

# Using Cold Therapy to Mitigate Thermogenesis during Sleep

A White Paper

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## Introduction / Background

Environmental temperature is a universal entraining cue for circadian cycles for all mammals. Thermal regulation is a major factor for life as it influences most biochemical reactions. Temperature has become less of an influence in our day to day lives as behavioral adaptation including well-heated houses, good thermal insulation of clothing, warm vehicles and short exposures to cold has created an artificial single temperature climate. Modern mattresses and bedding focus on comfort but have added foams and materials that create a warm to hot microclimate under the sheets. Passive thermal regulation using gels, fans, moisture wicking, etc. are not sufficient to influence thermal triggers in the body. The trend to keep humans constantly comfortable in thermally regulated environments is preventing and in the case of insomnia, delaying or stopping the natural physiological thermal regulation at night.

Disease, hormone imbalance, age, high metabolism, diet, weight, are all contributing to making this disconnection from our natural thermal pathway even more exaggerated. Sleep deprivation is an epidemic. The Rand Institute estimates yearly productivity loss in the US at \$411 billion annually (9). It is a mandate for modern society to put aside the day and look closely at what we do during sleep. If sleep duration, sleep hygiene, and sleep quality can all be improved and changed without drugs and chemicals but with cold therapy then as a society we can reverse the sleep deprivation productivity deficit. When modern humans use cold therapy nightly, it will help treat diseases due to mismatches in circadian biology and allow the human body to heal, learn and manage itself during sleep as our biology demands.

## Abstract / Business Case

Studies done on the Sherpa's and NASA astronauts clearly show a major metabolic benefit of cold environment adaption and cold exposure therapy that has been under served by modern science and medicine. Sherpas and astronauts can sustain themselves well on a lowered caloric intake yet with superior ability to handle physical

and emotional stress when cold adapted. Applying this cold exposure time each day allows higher circulation.

Cold Therapy has had increased popularity and with that documented results. Spending time each 24-cycle using cold exposure, shortens healing and recovery times. Athletes have been using ice baths and Cryotherapy chambers for recovery with amazing results. Core body temperature remains stable while the extreme temperatures outside cause the body to release anti-inflammatory proteins and endorphins. It allows athletes almost instant muscle recovery, reduces chronic pain and inflammatory conditions, aids weight loss and skin rejuvenation. Cryotherapy is used post-surgery to accelerate healing and reduce pain without the side effects of pain medications.

The key question then should be how can we get these benefits to everyone. How can we use the time we sleep to recover more and be more productive during the day? Time is relative for all of us. A large percentage of the population gets less than 6 hours of sleep. We need to realize that the thermal coefficient of the sleep environment makes this biochemistry work against their efforts during the day of diet and exercise to live better. If they changed only the thermal sleep environment to cold and kept everything else the same the quality of the recovery during each 24-hour cycle is measurably different.

Current wearables, sleep apps, sleep trackers are confirming what we as a society are measuring in productivity loss; modern humans are sleeping horribly. Despite advances in technology, and perhaps because of the added technology we are less healthy, sleeping poorly and struggling with chronic, inflammation, stress, and mental and physical health issues. The mandate to use sleep efficiently and effectively must be applied to the country as a whole. No drugs, no habit changes are required to stop the sleep deprivation epidemic; but we must allow the thermal regulation adaptations that ruled our biological clocks to do what they are meant to do during sleep-rest, recover, manage emotional and physical stress so we can do it all again the next day.

## **Problem Statement / Introduction**

Cold exposure and cold therapy are documented to affect recovery and health. By delving deeper, and taking cold therapy into sleep and applying it to the current thermogenesis crisis happening nightly and preventing optimal sleep. Research proves the role that temperature has on the sleep-wake cycles and proves that cold therapy can influence and improve sleep quality and quantity.

## **Proposed Solution(s)**

In the past two decades, research has been carried out on animals and humans to clarify the influence of ambient temperatures on sleep. This research focuses on the structure of various parts of the sleep cycle at ambient or near ambient temperatures.

Thermoneutrality, is defined as the range of ambient temperatures within which the metabolic process and natural thermoregulation is actuated by the body naturally.(23) The current microclimate created during sleep in the microclimate under the covers, exceeds thermoneutrality for significant numbers of people. Several factors such as body size, age, sexual cycle, season, disease, etc. all exacerbate the extent to which the sleeping body is out of thermoneutrality. Present experimental evidence shows that this thermal load outside of thermoneutrality elicits not only an increase in waking time but also an alteration of sleep structure, causes total or selective sleep deprivation.

Sleep deprivation causes adverse health effects and even mortality. It is now an established fact that sleep is strongly related the thermoregulation. Core body temperature cycles in conjunction with the sleep-wake rhythm. During a baseline of normal sleep cycles, core body temperature decreases during the nocturnal or sleep onset phase and increases during the wake phase. Without thermoneutrality, sleep onset with a required body core decrease doesn't happen or is delayed. 98% of insomnia sufferers exhibit a delayed or non-existent core body drop. Parasomnia occurs often as a result of an increase in core body temperature during REM sleep. In a normal cycle the core temperature doesn't start to increase until much later and close to the wake onset. The changes in thermal load over time can lead to the evolution of a ultradian waking-sleep cycle.

Heavy positive thermal loads exert arousing episodes and often start the body to respond by movement, sweating and poor sleep structure. Night sweats often occur during slow wave sleep or deep sleep. In contrast, a normal deep sleep cycle has a lower core body temperature. In a warmer thermal environment, body movement increases which is contrary to the sleep paralysis state that exists during normal sleep cycles. All of these thermal environmental conflicts can be mitigated and prevented by using cold therapy throughout the night.

