

Prevention of hypothermia in TKA

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Conflict of interest disclosure form

☐ I have no potential conflict of interest to report



ÇANKAYA ORTHOPEDICS



Hypothermia in TKA

- Core body temp less than 36° C
 - Mild : 33-36° C
 - Severe : 33° C(-)
- Consequence of anesthetic agents & OR temperature
 - Loss of thermoregulation due to loss of shivering and vasoconstriction
 - Decreased metabolic heat production
 - Increased cutaneous skin loss

Frequency

- Incidence in 672 cases
 - THA 26.3%
 - TKA 28.0%.
 - *Leijtens B. J Arthroplasty. 2013;28(6):895-8*
- 1-2° C fall in body temp without active warming measures

Mild hypothermia

- Protein catabolism
- Changes in glucose metabolism
- Hypokalemia
- Negative effect on glomerular filtration
 - *Dennison D. AORN 1995;61:827–32.*
- Impaired wound healing
- Postoperative increase in oxygen consumption
- Decrease in drug metabolism
- Negative nitrogen balance and respiratory distress
 - *Sessler DI. Anesthesiology 2000;92:578–96.*

General Surgery Literature

- Increased cardiac mortality
 - Hyperkalemia & arrhythmia
- Increased incidence of postoperative infections
- Increased risk of DVT
- Increased length of hospitalization

Hypothermia impairs clotting



- Increased PT & APTT
- Decreased production of thromboxane A₂
- The effect of hypothermia on increased blood loss in arthroplasty is controversial
- Less blood loss in warmed patients
 - Schmied H. *Lancet*. 1996;347:289–92.
 - Winkler M. *Anesth Analg*. 2000;91:978–84.
 - Schmied H. *Anesth Analg*. 1998;86:387–91.
- No effect of body temp on blood loss
 - Dan M. *J Orthop Surg Res* (2015) 10:97
 - Johansson T. *Acta Anaesthesiol Scand*. 1999;43(10):1005–10.

Hypothermia

- Longer recovery post-anesthesia
- More opioid consumption
 - *Benson EE. Am J Nurs. 2012;112(5):26-33*
- Cognitive dysfunction ??
 - *Salazar F. Acta Anaesthesiol Scand. 2011;55(2):216-22.*
- Increased infection rate ?
 - *Ozaki M. Masui 2011, 60:303–306.*

TKA

- Tourniquet release : sudden decrease in core temp
- Especially harmful for elderly patients with coronary problems
- Active warming devices may prevent this effect
 - Kim YS. *J International Medical Research* 2009; 37: 1457 – 1464



Warming the OR

- Warming the OR from 17 to 24°C
- Minimal effect on hypothermia
- Increased discomfort for the surgical team
- Faster setting of cement

- *Deren ME. J Arthroplasty. 2011;26(8):1380-6*



Pre-warming the patient

- No studies on arthroplasty
- General surgery/Gynecology literature
 - Small but significant effect
 - Erdling A. AANA Journal 2015, 83 (2): 99
 - Poveda Vde B. Rev Lat Am Enfermagem. 2012;20(1):183.
 - No effect
 - Adriani MB. AANA J. 2013;81(6):446-451.
- 10-20 minutes is enough
 - Horn EP. Anaesthesia. 2012;67(6):612-617.

Warming the patient during surgery

- Passive
 - Standard blankets
 - Reflective blankets
- Uses patient's own heat
- Not as effective as active heaters
- *Ng SF. Anesth Analg. 2003;96(1):171-6*
- Better than nothing..



Active warming devices

- Forced air warming (*Bair Hugger*)
- Circulating water blankets/garments
- Conductive fabric blankets (*Hot Dog*)
- Conductive mattress (*Koala*)
- Negative pressure warming gloves (*vitalHEAT*)



Is forced air warming superior to resistive heating ?

John M. Anaesthesia 2014, 69, 623–638

References	n	Groups	Temperature measured	Main findings
Negishi et al. [55]	24	RHB = 8 FAW = 8 (CWM = 8)	Intra-operative	No significant difference in intra-operative temperature change between RHB and FAW ($p > 0.05$)
Matsuzaki et al. [54]	24	RHB = 8 FAW = 8 (CWM = 8)	Intra-operative	No significant difference in intra-operative temperatures between RHB and FAW ($p < 0.05$)
Egan et al. [93]	36	RHM = 18 FAW = 18	Intra-operative; end of surgery	No significant differences in intra-operative or end of surgery temperatures ($p = 0.018$, non-inferiority)
Brandt et al. [94]	80	RHB = 40 FAW = 40	Intra-operative	No significant difference in intra-operative temperature changes
Fanelli et al. [95]	56	RHM = 28 FAW = 28	Intra-operative; end of surgery	No significant differences in intra-operative and end of surgery temperatures between RHM and FAW ($p > 0.05$)
Ng et al. [96]	60	RHM = 30 FAW = 30	Intra-operative	No significant difference in intra-operative temperatures between RHM and FAW ($p > 0.05$)
Engelen et al. [97]	129	RHM = 43 FAW = 41 PI = 41	Intra-operative (CPB rewarming)	Significantly greater rewarming rate in the FAW group ($p < 0.001$)
Röder et al. [57]	28	RHB = 14 FAW = 14	Intra-operative (rewarming)	Significantly greater rewarming rate in the FAW group ($p < 0.001$)
Leung et al. [56]	60	RHM = 30 FAW = 30	Intra-operative; end of surgery	Significant difference in intra-operative and end of surgery temperatures favouring FAW ($p < 0.01$)

