Heat and Cold Illnesses During Distance Running

American College of Sports Medicine Position Stand

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Summary

Many recreational and elite runners participate in distance races each year. When these events are conducted in hot or cold conditions, the risk of environmental illness increases. However, exertional hyperthemia, hypothermia, dehydration, and other related problems may be minimized with pre-event education and preparation. This position stand provides recommendations for the medical director and other race officials in the following areas: scheduling; organizing personnel, facilities, supplies, equipment, and communications providing competitor education; measuring environmental stress; providing fluids; and avoiding potential legal liabilities. This document also describes the predisposing conditions, recognition, and treatment of the four most common environmental illnesses: heat exhaustion, heatstroke, hypothermia, and frostbite. The objectives of this position stand are: 1) To educate distance running event officials and participants about the most common forms of environmental illness including predisposing conditions, warning signs, susceptibility, and incidence reduction. 2) To advise race officials of their legal responsibilities and potential liability with regard to event safety and injury prevention. 3) To recommend that race officials consult local weather archives and plan events at times likely to be of low environmental stress to minimize detrimental effects on participants. 4) To encourage race officials to warm participants about environmental stress on race day and its implications for heat and cold illness. 5) To inform race officials of preventive actions that may reduce debilitation and environmental illness. 6) To describe the personnel, equipment, and supplies necessary to reduce and treat cases of collapse and environmental illness.

Introduction

This document replaces the position stand titled *The Prevention of Thermal Injuries During Distance Running* (4). It considers problems that may affect the extensive community of recreational joggers and elite athletes who participate in distance running events. It has been expanded to include heat exhaustion, heatstroke, hypothermia, and frostbite–the most common environmental illnesses during races.

Because physiological responses to exercise in stressful environments may vary among participants, and because the health status of participants varies from day to day, compliance with these recommendations will not guarantee protection from environmentally induced illnesses. Nevertheless, these recommendations should minimize the risk of exertional hyperthermia, hypothermia, dehydration, and resulting problems in distance running and other forms of continuous athletic activity such as bicycle, soccer, and triathlon competition.

Managing a large road race is a complex task that requires financial resources, a communication network, trained volunteers, and teamwork. Environmental extremes impose additional burdens on the organizational and medical systems. Therefore, it is the position of the American College of Sports Medicine that the following RECOMMENDATIONS be employed by race managers and medical directors of community events that involve prolonged or intense exercise in mild and stressful environments.

1. Race Organization

a. Distance races should be scheduled to avoid extremely hot and humid and very cold months. The local weather history should be consulted when scheduling an event. Organizers should be cautious of unseasonably hot or cold days in early spring or late fall because entrants may not be sufficiently acclimatized. The wind chill index should be used to reschedule races on cold, windy days because flesh may freeze rapidly and cold injuries may result.

b. Summer events should be scheduled in the early morning or the evening to minimize solar radiation and air temperature. Winter events should be scheduled at midday to minimize the risk of cold injury.

c. The heat stress index should be measured at the site of the race because meteorological data from a distant weather station may vary considerably from local conditions (66). The wet bulb globe temperature (WBGT) index is widely used in athletic and industrial settings [see Appendix I;(87)]. If the WBGT index is above 28 °C (82 °F), or if the ambient dry bulb temperature is below -20 °C (-4 °F), consideration should be given to canceling the race or rescheduling it until less stressful conditions prevail. If the WBGT index is below 28 °'C, participants should be alerted to the risk of heat illness by using signs posted at the start of the race and at key positions along the race course [see Appendix I;(61)]. Also, race organizers should monitor changes in weather conditions. WBGT monitors can be purchased commercially, or Figure I may be used to approximate the risk of racing in hot environments based on air temperature and relative humidity. These two measures are available from local meteorological stations and media weather reports, or can be measured with a sling psychrometer.

d. An adequate supply of fluid must be available before the start of the race, along the race course, and at the end of the event. Runners should be encouraged to replace their sweat losses or consume 150-300 ml (5.3-10.5 oz) every 15 minutes (3). Sweat loss can be derived by calculating the difference between pre and postexercise body weight.

