.5%)	
Very hot	1 (2.0%)	14 (40.0%)		9 (17.0%)	9 (18.4%)	

[a] Values are n (%). When not all data are present, numbers of observations with complete data are noted.
[b] Cochran-Armitage trend test;

(78% vs 83%; P = 0.091). There was no difference in mean intraoperative temperature (36.4 °C vs 36.4 °C; P = 0.315) or in PACU length of stay (2 h vs 2 h; P = 0.3303). However, there was an increase in staff satisfaction with the combined intervention (Table 2). Gynecologic surgery staff perceived an increased effectiveness of the intervention, with 86% of staff members rating the combination intervention very or somewhat effective, compared to 42% for the use of only the intraoperative temperature algorithm. Further, staff comfort with room temperatures increased, with 35% rating the temperature as just right after addition of pre-warming with the Bair Paws Flex gown, compared to 26% before this addition; however, this difference was not statistically significant. There was a non-statistical decrease in staff reporting the room being somewhat hot, 34.0% versus 24.5%, although no change in those reporting the room very hot, 17% versus 18%.

4. Discussion

In this study, we describe a 2-phase quality improvement project to increase normothermia rates in gynecologic surgical patients. We found that 1) algorithm-driven intraoperative temperature control via digital thermostats was an effective and inexpensive means of increasing normothermia rates in the gynecologic surgery population, but at the cost of staff dissatisfaction and discomfort; and 2) combining intraoperative temperature regulation with a second method of warming patients, i.e., prewarming with a Bair Paws Flex gown was an effective way of maintaining normothermia while addressing staff satisfaction and comfort.

Hypothermia is both a common finding in surgical patients and a modifiable source of increased surgical morbidity. Hypothermia results in a number of pathophysiologic changes, such as abnormal immune function, alterations in cell-mediated antibody function, vasoconstriction, and subsequent hypoxia. Abnormalities in enzymatic activation of the coagulation cascade and derangement in platelet aggregation have been observed in the setting of hypothermia and may result in increased blood loss, need for blood transfusion, and rates of perioperative venous thromboembolism [5,7,8]. Finally, hypothermia up-regulates the sympathetic nervous system, leading to increased circulating levels of norepinephrine with concomitant hypertension [14]. These multiple physiologic derangements from even mild intraoperative hypothermia have been associated with increased rates of perioperative cardiac morbidity, infectious morbidity, mortality, longer recovery times, and prolonged length of hospital stay [5,6,9]. There are some studies that have not demonstrated the same improvement in outcomes with normothermia. Specifically, one retrospective case controlled study of clean (Type 1) surgical procedures demonstrated no association of hypothermia with surgical site infection [15]. This study is limited to only Type I surgical wounds and therefore the population studied is entirely different than the population of gynecologic surgery patients presented here. This study only concentrated on the outcome of surgical site infection, and did not investigate other adverse outcomes associated with hypothermia.

We were able to achieve higher rates of normothermia with management of the intraoperative room temperature via an algorithm and prewarming with Bair Paws Flex gowns in gynecologic surgery patients. With this approach, we are able to achieve both patient normothermia while maintaining staff satisfaction at a relatively low cost, using Bair Paws Flex gowns ($10–$20 per gown) and intraoperative room temperature management ($75 per digital thermostat, one time cost).

Intraoperative hypothermia is an excellent example of an area of medical care that warrants process improvement, as there is a gap between the medically accepted desired outcome of normothermia and current clinical practice. Each study and phase of this process improvement project adapted approaches to suit the needs of patients and staff so that we could effectively change the team's behaviors and achieve higher rates of normothermia without the cost of staff discomfort. Through this quality improvement process, we learned the importance of staff satisfaction aiding in guiding the interventions. In order to achieve operating room staff compliance with intraoperative room temperature algorithms, we had to 1) educate every level of staffing about the risks of intraoperative hypothermia and 2) address the staff complaints about room temperature. In addition, a standardized, algorithm-based approach has led to a reliable increased rate of normothermia in our intraoperative patients. Ultimately, the standardized multimodal approach led to a relatively low-cost, highly effective patient-centered solution. We note a very high rate of compliance with our interventions. We believe this is due to the efforts of the multi-disciplinary team to education the staff and get buy-in around this effort. By consider staff satisfaction and using interventions such as pre-warming to allow for lower room temperatures, the staff felt their voices were heard and concerned addressed. This highlights the importance of the PDSA (plan-study-do-act) cycles within quality improvement. We also think it reflects the over-arching value of "the needs of the patient come first" at Mayo Clinic.

A strength of this study is availability of continuous temperature monitoring via the electronic medical record in the majority of patients. This allows objective collection of extensive data. Weaknesses include the setting of a large tertiary academic referral center, and we do not know if these projects would be reproducible in other communities or smaller centers. We do not have information about the increased use of warmed fluids, although this is not routine in our practice so we feel did not effect the results. Finally, we did not collect information about actual room temperatures when the algorithm was followed, so how often temperatures needed to be at 23.3 °C (74 °F) vs 21.1 °C (70 °F) was unknown.

