

# Prevention and Treatment of Heat Illness

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## Abstract

The most effective radical treatment for heat illness is its prevention. Once prevention fails, symptomatic therapies such as cooling the body and supporting impaired organs are the only remaining treatment options. In order to prevent heat illness, it is essential to understand the types of environment that can lead to heat illness and the types of situations in which heat cannot be endured or avoided. Preventing heat illness aggravation also requires a citizen to understand the symptoms of heat illness, diagnose the condition early, and start treatment promptly. Mortality is particularly related to the duration of hyperthermia, and therefore, it is also important to understand the need for prompt and appropriate emergency care, including body cooling. Focusing on these points, we describe the risk factors and preventive measures for heat illness on the basis of recent heat illness cases, as well as discuss the main clinical treatment practices and their effectiveness, in the hope of contributing to heat illness care as global warming progresses.

**Key words** Wet Bulb Globe Temperature (WBGT) heat index, Heat illness prevention information, Oral rehydration solution, Transpiration cooling method

## Introduction

Saying that the radical treatment for heat illness begins with prevention and ends with prevention is not an exaggeration. Because symptomatic therapies such as cooling the body or supporting impaired organs are the only treatment options left once prevention fails, prevention is critical. Heat illness is commonly described as “a general term for a condition that results from physical adjustment disorders in hot environments.” Consequently, prevention is completely possible by only avoiding hot environments. Thus, a risk for heat illness arises only when one willingly or unwillingly remains in a hot environment; therefore, taking measures to avoid such situations is key in preventing heat illness. If heat illness occurs, it is important that the patient is diagnosed early and receives prompt and appropriate emergency care, including body cooling, because

the duration of hyperthermia is related to mortality risk.

## Prevention of Heat Illness

To prevent heat illness, it is necessary to understand the risk factors for heat illness, i.e., the circumstances in which heat illness is likely to occur. Avoiding these risk factors is the most effective means of preventing heat illness. When risk factors are known, but a hot environment cannot be avoided for reasons of exercise or employment, taking preventive measures before entering such an environment is necessary. Furthermore, a third party may need to intervene to provide preventive measures for patients who have previously experienced impaired consciousness, for people such as the elderly who have reduced ability of sensing a hot environment, or for those who cannot take evasive action even

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when they realize the risk of heat illness. This section describes (1) risk factors for heat illness, (2) prevention of heat illness in a hot environment, and (3) prevention by a third party.

### Risk factors

Many people are aware in everyday life that the environmental factors that can lead to heat illness include not only temperature but also humidity. In fact, the Japan Weather Association (JWA) provides information on heat illness prevention using the Wet Bulb Globe Temperature (WBGT) heat index (a heat index expressed in °C that incorporates humidity, radiant heat, and ambient temperature, all of which greatly affect heat balance in the human body). According to some data, an increase in the WBGT index increases the number of heat illness cases.<sup>1</sup> Hourly WBGT forecasts for finely divided geographical areas are provided through the JWA home page and mobile phone services; these media also recommend preventive measures to be taken, on the basis of the WBGT values. People are advised to take advantage of these services for heat illness prevention.

### Prevention in a hot environment

When continuously performing labor or exercise in a hot environment, the following preventive measures are required:

#### **Understanding that the labor/exercise is being conducted in a hot environment and consciously taking breaks and staying hydrated**

Most people are capable of sensing discomfort due to heat or high humidity. However, it is not always easy to perceive the degree of risk of heat illness posed by hot or uncomfortable environments or to estimate the WBGT value through intuition.

Unfortunately, people often underestimate the risks associated with the environment they are in and become overconfident believing that “I am okay.” This can lead to unexpected onset of heat illness. It is essential to realize that any environment that feels “hot” has the potential to cause heat illness, and sufficient rest and frequent fluid intake are required in these circumstances. People are advised to consume fluid during labor or exercise in order to ensure that the body weight loss is of 2% or less. It may be a good idea to increase the opportunities for measuring body weight, which will also help with daily health management. Commercial sports drinks may be

appropriate for hydration, but when sweating is extreme, oral hydration solutions with slightly higher salinity are also available on the market and may be recommended.