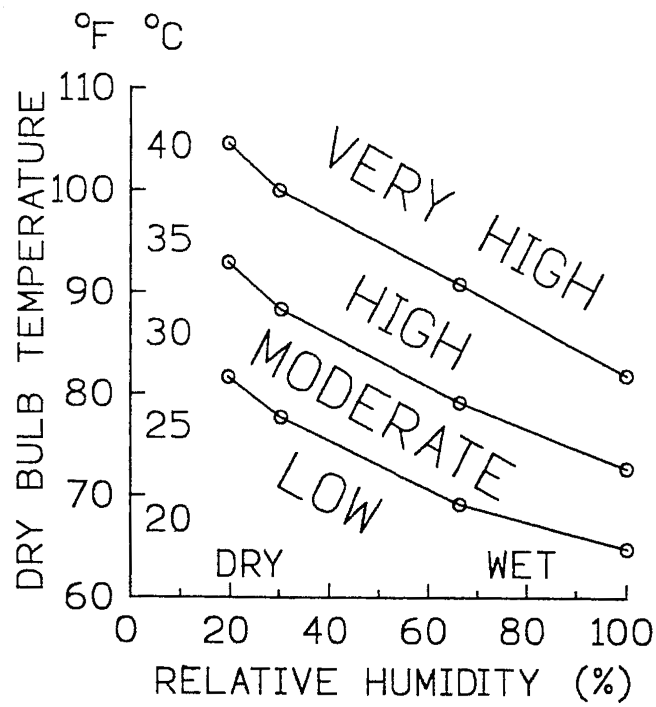

Figure 1 Risk of heat exhaustion or heatstroke while racing in hot environments. Figure drawn from data presented in American College of Sports Medicine Position stand: the prevention of thermal injuries during distance running. *Med. Sci. Sports Exerc.* 19:529-533, 1987.

e. Cool or cold (ice) water immersion is the most effective means of cooling a collapsed hyperthermic runner (25, 48, 49, 59, 88). Wetting runners externally by spraying or sponging during exercise in a hot environment is pleasurable but does not fully attenuate the rise in body core temperature (14, 88). Wetting the skin can result in effective cooling once exercise ceases.

f. Race officials should be aware of the warning signs of an impending collapse in both hot and cold environments and should warn runners to slow down or stop if they appear to be in difficulty.

g. Adequate traffic and crowd control must be maintained along the course at all times.

h. Radio communication or cellular telephones should connect various points on the course with an information processing center to coordinate emergency responses.

2. Medical Director

A sports medicine physician should work closely with the race director to enhance the safety and provide adequate medical care for all participants. The medical director should understand exercise physiology, interpretation of meteorological data, heat and cold illness prevention strategies, potential liability, and the treatment of medical problems associated with endurance events conducted in stressful environments.

3. Medical Support

a. Medical organization and responsibility: The medical director should alert local hospitals and ambulance services and make prior arrangements to care for casualties, including those with heat or cold injury. Medical personnel should have the authority to evaluate, examine, and stop runners who display signs of impending illness or collapse. Runners should be advised of this procedure prior to the event.

b. Medical facilities: Medical support staff and facilities must be available at the race site. The facilities should be staffed with personnel capable of instituting immediate and appropriate resuscitation measures. The equipment necessary to institute both cooling therapy (ice packs, child's wading pools filled with tap water or ice water, fans) and warming therapy (heaters, blankets, hot beverages) may be necessary at the same event. For example, medical personnel treated 12 cases of hyperthermia and 13 cases of hypothermia at an endurance triathlon involving 2300 competitors: air temperature was 85°F, water temperature was 58°F (92).

4. Competitor Education

The physical training and knowledge of competitive runners and joggers has increased greatly, but race organizers must not assume that all participants are well prepared or informed about safety. Distributing this position stand before registration, publicizing the event in the media, and conducting clinics or seminars before events are valuable educational procedures.

a. All participants should be advised that the following conditions may exacerbate heat illness: obesity (13, 39, 89), low degree of physical fitness (30, 63, 79, 83), dehydration (23, 34, 69, 83, 84, 95), lack of heat acclimatization (31, 51, 89), a previous history of heat stroke (82, 89), sleep deprivation (5), certain medications, including diuretics and antidepressants (31), and sweat gland dysfunction or sunburn (31). Illness 1 week prior to an event should preclude participation (32, 96), especially those involving fever, respiratory tract infections, or diarrhea (41, 46).

b. Prepubescent children sweat less than adults and have lower heat tolerance (11, 12).