Thermal stimuli in the form of cold therapy, and in the range of influence from providing thermoneutrality to pushing the limits of cold exposure just before sleep arousal, causes specific and non-specific changes in the waking-sleep cycle. For the purpose of this paper, we will look at cold therapy as an actively maintained sleep environment with a thermal coefficient of more than 5F from the thermally maintained environment in a modern household. A coefficient of more than 5 (to the edge of individual comfort) is preferred. The state of comfort, being objective since the individual sleeping may not be able to register discomfort even at a lower temperature environment than the ambient temperature that existed at the start of sleep. Although passive cooling such as fans, gel or moisture wicking can contribute to a more comfortable environment, the amount of cooling has to be defined as significant enough to change and influence core body temperature.

## ***Introduction of Solution***

Water is a unique molecule. The specific heat capacity of water is far superior to air. The fluidity of water allows it to circulate and be thermally regulated in a manner that a gel, although derived from water, doesn't have. In order for cold therapy at night to be significant and therefore measurable it has to cause a change in the biological stages allowing for a healthy sleep onset and wake timing cycle. Cold therapy would then use water as the thermal delivery device to effect thermal regulation during the thermogenesis that happens in the body at night and in modern bedroom scenarios.

In 2007, Todd and Tara Youngblood, invented the ChiliPad; thermal regulated, thermostat controlled, mattress pad. Using water, to circulate under a body and regulate the effect of the thermogenesis that occurs in that microclimate, the ChiliPad was able to have profound effects on insomnia and thermoregulation symptoms. Thousands of real life testimonies, support the research evidence that in studies such as Kumar et al, that body temperature and sleep are controlled by the same mechanism, and by controlling body temperature we can control sleep.

## ***Application of Solution***

Daily cycles of light and temperature are perhaps the two most reliable environmental timing cues for living systems on Earth. The neurobiological mechanisms of both sleep and circadian regulation have been unraveled partly in the last decade. By using cold therapy in relation to body temperature, arousal state, and the circadian timing system as the signaling pathway for the circadian modulation of sleep and wakefulness. Although mammals do not normally entrain to external environmental temperature cycles (19), cold therapy is ideal as an *internal* entraining cue in mammals because of the existence of circadian rhythms of body temperature driven by the suprachiasmatic nucleus SCN. Indeed, externally applied temperature cycles can sustain rhythmic clock. In the mammalian brain, a "master clock" located in the SCN of the hypothalamus keeps in sync the many independent clocks located in tissues and organs throughout the body (62). The coherence of these peripheral clocks is achieved through a cold therapy system in which the thermal regulation, in this case, the ChiliPad, mimics natural temperature and sleep cycles by removing modern thermal statis in the bed microclimate. This temporal shift is converted to nonphotic cues that permeate the rest of the body, coordinating the oscillation of peripheral clocks, improving quality and quantity of sleep.

Buhr et al. also make inroads into the molecular pathways involved in temperature entrainment by building on an old idea that the temperature shock response plays a role in circadian systems ( 58). Cold therapy and cold exposure can evoke slight variations in core body temperature ( 60). The roles of temperature and cold therapy in the circadian system are part of an emerging realization of the deep interconnections between metabolism and peripheral clock function ( 62). Thus, despite the thermal

dynamics of a modern bed environment, seemingly slight fluctuations in core body temperature—if occurring at regular intervals—appear to be a major modality to enhance, deepen, and lengthen sleep cycles. It will be important to continue research into the extent that cold therapy modulates core body temperature rhythms in people of all states of health, diet, gender, age, stress level, etc. but the real possibility now exists to help biological clocks undergo life changing adjustments.

The ChiliPad, as a cold therapy device is designed for and effectively thermal regulates the body throughout the night. By circulating water through the mattress pad, activity testing and maintaining the desired temperature throughout the night, sleep quality and quantity is improved. The application of this one device has the potential to be the first to dramatically affect the sleep deprivation epidemic and the productivity of millions of people without drug side effects and without a significant commitment of energy on behalf of the user. The simplicity of using cold therapy to manage and mitigate body thermogenesis throughout the night makes this an ideal solution. There has to be a significant and measurable change in temperature to affect the core body temperature.

## **Results / Conclusion**

The circadian timing system in humans governs the wake-sleep cycle and synchronizes biological processes but it is, to epidemic levels, being forced into a state of dysfunction through the modern sleep environment. The results of the research and antidotal user experience as well as, performance improvements, demonstrate that changes in core body temperature rhythms are capable of entraining and enhancing the amplitude of the circadian rhythms of sleep even though the SCN remains resistant. By allowing the body to achieve thermoneutrality, or even aid the body in the temperature drop required for sleep onset and healthy sleep cycles, thermal stimuli and cold therapy creates consistent waking-sleep cycles. This reveals the critical role of ChiliPad in the resetting of circadian and sleep wake cycles to prevent sleep deprivation its productivity and life costs.

## **Appendices**

### ***Appendix A – Author***

Tara Youngblood, co-founder of Kryo, Inc.; sleep researcher and scientist

## **Appendix B – Websites of Interest**

<https://www.polyphasicsociety.com/polyphasic-sleep/beginners/cold-adaptation/>

<https://www.jackkruse.com/cold-thermogenesis-easy-start-guide/>

<https://www.scientificamerican.com/article/putting-insomnia-on-ice/>

<https://www.selfhacked.com/blog/12-reasons-embrace-cold/>

<https://www.marksdailyapple.com/cold-water-therapy/>

<https://tim.blog/2015/10/17/5-tools-i-use-for-faster-and-better-sleep/>

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