#### **Acclimation to heat**

Japan was hit by 3 heat waves in the summer of 2010. The WBGT values were high in each wave, with the values increasing in each successive wave (i.e., third > second > first wave); however, approximately one-quarter of all ambulance transports for heat illness and one-half of all deaths occurred during the first heat wave, which had the lowest WBGT value. These data reflect the common belief that the risk of heat illness is highest when the weather suddenly becomes hot and the body is not accustomed to heat. When the weather suddenly becomes hot, workload and exercise levels should be lightened so that the body can gradually acclimatize to the heat.

#### **Consider your limitations**

People sometimes feel, “It is cooler today, but I can’t go on.” The same person may experience daily changes in his/her heat tolerance depending on the conditions. It is recommended that people refrain from labor or exercise or reduce their workload when they are in a dehydrated condition, including when they are experiencing diarrhea, fever, fatigue, or loss of appetite. Obesity is another strong risk factor for heat illness; therefore, the work or exercise load in obese people should be reduced, and they should particularly consume sufficient fluids, as well as manage their weight in everyday life. In any event, it is important to know and control oneself well.

#### **Select proper clothing**

Light clothing made from highly absorbent or breathable material should be worn. When the nature of the work requires protective clothing to be worn, which may have poor breathability for safety reasons, the forms of and environment for such work must be adjusted. These adjustments can include shortening the duration of a work period, securing a rest space where the protective clothing can be removed, and providing hydration equipment that is easily accessible.

#### **Do not overdo exercise/work when you start feeling ill**

Heat illness can develop no matter how hard one tries to prevent it, and the first person to notice its onset will be the person himself/herself. It is most ideal to give yourself a rest and consume fluids before someone else becomes aware of your con-

dition. Thus, it is important to (1) understand and admit that even a person with great stamina can develop heat illness (2) be familiar with the initial symptoms of heat illness (e.g., feeling dazed, weary, or unwell and having headache, stomachache, diarrhea, or numbness in limbs), and (3) establish a working environment in which people are able to take a break without hesitation.

### Prevention provided by a third party

The elderly and people with physical/mental impairment may be limited in their ability to proactively take heat illness prevention measures. Therefore, a third party must intervene for such people. The approach needs to take into account the physical characteristics of the people involved and should not come from the viewpoints of younger caregivers who are confident of their physical strength. The elderly have reduced ability to sense temperature changes and poor thermoregulatory competence in terms of adjusting their internal fluid volumes and sweating. Body temperature can be easily elevated in the elderly, but can be cooled just as easily; these are typical physical characteristics of the elderly. Many elderly also have cardiovascular problems, which makes it difficult to perform quick transfusions during emergencies.

For these reasons, it is advised to begin heat illness prevention for the elderly before the early summer; it should begin before the wet season ends, as the number of heat illness patients rapidly increases. Specific examples of actions to be taken include encouraging the habit of drinking fluids frequently and adjusting the room temperature properly. It has been reported that elderly heat illness patients who had been drinking fluids had significantly lower body temperatures after the onset of heat illness.<sup>1</sup> Thus, a habit of fluid intake can help prevent the onset of heat illness and the aggravation of symptoms. A patient who is under limited fluid intake due to cardiovascular or other disease, however, should consult his/her primary physician for suitable heat illness prevention measures, including guidance on fluid intake.

### Treatment of Heat Illness

Once heat illness has developed, the treatment options vary depending upon the degree of severity. However, the foundation of all treat-

ment lies in symptomatic treatment such as “body cooling” and the support of impaired organs, including resuscitation. The symptomatic treatments for the organ impairments and symptoms that accompany heat illness (e.g., dehydration, convulsions, shivering, rhabdomyolysis, disseminated intravascular coagulation [DIC], electrolyte abnormality, and shock) have been well documented in the literature, but such treatments are not peculiar to cases of heat illness. This chapter will focus on the following 2 points: (1) an overview of the treatment options based on the severity of heat illness and (2) effective methods of body cooling.

It should be noted that the treatment options described in this chapter apply to cases that have been definitively diagnosed as heat illness. When other possible differential diagnoses have not been rejected, it is necessary to provide symptomatic treatment while examining the possibility of an underlying pathologic condition.

### Overview of the treatment options based on the severity of heat illness

**Class I heat illness:** The basic treatment for a Class I case is rest in a cool place and oral rehydration, although fluid therapy should be provided as needed.