c. Adequate training and fitness are important for full enjoyment of the event and will reduce the risk of heat illness and hypothermia (33, 64, 67, 85).

d. Prior training in the heat will promote heat acclimatization (6) and thereby reduce the risk of heat illness, especially if the training environment is warmer than that expected during a race (5, 51). Artificial heat acclimatization can be induced in cold conditions (6).

e. Adequate fluid consumption before and during the race can reduce the risk of heat illness, including disorientation and irrational behavior, particularly in longer events such as a marathon (23, 34, 95).

f. Excessive consumption of pure water or dilute fluid (i.e., up to 10 liters per 4 hours) during prolonged endurance events may lead to a harmful dilutional hyponatremia (60), which may involve disorientation, confusion, and seizure or coma. The possibility of hyponatremia may be the best rationale for inclusion of sodium chloride in fluid replacement beverages (3).

g. Participants should be advised of the early symptoms of heat illness, which may include clumsiness, stumbling, headache, nausea, dizziness, apathy, confusion, and impairment of consciousness (41,86).

h. Participants should be advised of the early symptoms of hypothemia (slurred speech, ataxia, stumbling gait) and frostbite (numbness, burning, pain, paresthesia) on exposed skin (36). Wet clothing, especially cotton, increases heat loss and the risk of hypothermia (68).

i. Participants should be advised to choose a comfortable running speed and not to run faster than environmental conditions or their cardiorespiratory fitness warrant (43, 71, 91).

j. It is helpful if novice runners exercise with a partner, each being responsible for the other's well-being (71).

5. Responsibilities and Potential Liability

The sponsors and directors of an endurance event are reasonably safe from liability due to injury if they avoid gross negligence and willful misconduct, carefully inform the participants of hazards, and have them sign waivers before the race (78). However, a waiver signed by a participant does not totally absolve race organizers of moral and/or legal responsibility. It is recommended that race sponsors and directors: 1) minimize hazards and make safety the first concern; 2) describe inherent hazards (i.e., potential course hazards, traffic control, weather conditions) in the race application; 3) require all entrants to sign a waiver; 4) retain waivers and records for 3 yrs; 5) warn runners of the predisposing factors and symptoms of environmental illness; 6) provide all advertised support services; 7) legally incorporate the race or organizations involved; and 8) purchase liability insurance (18, 78, 80).

Race directors should investigate local laws regarding Good Samaritan action. In some states physicians who do not accept remuneration may be classified as Good Samaritans. Race liability insurance may not cover physicians (78), therefore the malpractice insurance policy of each participating physician should be evaluated to determine if it covers services rendered at the race.

Medical and race directors should postpone, reschedule, or cancel a race if environmental conditions warrant, even though runners and trained volunteers arrive at the site and financial sponsorship has been provided. Runners may not have adequate experience to make the decision not to compete; their safety must be considered. Downgrading the race to a “fun run” does not absolve race supervisors from their responsibility or decrease the risk to participants (15, 66).

Background For This Position Stand

Dehydration is common during prolonged endurance events in both cold and hot environmental conditions because the average participant loses 0.5-1.5 quarts (0.47-1.42 liters) of sweat, and fluid replacement is usually insufficient (12, 42, 69). Runners may experience hyperthermia [body core temperature above 39°C (102.2°F)] or hypothermia [body core temperature below 35°C (95°F)], depending on the environmental conditions, caloric intake, fluid consumption, and clothing worn. Hyperthermia is a potential problem in warm and hot weather races when the body’s rate of heat production is greater than its heat dissipation (2). Indeed, on extremely hot days, it is possible that up to 50% of the participants may require treatment for heat-related illnesses such as heat exhaustion and heatstroke (1, 66). Hypothermia is more likely to occur in cold or cool-windy conditions. Scanty clothing may provide inadequate protection from such environments, particularly near the end of a long race when running speed and heat production are reduced. Frostbite can occur in low air temperature and especially when combined with high wind speed. The race and medical directors should anticipate the above medical problems and be capable of responding to a large number of patients with adequate facilities, supplies, and support staff. The four most common heat and cold illnesses during distance running are heat exhaustion, heatstroke, hypothermia, and frostbite.