No significant difference

RHB, resistive heating blanket; FAW, forced-air warming; CWM, circulating water mattress; RHM, resistive heating mattress; PI, passive insulation; CPB, cardiopulmonary bypass

Forced air warming is better than circulating water mattresses

Anaesthesia 2014, 69, 623–638

John et al. | Peri-operative warming devices

Table 5 Randomised trials comparing forced-air warming with circulating water mattresses/blankets.

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Matsuzaki et al. [54]	24	CWM = 8 FAW = 8 (RHB = 8)	Intra-operative	Intra-operative temperatures significantly lower in CWM group after 30 min ($p < 0.05$)
Ihn et al. [67]	90	CWM = 30 FAWu = 30 FAWs = 30	Intra-operative	Intra-operative temperatures significantly lower in CWM group ($p < 0.05$)
Kurz et al. [53]	99	CWM = 51 FAW = 48	Intra-operative	Intra-operative temperature significantly greater in FAW group ($p < 0.01$)
Hynson et al. [113]	20	CWB = 5 FAW = 5 (HH = 5) (None = 5)	Intra-operative	FAW was more effective than CWB in transferring heat and preventing hypothermia ($p < 0.05$)

CWM, circulating water mattress; FAW, forced-air warming; RHB, resistive heating blanket; FAWu, upper body forced-air warming; FAWs, surgical access forced-air warming; CWB, circulating water blanket; HH, heated humidifier.

Circulating water garments superior to forced air heating but are more expensive

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Forced air warmers

- Hot air convection currents disrupt airflow & increase the risk of particles mobilized from the ground into the surgical site
 - *Belani KG. Anesth Analg. 2013 Aug;117(2):406-11.*
- x 1000 increase in airborne particles in the surgical site
 - *Legg A. Bone Joint J. 2013 Mar;95-B(3):407-10.*
- Decrease in infection after reverting from hot air to convective blanket
 - *McGovern PD. JBJS-Br 2011,93(11):1537-44.*

Sessler DI, Olmsted RN, Kuelpmann R. Forced-air warming does not worsen air quality in laminar flow operating rooms. Anesthesia and Analgesia 2011; 113: 1416–21.

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hospital-acquired infections.

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Bair Hugger and Knee Replacement—the Perfect Storm

January 24, 2016, 08:00:00AM. By Jane Mundy

Fort Wayne, IN — If you came out of hip or knee replacement surgery with an infection, chances are you were wrapped in a **Bair Hugger** warming blanket during surgery.



According to some estimates, more than 100 million procedures have used Bair Huggers in the operating room, most of which are hip and knee replacement surgeries. *The Star Tribune* (Nov. 2015) doubles that number, reporting the blanket has been used in 200 million surgeries since 1987.

Hospital infections are rampant, but not until recently were infections believed to occur in the supposedly sterile operating room. The Centers for Disease Control (CDC) reports that 719,000 total knee replacements and 332,000 total hip replacements were performed in 2014. Knee replacement procedures take at least two hours, and hip replacement surgery from 4-6 hours, if all goes well. The body loses heat increasingly during surgery so it is important to keep the patient warm - with a warming blanket.

The Bair Hugger device is believed to blow bacteria onto the patient. Factor in a metal device: Metal hip and knee replacement surgery exposes your body to infection during surgery because metal helps spread infection. In fact one study found a whopping 96 percent of 3M's Bair Huggers were dispersing excessive levels of contaminants."

Carolyn doesn't know if she had the Bair Hugger blanket - she is in the process of getting her medical records from the hospital. Given the amount of hip and knee replacement surgeries performed, and having acquired three infections after



Warming the fluids

- 1 litre IV fluid at 21 °C decreases core body temperature by 0.25 °C

- *Sessler DI. NEJM 1997; 336: 1730–7.*

- Warming the IV infusion line

- Warming the fluids/blood

- *Wei C. J Orthop Surg Res 2014, 9:8*

- Warming the lavage fluid

- More important in hip/shoulder arthroscopy
 - Effect on TKA unclear



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Complications

- Patient discomfort
- Burns requiring surgery
 - Technical error /Improper application
 - Uzun G. *Journal of Anesthesia* 2010; 24: 980–1.
 - Stewart C. *Pediatric Anesthesia* 2012; 22:414–5.
- Air embolus with high volume iv fluid warmers
 - Bubble eliminators
 - Adhikary GS, *Journal of Clinical Anesthesia* 1998; 10: 70–2.
- Haemolysis of erythrocytes
 - Do not exceed 43° C

Take Home Messages

- *Normothermia is important for pain control & early recovery*
- *Normothermia decreases post-op complications*
- *Active heating devices are better than passive devices*
- *Any kind of heating is better than no heating*