**Class II heat illness:** The basic treatment for a Class II case is rest in a cool place and fluid therapy. Rapid cooling (described later) is not usually necessary because the thermoregulatory function is not lost. Rather, rapid cooling might induce the adverse effect of shivering. Body cooling should be kept at a level at which the patient feels comfortably cool. The principle is to provide fluid therapy; however, oral fluid intake will be sufficient if there is no electrolyte abnormality and the patient is fully capable of oral intake. In either case, the patient should be kept at a medical facility for several hours for observation. The patient can be discharged when he/she is fully capable of oral intake and can be guaranteed a cool place to rest with a capable caregiver to monitor the patient. If any questionable issue persists, the patient should be admitted to the facility for further observation.

**Class III heat illness:** In a Class III case, the thermoregulatory function has completely failed. After determining the level of consciousness and identifying any signs of shock, necessary resuscitation must begin immediately (e.g., securing a

reliable airway and securing a vascular line with a large indwelling needle) along with rapid cooling of the body. Core body temperature, such as rectal, bladder, or blood temperature, should be used as the indicator for heat illness, rather than the body surface temperature such as that at the axilla. When cooling, the target core body temperature should be 39°C, and the core body temperature must be continuously monitored to avoid over-cooling or re-elevation of the body temperature (i.e., rebound).<sup>2</sup> Various imaging tests or tests and treatments for the accompanying organ impairments can be carried out as long as they do not interfere with the rapid cooling.

**Effective methods of body cooling**

Non-steroidal anti-inflammatory drugs (NSAIDs) such as acetaminophen and aspirin have no effect when the thermoregulatory function of the body has failed. Rather, they can encourage hepatorenal dysfunction or DIC. Therefore, NSAID use is contraindicated. Dantrolene, which is used for malignant hyperthermia or malignant syndrome, also has no effect and should not be used.<sup>3</sup> Physical cooling is the first-line treatment of choice.

There are various cooling methods available, but the method of transpiration cooling, which is to wet the body surface with fluid and allow evaporation, provides the best balance among invasiveness, simplicity, and effectiveness.<sup>4</sup>

The method we use is wetting sheets of gauze

or thin paper towels to the point that the water will drip, paste each sheet on the body surface closely without any wrinkles, and use electric or paper fans to evaporate the fluid. Merely spraying water onto the body surface can reduce efficiency, because the water will drip away from the body and decrease transpiration area. Thick gauze or paper towels may not adhere to the body surface well, and they are not particularly efficient because the evaporation takes place only at the surface, leaving the heat trapped inside. The important point is to use very thin sheets of gauze or paper towels, such that the skin underneath can be easily visible when wet. When the sheets lose moisture, they will begin to lift from the skin as the air moves; water spraying should be repeatedly performed before this happens.

In the method employing the extracorporeal membrane oxygenation (ECMO) device, the blood is drawn outside the body and returned after cooling. Contrary to transpiration cooling, it is invasive, and there are limited facilities capable of performing this method; however, it has a very good cooling effect. This method is the fastest and surest method of body cooling and provides respiratory and circulatory support. A patient with a particularly severe heat illness, whose thermoregulatory function has failed, may need to be transferred to a facility capable of performing this procedure. **Table 1** shows an overview of various cooling methods.

**Table 1 Comparison of various methods of body cooling**

Cooling method	Simplicity	Effectiveness	Description
Transpiration cooling	★★-★★★	★★	Good balance between simplicity and effectiveness; the first choice
Cold bath	★-★★	★★	Difficult to respond to sudden change in the patient's condition
Gastric and intraperitoneal lavage with cold water	★	★-★★	Not as effective considering the complexity of the procedure
Cooling of the groin, axilla, and cervical regions with ice	★★★	★	Not very effective; for supplementary use only
Cooling the infusion fluid	★★★	★	Not very effective; for supplementary use only
Cooling blanket	★★★	★	The instrumental progress may improve effectiveness
Extracorporeal membrane oxygenation (ECMO)		★★★	Highly effective but invasive, and the number of facilities capable of using this device is limited

More stars (★) indicate better simplicity or higher effectiveness.

## Conclusion

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The number of heat illness patients is expected to increase in Japan in the future, given the rise in average temperatures due to global warming and the reluctance to use air conditioners due to recent power situations in Japan. It is important to be aware that anyone can experience heat illness whether or not they are physically

exercising, and that resting and actively consuming fluids are crucial for preventing heat illness. Furthermore, the elderly and people with physical/mental impairments are limited in their ability to proactively take heat illness prevention measures; hence, aggressive interventions by third parties such as neighbors or social welfare services are essential.

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