1. Heat Exhaustion

Body sweat loss can be significant in summer endurance races and may result in a body water deficit of 6-10% of body weight (41, 95). Such dehydration will reduce the ability to exercise in the heat because decreases in circulating blood volume, blood pressure, sweat production, and skin blood flow all inhibit heat loss (41, 81) and predispose the runner to heat exhaustion or the more dangerous hyperthermia and exertional heatstroke (41, 66).

Heat exhaustion, typically the most common heat illness among athletes, is defined as the inability to continue exercise in the heat (7). It represents a failure of the cardiovascular responses to workload, high external temperature, and dehydration (16, 41, 42). Heat exhaustion has no known chronic, harmful effects. Symptoms may include headache, extreme weakness, dizziness, vertigo, “heat sensations” on the head or neck, heat cramps, chills, “goose flesh” (“goose bumps”), vomiting, nausea, and irritability (41, 42). Hyperventilation, muscular incoordination, agitation, impaired judgment, and confusion also may be seen. Heat syncope (fainting) may or may not accompany heat exhaustion (41). The onset of heat exhaustion symptoms is usually sudden and the duration of collapse brief. During the acute stage of heat exhaustion, the patient looks ashen-gray, the blood pressure is low, and the pulse rate is elevated. Hyperthermia may add to the symptoms of heat exhaustion, even on relatively cool days (20, 22, 30, 37, 38, 43, 62, 90).

Although it is improbable that all heat exhaustion cases can be avoided, the most susceptible individuals are those who either exert themselves at or near their maximal capacities, are dehydrated, not physically fit, and not acclimatized to exercise in the heat. It is imperative that runners be adequately rested, fed, hydrated, and acclimatized (7); they should drink ample fluids before, during, and after exercise (3). Also, repeated bouts of exercise in the heat (heat acclimatization) reduce the incidence of both heat exhaustion and heat syncope. Heat acclimatization can best be accomplished by gradually increasing the duration and intensity of exercise training during the initial 10-14 d of heat exposure (6).

Oral rehydration is preferred for heat exhaustion patients who are conscious, coherent, and without vomiting or diarrhea. Intravenous (IV) fluid administration facilitates rapid recovery (42, 57). Although a variety of IV solutions have been used at races (42), a 5% dextrose sugar in either 0.45% saline (NACI) or 0.9% NaCl are the most common (1). Runners may require up to 4 1 of IV fluid if severely dehydrated (57).

2. Exertional Heatstroke

Heat production, mainly from muscles, during intense exercise is 15-20 times greater than at rest, and is sufficient to raise body core temperature by 1°C (1.8°F) each 5 minutes without thermoregulatory (heat loss) adjustments (56). When the rate of heat production exceeds that of heat loss for a sufficient period of time, severe hyperthermia occurs.

Heatstroke is the most serious of the syndromes associated with excess body heat. It is defined as a condition in which body temperature is elevated to a level that causes damage to the body's tissues, giving rise to a characteristic clinical and pathological syndrome affecting multiple organs (32, 83). After races, adult core (rectal) temperatures above 40.6°C (105.1°F) have been reported in conscious runners (24, 52, 69, 74, 77), and 42-43°C (107.6-109.4°F) in collapsed runners (72-74, 86, 90). Sweating is usually present in runners who experience exertional heatstroke (87).

Strenuous physical exercise in a hot environment has been notorious as the cause of heatstroke, but heatstroke also has been observed in cool-to-moderate [13-28°C (55-82°F)] environments (5, 32, 74), suggesting variations in individual susceptibility (5, 31, 32). Skin disease, sunburn, dehydration, alcohol or drug use/abuse, obesity, sleep loss, poor physical fitness, lack of heat acclimatization, advanced age, and a previous heat injury all have been theoretically linked to increased risk of heatstroke (5, 31, 51, 84). The risk of heatstroke is reduced if runners are well-hydrated, well-fed, rested, and acclimatized. Runners should not exercise if they have a concurrent illness, respiratory infection, diarrhea, vomiting, or fever (5, 7, 46). For example, a study of 179 heat casualties at a 14-km race showed that 23% reported a recent gastrointestinal or respiratory illness (70), whereas a study of 10 military heatstroke patients reported that three had a fever or disease and six recalled at least one warning sign of impending illness at the time of their heatstroke (5).

Appropriate fluid ingestion before and during prolonged running can minimize dehydration and reduce the rate of increase in body core temperature (24, 34). However, excessive hyperthermia may occur in the absence of significant dehydration, especially in races of less than 10 km, because the fast pace generates greater metabolic heat (90).

