
What evidence exists that describes the safe application of heat therapy in a healthcare context?

This report aims to summarize the best available evidence around the safe application of heat in a healthcare context. This information is to guide the development of a protocol.

Key Messages:

- Heat application has a longstanding therapeutic use and continues to be an important and widely used treatment.
- Various methods and materials are used to apply heat, which produce physiological responses on the circulatory system, on cellular and nerve function, and connective tissue systems.
- The application of heat in a healthcare context has been used to decrease joint stiffness, lessen pain, relieve muscle spasms, increase blood flow, speed up the inflammatory process, while providing a sensation of warmth and comfort to the patient.
- Despite the extensive use of heat, the evidence for safe application of heat is minimal, encompasses mostly low level studies and is of relatively poor quality. Specifically:
 - Many case reports documented burn injuries from the use of microwave-heated materials, extended duration of heat application, solutions and materials used intraoperatively, and burns sustained by the patient at home on insensate areas due to a surgical procedure or chronic illness. Recommendations are made by the authors based on these individual cases.
 - Reports that outline recommendations for the safe application of heat are derived from opinion or experiential knowledge and not from robust studies. Some recommendations included imposing time limits for heat application, positioning of heat source, avoiding direct contact of heat with skin and assessment and education of the patient.
 - Two low level experiments were conducted to determine the temperature of the skin using specific products such as heat pads or heated cotton blankets.
- In most of the case reports, detailed descriptions of heat therapy methods were lacking which contributes to the difficulty in understanding what needs to be changed.
- Unsafe application of heat, causing burns can have implications on the patient, clinician and healthcare system. Rehabilitation from burn injuries was described as long as 8 months, and can have serious medico-legal ramifications.

Who is this summary for?

This summary was requested by Luisa Luciani Castiglia, CNS, Cancer Care Mission at the MUHC.

Information about this summary:

This report covers a broad collection of literature and evidence sources with a search emphasis on systematic reviews.

This summary includes:

Key findings from a broad collection of recently published literature (from 1993-2015) and evidence sources.

This summary does not include:

Recommendations, additional information, or detailed description of the interventions in the studies.

1. Background:

Therapeutic application of heat is a longstanding practice, and as has been documented for use in primitive times. [2] Fire was used to drive out demons causing disease, while Egyptians buried people in hot sand to alleviate joint pain and obesity. Similarly, Hippocrates used earthenware bowls with hot water to relieve congestion. Currently, heat therapy is widely used in hospitals, nursing homes and in the home by various health care professionals and patients. Typical uses of heat include pain or strain relief due to injury, chronic illness or postoperatively, for warming due to low body temperature, to facilitate procedures such as IV insertion and to promote comfort and relaxation. (Note: The effectiveness of heat for different indications was not reviewed here.)

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The methods used to apply heat vary greatly depending on the material, heating element and indication for use. Heat can be applied in moist and dry formats, with materials such as blankets, hot or chemical packs, cotton washcloths, hot water baths, Sitz baths, electricity or ovens to deliver heat. Burn injuries have occurred from these methods and remain a risk for all patients. Evidence-based standardized uses and methods of heat application are not readily available or described which may increase this risk. As well, the ubiquity of this practice in the healthcare context and home has led to variations in practice, with the potential for burns to occur. Contact burns (direct skin contact) from therapeutic heat application with hot packs, laser therapy, heating pads, grounding pads were more frequently reported in a recent chart analysis.[3] Other documented burns were from heating equipment used in hospitals, such as electric heat pads, that are made for domestic use and do not meet criteria for use in healthcare [15] Burn injuries have wide reaching implications and are “unsettling to the patient, healthcare provider and facility involved.”[17] The consequences of burns from therapeutic uses include lengthy and painful treatments and rehabilitation, emotional sequelae and potential medico-legal repercussions.

This rapid review will present summaries of the best available evidence for safety regarding the therapeutic application of heat in a healthcare context. Detailed search strategies were developed by an experienced librarian (specific search terms are available upon request). Sources include: Medline via Ovid SP, Embase via Ovid SP and CINAHL via EBSCO. Search concepts included Subject Headings and text words. The search date was January 7, 2016. Duplicates and out of scope articles were discarded by the librarian. In addition, the EIDM-Advisor reviewed the cited references of the included articles. The EIDM-A also reviewed the Joanna Briggs Library and Uptodate databases which produced no relevant articles. The analysis of studies, including appraisal and summary, and the final report were prepared by the EIDM-A and reviewed by the librarian and Chair of the Clinical Practice Review Committee of the MUHC. Heat used as part of an instrument to perform surgical procedures were discarded (such as Electrocautery), but burns as a results of intraoperative use or postoperative use of heat for relief of pain or warmth were kept.

