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Wilderness Medical Society Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia

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To provide guidance to clinicians, the Wilderness Medical Society (WMS) convened an expert panel to develop evidence-based guidelines for the out-of-hospital evaluation and treatment of victims of accidental hypothermia. The guidelines present the main diagnostic and therapeutic modalities and provide recommendations for the management of hypothermic patients. The panel graded the recommendations based on the quality of supporting evidence and the balance between benefits and risks/burdens according the criteria published by the American College of Chest Physicians. The guidelines also provide suggested general approaches to the evaluation and treatment of accidental hypothermia that incorporate specific recommendations.

Key words: accidental hypothermia, hypothermia, rewarming, resuscitation, wilderness medicine, avalanche, cold

Introduction

Accidental hypothermia is defined as an unintentional drop in core temperature to 35°C or below. Accidental hypothermia caused by environmental exposure can occur during any season, even in temperate or tropical climates. Cold and wet environments pose the greatest risk. Accidental hypothermia can occur in people participating in outdoor work and recreation, including wilderness travelers. Accidental hypothermia has been a disease of wars and other disasters throughout history. In addition to occurring in wilderness environments, hypothermia is associated with urban homelessness and with the use of alcohol and other substances, including recreational and therapeutic drugs. Hypothermia can occur during resuscitation in emergency settings (iatrogenic hypothermia). Hypothermia can accompany trauma, sepsis, diseases that decrease metabolic rate such as hypoendocrine states, and diseases that affect thermoregulation such as cancer or stroke. Therapeutic hypothermia, which is induced for neuroprotection in cardiac arrest patients who do not regain consciousness after return of spontaneous circulation, is beyond the scope of this review.

Hypothermia occurs as a result of net heat loss from the body. Heat can be lost or gained by conduction, convection, and radiation and lost through evaporation. Conduction is the direct transfer of heat from warmer to cooler objects that are in contact with each other. Convection is the transfer of heat to or from a gas or a liquid that is in motion. Radiation is the transfer of heat in the form of electromagnetic energy between 2 objects that are visible to each other. Evaporation is the loss of heat by vaporizing liquid—usually water—in

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sweat, on the skin, or in clothing, or from insensible losses from the skin or from respiration.

The human body attempts to maintain a core temperature of 37°C ± 0.5°C. The thermoregulatory control center in the hypothalamus receives input from central and peripheral thermal receptors. The integrated thermal signal triggers autonomic reflexes that control whether cooling responses, such as vasodilation or sweating, or warming responses, such as vasoconstriction or shivering, are initiated.[1] Peripheral blood flow is also partly regulated by local skin temperature.

Humans originated in the tropics with limited physiologic means to avoid developing hypothermia. Exercise and shivering can raise the metabolic rate to prevent hypothermia if nutritional reserves and insulation are adequate, but the benefit may be limited by environmental conditions. Prevention of hypothermia in humans mostly depends on behavior, especially wearing insulating clothing and using shelter.

Methods

The Wilderness Medical Society (WMS) convened an expert panel to develop evidence-based guidelines for the prevention and out-of-hospital diagnosis and treatment of victims of accidental hypothermia. Panelists were selected by the WMS on the basis of clinical or research experience with hypothermia. The panel generated a set of questions (Figure 1) to define the most significant areas of interest and identified relevant articles with a key word search of the MEDLINE database. Key words were hypothermia, accidental hypothermia, wilderness hypothermia, avalanche, shivering, and rewarming. The literature search included related and secondary references. The panel considered only peer-reviewed randomized controlled trials, observational studies, case series, and case reports related to evaluation and treatment of accidental hypothermia.

The panel assessed the level of evidence supporting each diagnostic and therapeutic modality. Conclusions from review articles were not used in the formulation of recommendations, but the guidelines cite review articles when necessary to provide background information.

The panel used a consensus approach to develop recommendations regarding each evaluation technique and intervention and its role in management. The panel graded each recommendation on the basis of the quality of supporting evidence and the balance between the benefits and risks or burdens, according to the criteria of the American College of Chest Physicians (Table 1).[2]

Pathophysiology of Hypothermia

The primary physiologic effects of tissue cooling are decreased resting metabolism and inhibition of central and peripheral neurologic function. During the initial stages of cooling of a neurologically intact victim, secondary responses to skin cooling predominate.[1] Shivering thermogenesis, triggered by skin cooling even at a core temperature of 37°C, results in increased metabolism because of the work of shivering and increased ventilation, cardiac output, and mean arterial pressure.[3] These parameters increase initially as core temperature decreases to approximately 32°C, then decrease with further decreases in core temperature.[1] Shivering ceases at and below a core temperature of approximately 30°C.[4] Once this occurs, metabolism decreases with decreases in core temperature.

Clinical manifestations of accidental hypothermia relate predominantly to cerebral and cardiorespiratory effects. Brain activity begins to decline at a core temperature of approximately 33°C to 34°C and continues to decline with further cooling.[5,6] Cooling of the brain leads to irritability, confusion, apathy, poor decision-making, lethargy, somnolence, and eventually coma. Brain cooling decreases cerebral oxygen requirements.[7] This provides temporary protection during anoxic conditions such as cold-induced cardiac standstill and cold water drowning. Cold stress reduces circulating blood volume as a result of a combination of cold-induced diuresis, extravascular plasma shift, and inadequate fluid intake.[8] As the heart cools below 30°C, cardiac output decreases markedly and bradycardia usually occurs. Abnormalities in electrical conduction lead to dysrhythmias such as premature atrial and ventricular contractions, atrial fibrillation, and ventricular fibrillation (VF).[9] Below 28°C, the heart is susceptible to VF, which can be triggered by acidosis, hypocarbia, hypoxia, or movement.[1] Decreased ventilatory response to carbon dioxide leads to hypoventilation and respiratory acidosis.[10]

Field Assessment

CLASSIFICATION OF HYPOTHERMIA

Most guidelines now use a standard classification of hypothermia based on core temperature. Hypothermia is classified as mild, 35°C to 32°C; moderate, 32°C to 28°C; or severe, <28°C.[1,11–13] Some experts have advocated a further category, profound hypothermia, <24°C[12] or <20°C.[1] The chance of survival seems to be much lower in this range, probably because of a high likelihood of cardiac arrest. Although it is helpful to use core temperature to classify hypothermia, there is great variation among individuals in response to core temperature, as with any other physiologic parameter. Measuring core temperature is not always feasible in the out-of-hospital environment.[14]