The mortality rate and organ damage due to heatstroke are proportional to the length of time between core temperature elevation and initiation of cooling therapy (5, 26). Therefore, prompt recognition and cooling are essential (1, 5, 22, 42, 48, 51, 62, 74, 83). A measurement of deep body temperature is vital to the diagnosis, and a rectal temperature should be measured in any casualty suspected of having heat illness or hypothermia. Ear (tympanic), oral, or axillary measurements are spuriously affected by peripheral (skin) and environmental temperatures and should not be used after exercise (8, 75, 76). When cooling is initiated rapidly, most heatstroke patients recover fully with normal psychological status (79), muscle energy metabolism (65), heat acclimatization, temperature regulation, electrolyte balance, sweat gland function, and blood constituents (5).

Many whole-body cooling techniques have been used to treat exertional heatstroke, including water immersion, application of wet towels or sheets, warm air spray, helicopter downdraft, and ice packs to the neck, underarm, and groin areas. There is disagreement as to which modality provides the most efficient cooling (7, 47, 97), because several methods have been used successfully. However, the fastest whole-body cooling rates (25, 48, 49, 59, 88) and the lowest mortality rates (25) have been observed during cool and cold water immersion. Whichever modality is utilized it should be simple and safe, provide great cooling power, and should not restrict other forms of therapy (i.e., cardiopulmonary resuscitation, defibrillation, IV cannulation). The advantages and disadvantages of various cooling techniques have been discussed (47, 75, 97).

Heatstroke is regarded as a medical emergency that might be fatal if not immediately diagnosed and properly treated. Early diagnosis is of utmost importance and time-consuming investigation should be postponed until body temperature is corrected and the patient is evacuated to a nearby medical facility that is aware of such conditions.

3. Hypothermia

Hypothermia [body core temperature below 36°C (97 °F)] occurs when heat loss is greater than metabolic heat production (94). Early signs and symptoms of hypothermia include shivering, euphoria, confusion, and behavior similar to intoxication. Lethargy, muscular weakness, disorientation, hallucinations, depression, or combative behavior may occur as core temperature continues to fall. If body core temperature falls below 31.1°C

(88°F), shivering may stop and the patient will become progressively delirious, uncoordinated, and eventually comatose if treatment is not provided (10).

During cool or cold weather marathons, the most common illnesses are hypothermia, exhaustion, and dehydration. The most common medical complaints are weakness, shivering, lethargy, slurred speech, dizziness, diarrhea, and thirst (1, 45). Runner complaints of feeling hot or cold do not always agree with changes in rectal temperature (74). Dehydration is common in cool weather (1, 45). Runners should attempt to replace fluids at a rate that matches their sweat and urine losses. Cases of hypothermia also occur in spring and fall because weather conditions change rapidly and runners wear inappropriate clothing that becomes sweat-soaked during training or competition (19).

Hypothermia may occur during races, for example when distance runners complete the second half of the event more slowly than the first half (54). Evaporative and radiative cooling increase because wet skin (from sweat, rain, or snow) and clothing are exposed to higher wind speed at a time when metabolic heat production decreases. Hypothermia also occurs after a race, when the temperature gradient between the body surface and the environment is high. Subfreezing ambient temperatures need not be present and hypothermia may develop even when the air temperature is 10-18°C (50-65°F) (19, 36, 74). A WBGT meter can be used to evaluate the risk of hypothermia (see Appendix 1). Cold wind increases heat loss in proportion to wind speed; i.e., wind chill factor. The relative degree of danger can be assessed (Fig. 2) (55). Wind speed can be estimated; if you feel the wind in your face the speed is at least 16 km per hour^{-1} (kph) [10 miles per hour^{-1} (mph)]; if small tree branches move or if snow and dust are raised, approximately 32 kph (20 mph); if large tree branches move, 48 kph (30 mph); if an entire tree bends, about 64 kph (40 mph) (9).

To reduce heat loss, runners should protect themselves from moisture, wind, and cold air by wearing several layers of light, loose clothing that insulate the skin with trapped air (17). An outer garment that is windproof, allows moisture to escape, and provides rain protection is useful. Lightweight nylon parkas may not offer thermal insulation but offer significant protection against severe wind chill, especially if a hood is provided. Wool and polyester fabrics retain some protective value when wet; cotton and goose down do not (10). Areas of the body that lose large amounts of heat (head, neck, legs, hands) should be covered (17).