No systematic reviews or randomized control trials involving heat application safety were found. The studies that were reviewed are mainly case reports, expert opinions and a few observational studies that reviewed burn incidence, or tested the safety of heat providing materials. A table of all the articles found and reviewed is available upon request (sonia.castiglione@muhc.mcgill.ca).

Levels of Evidence (adapted from OHRI KTA Evidence Summary document)

Each piece of evidence presented in this summary is assigned a level.

This assignment is based on the evidence being presented and not on the claim made by the authors.

⚙️ **Platinum:** systematic reviews and meta-analysis

✳️ **Gold:** Randomized controlled trials

★ **Silver:** Observational studies (non-randomized trials, case-control, time-series, cohort studies, case series, literature reviews, qualitative studies.)

★ **Bronze:** Expert committee guidelines, reports or opinions, commentary or editorials.

● **Level of evidence** cannot be determined.

2. Summary of Findings:

a. Burns from microwave-heated materials

★ In 2011, a case report highlighted an incident of 3rd degree burns to the latissimus dorsi donor site of a 33 year old patient, 6 weeks following breast reconstructive surgery. The burn was caused by a domestic microwaveable heat pad applied to the skin for 3 hours. No information was provided as the type of microwaveable heating pad, or the amount of time the pad was heated in the microwave. The authors advocate for prevention by including warning of heat pads or objects to prolonged contact with donor skin sites in patient education leaflets. [4]

★ In 2010, an article described two cases of burn injury in the eyelid area due to application of a wet washcloth that was heated in the microwave. The microwave heating time and strength of the microwave oven was not indicated. In one case, the application of the heated washcloth was 10 minutes, 2-3 times per day. The authors conclude that "caution should be taken when using a [wet] washcloth, particularly in postoperative patients who likely have hypesthesia in areas where the [washcloth] is applied." They continue to recommend a warm water compress, but caution that it should not be heated beyond 45^oC (113^oF). This recommendation was not supported by evidence, nor was any specific instruction given for how to patients can execute this safety precaution in the home. [5]

★ In 2000, a letter to the editor described a 2nd degree burn due to a microwave heated warm compress 72 hours after eyelid surgery. The patient heated the wet cloth in the microwave for 1 minute before applying it on the affect eye. The authors state that patient was instructed to heat the cloth in hot water and not in the microwave. The author's conclusions could not be recorded due to unavailability of full text, however, this article documents another burn injury in the postoperative period sustained at home. [6]

★ A case report in 1993 highlighted burns sustained by a 3 y.o girl when a microwave-heated cryogel pack was applied for IV extravasation. The authors warn that microwaves heat quickly, deeply and unevenly and may cause serious injuries. [7]

b. Intraoperative burn injury

★ A 2011 case series described 4 CABG surgical patients from the same hospital who acquired burns from a combination of pooled isopropyl alcohol preparation solution and electronic heating pads. The burns were initially diagnosed as pressure ulcers until re-examined by the wound care nurse. Based on an internal review of the incidents, the following changes were implemented at the hospital: Discontinuation of isopropyl alcohol as a

surgical preparation solution; lowering of heating pad temperatures from 41°C to 37°C.; mandated zero tolerance for burns; inclusion of a second skin check in the OR for prevention of pooled liquid; the use of rolled towels for vulnerable patient areas; inclusion of post op skin checks on concealed skin sites (such as abdominal folds); and education provided to critical care nurses on assessment of all areas of the skin (not only bony prominences). Following the changes, the wound care nurse visited all CABG patients for 3 months regularly for burn screening. No further burns were reported at the institution. [8]

★ *A legal brief described a ruling of negligence by a court in Bangalore, India of postoperative burn injury in 2009. The court found that burns to the patient's lower limb were likely the cause of hot water bags placed on the skin while the patient was sedated and unconscious and could not react to the burning sensation. The court suggested that "old patients as well as unconscious and anesthetized patients must be handled with utmost care, especially in procedures like giving hot water bags that may cause burn injuries." [9]*

★ *In 2007, burns caused by perioperative use of electronic heating pads were discussed and reported on with 2 case studies. In both cases, the patients were placed on top of the electric heating pad, where human error led to augmentation in the heat potential causing burns. In one case, physical and emotional repercussions lead to a long rehabilitation. The authors recommend the discontinuation of electric heating pads in patients under sedation or anesthesia. [10]*