In conclusion, there is a recognized gap between medical knowledge and implementation, and in many cases implementation takes decades. It has long been recognized that patients who are normothermic during surgery experience fewer complications and quicker recovery. Nevertheless, rates of hypothermia are unacceptably high in many large academic medical institutions. We have demonstrated significant and practical improvements in day-to-day practice. These results seem to be extensible and durable. Intraoperative hypothermia is both common and modifiable and therefore represents an ideal target for quality improvement. We share our experience in addressing this surgical quality issue and feel that our process could be reproduced at other centers to decrease intraoperative hypothermia and improve patient care.

Author contributions

Study conception and design: DM, SB, RC, SD
Acquisition of data: DM, SB
Analysis and interpretation of data: DM, SD, SB, DS, AH
Drafting of manuscript: AK,
Critical revision: AK, DM, SD, AH, RC, SD

Declaration of Competing Interest

The authors have no relevant financial conflicts of interest to disclose.

Acknowledgments

Funds for this study were provided by the Mayo Foundation. The authors wish to thank the many dedicated staff members in the operating rooms who endorsed the goals of this project for the greater good of patients in their care.

References

[1] S.S. Forbes, C. Eskicioglu, A.B. Nathens, D.S. Fenech, C. Laflamme, R.F. McLean, et al., Evidence-based guidelines for prevention of perioperative hypothermia, ACS 209 (2009) 492–503.e1, https://doi.org/10.1016/j.jamcollsurg.2009.07.002.

[2] S.I. Berríos-Torres, C.A. Umscheid, D.W. Bratzler, B. Leas, E.C. Stone, R.R. Kelz, et al., Centers for disease control and prevention guideline for the prevention of surgical site infection, 2017, JAMA Surg. 152 (2017) 784, https://doi.org/10.1001/jamasurg.2017.0904.

[3] R. Forstot, The etiology and management of inadvertent perioperative hypothermia, J. Clin. Anesth. 7 (1995) 657–674.

[4] D.I. Sessler, Temperature monitoring and perioperative thermoregulation, Anesthesiology 109 (2008) 318–339.

[5] M. Moslemi-Kebria, S.A. El-Nashar, G.D. Aletti, W.A. Cliby, Intraoperative hypothermia during cytoreductive surgery for ovarian cancer and perioperative morbidity, Obstet. Gynecol. 119 (2012) 590–596, https://doi.org/10.1097/AOG.0b013e3182475f8a.

[6] R. lenhardt, E. Marker, V. Goll, H. Tschernich, A. Kurz, D.I. Sessler, et al., Mild intraoperative hypothermia prolongs postanesthetic recovery, Anesthesiology 87 (2010) 1–6.

[7] H. Schmied, A. Kurz, D.I. Sessler, S. Kozek, A. Reiter, Mild hypothermia increases blood loss and transfusion requirements during hip arthroplasty, Lancet 347 (1996) 289–292.

[8] S. Rajagopalan, E. Mascha, J. Na, D.I. Sessler, The effects of mild perioperative hypothermia on blood loss and transfusion requirement, Anesthesiology 108 (2007) 71–77.

[9] S.M. Frank, L. Fleisher, M. Breslow, M.S. Higgins, K.F. Olson, S. Kelly, et al., Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events, JAMA 277 (2008) 1127–1134.

[10] L.R.R. Associate, M.S. James Beckmann Research Associate, P.O.A. Andrea Kurz MD Vice Chair, Perioperative complications of hypothermia, Best Pract. Res. Clin. Anaesthesiol. 22 (2008) 645–657, https://doi.org/10.1016/j.bpa.2008.07.005.

[11] A. Kurz, D.I. Sessler, E. Narzt, A. Bekar, R. lenhardt, G. Huemer, et al., Postoperative hemodynamic and thermoregulatory consequences of intraoperative core hypothermia, J. Clin. Anesth. 7 (1995) 359–366.

[12] A. Kurz, D.I. Sessler, R. Lenhardt, Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization, N. Engl. J. Med. 334 (1996) 1209–1215.

[13] Z. Sun, H. Honar, D.I. Sessler, A. Kurz, Intraoperative core temperature patterns, transfusion requirement, and hospital duration in patients warmed with forced air, Anesthesiology 122 (2014) 1–10.

[14] S.M. Frank, Consequences of hypothermia, Curr. Anaesth. Crit. Care 12 (2001) 79–86, https://doi.org/10.1054/cacc.2001.0330.

[15] M. Brown, T. Curry, J. Hyder, E. Berbari, M. Truty, D. Schroeder, A. Hanson, D. Kor, Intraoperative hypothermia and surgical site infections in patients with class I/clean wounds: a case-control study, ACS 224 (2017) 160–171, https://doi.org/10.1016/j.jamcollsurg.2016.10.050.