Mild [34-36°C (93-97°F)] or moderate [30-34°C (86-93°F)] hypothermia should be treated before it progresses. Wet clothing should be replaced with dry material (sweatsuit, blanket) that is insulated from the ground and wind. Warm fluids should be consumed if patients are conscious, able to talk, and thinking clearly. Patients with moderate and severe [<30°C (86°F)] hypothermia should be insulated in a blanket and evacuated to a hospital immediately (19, 58). Although severe hypothermia should be treated in the field (27), it is widely recognized that life-threatening ventricular fibrillation is common in this state and may be initiated

Wind Chill Chart

AIR TEMPER-ATURE	ESTIMATED WIND SPEED IN MPH (KPH) 0 (0)	10 (16)	20 (32)	0 (48)	
30F (-1.l C)	30 (1.1)	16 (-8.9)	4 (-15.6)	-2 (-18.9)	LITTLE RISK
20 F (-6.7 C)	20 (-6-7)	4 (-15.6)	-10 (-23-3)	-18 (-27.8)	
10F (12.2 C)	10 (-12.2)	-9 (-22.8)	-25 (-31.7)	-33 (-36.1)	INCREASED RISK
0 F (-17.8 C)	0 (-17.8)	-24 (-31.1)	-39 (-39.4)	-48 (-44.4)	
-10 F (-23.3 C)	-10 (-23.3)	-33 (-36.1)	-53 (-47.2)	-63 (-52.8)	
-20 F (-28.9 C)	-20 (-28.9)	-46 (-43.3)	-67 (-55)	-79 (-61.7)	GREAT RISK

Figure 2 The risk of freezing exposed flesh in cold environments.
Reprinted from Milesko-Pytel, D. Helping the frostbitten patient. *Patient Care* 17:90-115, 1983.

by physical manipulation, chest compression, or intubation (10, 27, 58, 93). However, with conclusive evidence of cardiac standstill and breathlessness, emergency procedures (i.e., Basic Life Support, Advanced Cardiac Life Support) should be initiated. Life-support procedures (27) and commonly observed laboratory (i.e., electrolyte, acid-base) values (10, 58) have been described by others.

4. Frostbite

Frostbite involves crystallization of fluids in the skin or subcutaneous tissue after exposure to subfreezing temperatures [< -0.6°C (31°F)]. With low skin temperature and dehydration, cutaneous blood vessels constrict and circulation is attenuated because the viscosity of blood increases (55). Frostbite may occur within seconds or hours of exposure, depending upon air temperature, wind speed, and body insulation. Frostbitten skin can appear white, yellow-white, or purple, and is hard, cold, and insensitive to touch (55). Rewarming results in intense pain, skin reddening, and swelling. Blister formation is common and loss of extremities (fingers, toes, ears, hands, feet) is possible (36, 55). The degree of tissue damage depends on duration and severity of the freezing and effectiveness of treatment.

No data have been published regarding the incidence of frostbite among athletes during training or competition. Since winter running races are rarely postponed when environmental conditions are harsh, and frostbite is the most common cold injury in military settings (35), it is imperative that runners be aware of the dangers. Crosscountry ski races are postponed if the temperature at the coldest point of the course is less than -20 °C (-4 °F), due to the severe wind chill generated at race pace.

Runners risk frozen flesh within minutes if the air temperature and wind speed combine to present a severe wind chill. Because runners prefer to have unrestricted movement during races, and because they know that exercise results in body heating, they may not wear sufficient clothing. Runners can avoid frostbite and hypothermia in cold and windy conditions by protecting themselves by dressing adequately: wet skin or clothing will increase the risk of frostbite (21, 29).

When tissue freezes [skin temperature -2 ° -O °C, (28-32 °F)], water is drawn out of the cells and ice crystals cause mechanical destruction of skin and subcutaneous tissue (36). However, initial ice crystal formation is not as damaging to tissues as partial rethawing and refreezing (40). Therefore, the decision to treat severe frostbite in the field (versus transport to a hospital) should consider the possibility of refreezing. If there is no likelihood of refreezing, the tissue should be rapidly rewarmed (36, 40) in circulating warm water (40-43.3 °C, 104-110 °F), insulated, and the patient transported to a medical facility. Research on animals suggests that topical aloe vera and systemic ibuprofen may reduce tissue damage and speed rehabilitation in humans (9). Other aspects of hospital treatment protocols are detailed elsewhere (9, 36, 40).