★ *In 1999, a study highlighted two cases of burn injury as a result of warmed intravenous fluid bags, heated in an intraoperative blanket warmer. Both cases resulted in 2nd and 3rd degree burns. The authors recommended that warmed IV bags should not be used as bolsters or warming devices during intraoperative hypothermia and that only equipment designed for their intended purpose should be used. [11]*

c. Burn injury sustained in the home

★ *A case report in 2003 briefly described burns sustained by a 53 year old patient following abdominoplasty surgery. The patient placed an unspecified heating pad on her abdomen for an undisclosed period of time, 3 weeks following surgery and sustained 2nd degree burns. The authors cautioned that there is a risk for burns in patients with insensate skin for a period of 6 months to 3 years following surgery and recommend that surgeons include the restriction of using hot objects or sun exposure following surgery in patient directed instructions. [12]*

★ *In 2003, authors reported a burn injury sustained by a 59 year old woman who used a heating pad to treat symptoms related to post-mastectomy pain syndrome. Burns were sustained due to falling asleep on a heating pad for an undetermined amount of time, 13 years following the surgery. The authors did not discuss the degree of burn or the treatment plan. The authors explained the lingering neuropathy that may accompany modified radical mastectomy due to resection of the nerves in the area. They cautioned women who have post mastectomy pain to avoid extreme temperatures. [13]*

★ *A case report published in 1999 described burn injury of the breast sustained by a 49 year old female with a history of mastectomy and reconstructive surgery following breast cancer metastases. The patient underwent surgeries in 1981 and 1986, and metastases were identified in 1996. Due to referred pain, the patient applied a hot water bottle at home for 6 hours at the breast site. Severe burns resulted and were treated with conservative treatment. The authors described that similar cases have previously been reported. They recommended that "all patients must be aware of the insensate skin likely to result following mastectomy, breast reconstruction and reduction mammoplasty and reminded of the hazards of applying heat to this region." [14]*

★ *A report in 1994 described burn injuries sustained by 2 patients with neurological diseases caused by heating pads used for chronic pain relief. Both patients were in their 30s and used heating pads on their feet for 6 hours to overnight. Both patients had extensive surgeries and hospitalizations to treat the burns. The authors recommended that heating pads should not be used with anesthetic skin and that patient education and comprehensive warning labels should be instituted. [15]*

d. Safety experiments for heat application

★ A 2013 nursing study, measured skin temperatures and thermal comfort of healthy volunteers after application of cotton blankets warmed in cabinets set at 130°F and 200°F. This study was developed in response to a recommendation by the ECRI that cabinet temperatures be reduced to 110°F due to risk of thermal burns. The staff were dissatisfied with the new temperature citing it resulted in lukewarm blankets. The results indicated that blankets warmed in the 200°F (manufacturer maximum setting) did not increase the skin temperature significantly to risk thermal injury. Most patients reported feeling “just right” 30 seconds, 1, 5 and 10 minutes after blanket application. Temperature was also measured on the warmed blankets within the cabinet and when removed, where they lost about 14% of their acquired heat. The authors concluded that “warmed blankets are an important passive thermal care measure and their use can be maximized by optimal cabinet warming temperatures.” The study had a small sample size of healthy women only, and it did not look for indication of potential burn during or following the application of blankets. It is possible that sick and hospitalized patients may not tolerate the application as did healthy counterparts. [16]

★ In 1996, an experiment used a repeated measures design to measure the skin temperature of adults during a 30-minute application of a chemical heating pack in the supine and prone positions. The purpose was to determine the safety of the product. The chemical pack heats up when the contents are exposed to air and oxidized. 77 healthy volunteers were randomized to have the heat pack applied in the supine/prone or prone/supine sequence. A significant difference in the minimum and maximum temperatures was recorded in the prone position. In both positions, temperatures did not exceed -114°F and were within safety limits for skin cell damage. There was no significant difference in either position with regards to patient perception of heat, skin color or skin type, or in the sequence of position. The authors conclude that monitoring of this type of heat application is important especially when open to air as it allows for greater heat production. [2]

e. Recommendations for heat application

★ A 2007 continuing education article for nurses described the proper management of hot and cold therapies. Recommendations for heat application were made with support from cited references. These were mostly textbook or general care articles. Some recommendations for hot therapy included:

1. “Never applying a heating device directly to the skin unless it has a protective cover. A thick towel can be used if no cover exists.”
2. “Never place a heating device under a patient’s limb or body part, because compression will promote burning.”
3. “Heat is typically applied for 15-30 min, except for thermal wraps, which provide low heat (104°F/40°C) which can be used for relief of sub-acute low back, neck or wrist pain when left for 8 hours.”
4. “Assessment prior to heat application should be done, with specific attention to circulation, sensation to area applied and vital signs. Education should also be given for the patient to report burning or pain sensations.”