Race Organization

The following suggestions constitute the ideal race medical team. They are offered for consideration, but are not intended as absolute requirements. Staff and equipment needs are unique to each race and may be revised after 1-2 yr, in light of the distinctive features of each race. Depending on the weather conditions, 2-12% of all entrants will typically enter a medical aid station (1, 45, 50, 74).

1. Medical Personnel

a. Provide medical assistance if the race is 10 km (6.2 miles) or longer.

b. Provide the following medical personnel per 1,000 runners: 1-2 physicians, 4-6 podiatrists, 1-4 emergency medical technicians, 2-4 nurses, 3-6 physical therapists, 3-6 athletic trainers, and 1-3 assistants. Approximately 75% of these personnel should be stationed at the finish area. Recruit one nurse (per 1,000 runners) trained in IV therapy.

c. Recruit emergency personnel from existing organizations (police, fire-rescue, emergency medical service).

d. One physician and 10-15 medical assistants serve as the triage team in the finish chute. Runners unable to walk are transported to the medical tent via wheelchair, litter, or two-person carry.

e. Consider one or two physicians and two to four nurses trained in the rehabilitative medical care of wheelchair athletes.

f. Medical volunteers should attend a briefing prior to the event to meet their supervisor and receive identification tags, weather forecast, instructions, and schedules. Supervisors from the following groups should be introduced: medical director; podiatry, nursing, physical therapy, athletic training, medical records, triage, wheelchair athlete care, and medical security (optional: chiropractic, massage therapy). Medical volunteers should be distinguished from other race volunteers; luminous/distinctive vests, coats, or hats work well.

2. Medical Aid Stations

a. Provide a primary medical aid station (250-1,500 ft^2 (23-139 m^2) for each 1,000 runners; see Table 1) at the finish area, with no public access. Place security guards at all entrances with instructions regarding who can enter.

b. Position secondary medical aid stations along the route at 2- to 3-km (1.2- to 1.9-mile) intervals for races over 10 km, and at the halfway point for shorter races (see Table 1). Some race directors have successfully secured equipment and medical volunteers from military reserve or national guard medical units, the American Red Cross, and the National Ski Patrol.

c. Station one ambulance per 3,000 runners at the finish area and one or more mobile emergency response vehicles on the course. Staff each vehicle with a nurse and radio person or cellular telephone. Stock each vehicle with a medical kit, automatic defibrillator, IV apparatus. blankets, towels, crushed ice, blood pressure cuffs, rehydration fluid, and cups.

d. Signs should be posted at the starting line and at each medical aid station to announce the risk of heat illness or cold injury (see Appendix 1).

e. A medical record card should be completed for each runner who receives treatment (1,74). This card provides details that can be used to plan the medical coverage of future events.

f. Provide personal protective equipment (gloves, gowns, face shields, eye protection) and hand washing facilities.

g. Provide portable latrines and containers for patients with vomiting and diarrhea.

h. Initial medical assessment must include rectal (not oral, aural, or axillary temperature; see ref. 8, 76), central nervous system function, and cardiovascular function. Rehydration and cooling or warming are the cornerstones of treatment (32, 41, 42, 50, 74, 94).