Procedure for sterile heat application to open wound were also provided. The authors concluded that vigilance monitoring and documentation are essential to applying hot therapy to a patient. [17]

Figure 1- Characteristics of hot and cold treatment modalities [1]

	Method of Application	Indications	Precautions	Adverse Treatment Effects
Cryotherapy	Ice pack Vapo-coolant spray Ice massage Cold whirlpool	Acute injury/trauma Chronic pain Muscle spasm Delayed onset muscle soreness Inflammation	Circulatory insufficiency Cold allergy Advanced diabetes	Cardiovascular effects (bradycardia) Raynaud’s phenomenon Cold urticaria Nerve and tissue damage Slowed wound healing Frostbite
Thermotherapy	Conduction Hydrocollator pack Low-level heat wrap Paraffin bath	Acute muscular pain Delayed onset muscle soreness Menstrual pain	Diabetes mellitus Multiple sclerosis Peripheral vascular disease Spinal cord injuries Rheumatoid disease	Burns
Thermotherapy (continued)	Convection Fluidotherapy Hydrotherapy	Wound debridement		Infections Cardiovascular issues
	Conversion Ultrasound Heat lamp Diathermy	Tendonitis Joint contractures Muscle spasms Osteoarthritis	Pregnancy Laminectomy sites Spinal cord Malignancy Vascular insufficiency Eye, testes, heart Growth plates Anesthetic area Joint prosthesis Total hip replacement	Burns Increased pain Increased inflammation
Contrast Therapy	Alternating cryotherapy and thermotherapy	Complex reflex sympathetic dystrophy Desensitization of skin		Burns Frostbite Cold urticaria Raynaud’s phenomenon

★ A 2004 narrative review clarified the use and contraindications of cryotherapy and thermotherapy for the pain practitioner. Multiple uses and methods for the application of thermotherapy were discussed (Figure 1). Contraindications of thermotherapy were listed and included conditions that posed sensory deficits. They provided vague recommendations around the use of heat in high risk patients and especially with products generating high intensity heat (specified as greater than 45°C) such as with hydrocollator packs or electric heating pads. They also recommend that heat application be restricted, but with no specific time limitations. The authors conclude that pain practitioners should be aware of the current research surrounding these modalities that are often used in therapy and in the home. [1]

● An overview article presented heat therapy methods used in hospitals discussed their safety implications. This article was published in 2002. The authors provided opinion-based recommendations on the use of electric heating pads, microwaveable wheat-based heating pads and hot water bottles for in-hospital use. They concluded that hot water bottles should not be used in hospitals, and that precautions should be taken with the other methods. The authors reported that most products are designed for domestic use and that they were unable to find heat therapy products made for use in hospitals in the UK. [18]

f. Additional Sources

★ A 2015 retrospective analysis of patients transferred to a burn centre in Korea for treatment-related burns was reported. Over a 5-year period, 116 medical patient records met the criteria for treatment-related burns. The average age of the patient was 41 years with more than double the number of females than males. The majority of the burns were deep burns (75%) caused by hot packs (23%), laser therapy (15%), heating pads and grounding pads. The burns occurred mostly in the lower extremities. The authors advocate for “safety guidelines [that] are needed for hot packs, heating pads and grounding pads to prevent incidents of burns.” [3]

★ In 2000, a study published a retrospective examination of burn injuries referred to a burn centre as a result of inpatient or home medical therapy. The investigators reviewed 4510 consecutive admissions from January 1979 to July 1997. Of these, 22 burn injuries were sustained in medical facilities where the majority were related to fire from cigarette smoking. Some burns identified were attributed to medications or surgical preparation solutions, intraoperative instruments or scalded during hot water baths (details were not provided.) 32 patients were burned as a result of home medical treatment. The most frequent cause at home was burn injury from hot water vapor inhaled to relieve upper respiratory symptoms. In addition, 6 burns occurred as a result of heating pads, heat lamps or contact with hot water bottles or soaks. The authors highlighted the risk of burns due to insensate skin from chronic illness or procedures. The results are dated and may not reflect current surgical or heat therapy practices or technology. [19]

★ A 1994 analysis of the American Society of Anesthesiologist Closed Claim Project identified 54 burns caused by materials to warm the patient or for other procedures or uses. The materials responsible for burn injury included warmed IV bags and bottles (either for warming the patient or positioning the patient), warm compresses, hot packs, circulating water mattresses, warming light, heated humidifiers, and from procedures such as electrocautery. Warmed IV bottles and bags were responsible for a majority of the burns found in the database. The authors highlight that the injuries could be prevented if the IV bags and bottles were used for their intended purpose: to hold fluids. [20]

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