Medical aid stations

Item	Secondary Aid Station	Primary Aid Station
Stretchers (at 10 km and beyond)	2-5	4-10
Cots	10	30
Wheelchairs	0	1
Wool blankets (at 10 km and beyond)	6-10	12-20
Bath towels	5-10	10-20
High and low temperature rectal thermometers (37-43˚C; 99-110˚F) and (22-37˚C; 77-99˚F)[d]	5	10
Elastic bandages (2, 4, and 6 inch)	3 each	6 each
Gauze pads (4 x 4 inch)	1/2 case	1 case
Adhesive tape (1.5 inch)	1/2 case	1 case
Skin disinfectant	1 l	2 l
Surgical soap	1/2 case	1case
Band-aids	110	220
Moleskin	1/2 case	1 case
Petroleum jelly, ointments	1/2 case	1 case
Disposable latex gloves	80 pairs	175 pairs
Stethoscopes	1	2
Blood pressure cuffs	1	2
Intravenous (IV) stations[d]	1	2
IV fluid (D5:1/2 NS or D5:NS; 0.5 or 1l)[d]	15[e]	30[e]
Sharps and biohazard disposal containers[d]	1	2
Alcohol wipes	50	100
Small instrument kits	1	1
Athletic trainer's kit	1	1
Podiatrist's kit	1-2	2-4
Inflatable arm and leg splints	2 each	2 each
Tables for medical supplies	1	2
Hose with spray nozzle, running water[e]	1	2
Wading pool for water immersion[d]	1	2
Fans for cooling	1	2-4
Oxygen tanks with regulators and masks	0	2
Crushed ice in plastic bags	7 kg	14 kg
Rehydration fluids	50 l	100 l[e]
Cups (≥0.3l, 10 oz)	1250	2250
Eye drops	1	1
Urine dipsticksd	10	20
Glucose blood monitoring kits[d]	1	2
Inhalation therapy for asthmatics[d]	1	1
EMS ambulance or ACLS station	1	1
Injectable drugs[d]		
Oral drugs[d]		

Table 1 Suggested equipment and supplies per 1,000 runners[a].

[a] Revised from Adner, M. M., J. J. Scarlet, J. Casey, W. Robison, and 8, H. Jones. The Boston Marathon medical care team: ten years of experience. *Physician Sportsmed.* 16:99-106, 1988; Bodishbaugh, R. G. Boston marathoners get red carpet treatment in the medical tent. *Physician Sportsmed.* 16:139-143, 1988; and Noble, H. B. and D. Bachman. Medical aspects of distance race planning. *Physician Sportsmed.* 7:78-84, 1979.
[b] Increase supplies and equipment if the race course is out and back.
[c] At finish area.
[d] Supervised by a physician.
[e] Depends on environmental conditions.

3. Universal Precautions

All medical personnel may encounter blood-borne pathogens or other potentially infectious materials, and should observe the following precautions (53, 63):

a. Receive immunization against the hepatitis B virus prior to the event.

b. Recognize that blood and infectious body fluids may be encountered from needle sticks, cuts, abrasions, blisters, and clothing.

c. Reduce the likelihood of exposure by planning tasks carefully (i.e., prohibiting recapping of needles by a two-handed technique, minimizing splashing and spraying).

d. Wear personal protective equipment such as gloves, gowns, face shields and eye protection. Remove this equipment and dispose/ decontaminate it prior to leaving the work area.

e. Wash hands after removing gloves or other personal protective equipment.

f. Dispose of protective coverings, needles, scalpels, and other sharp objects in approved, labeled biohazard containers.

g. Do not eat, drink, smoke, handle contact lenses, or any cosmetics/ lip balm in the medical treatment area.

h. Decontaminate work surfaces, bins, pails, and cans [1/10 solution of household bleach (sodium hypochlorite) in water] after completion of procedures.

4. Fluid Stations

a. At the start and finish areas provide 0.34-0.45 1 (12-16 oz) of fluid per runner. At each fluid station on the race course (2-3 km apart), provide 0.28-0.34 1 (10-12 oz) of fluid per runner. Provide both water and a carbohydrate-electrolyte beverage in equal volumes.

b. In cool or cold weather [≤10˚C (50˚F)], an equivalent amount of warm fluid should be available.

c. Number of cups (>0.3 1, 10 oz) per fluid station on the course = number of entrants + 25% additional for spillage and double use. Double this total if the course is out and back.

d. Number of cups at start and finish area = (2 × number of entrants) + 25% additional.

e. Cups should be filled prior to the race and placed on tables to allow easy access. Runners drink larger volumes if volunteers hand them cups filled with fluid.

5. Communications/Surveillance

a. Provide two-way radio or telephone communication between the medical director, medical aid stations, mobile vans, and pick-up vehicles.

b. Arrange for radio-equipped vehicles to drive the race course (ahead and behind participants) and provide communication with the director and his/her staff. These vehicles should be stationed at regular intervals along the course to search the course for competitors who require emergency care and encourage compromised runners to stop.

c. Place radio-equipped observers along the course.

d. Notify local hospitals, police, and fire-rescue departments of the time of the event, number of participants, location of aid stations, extent of medical coverage, and the race course.

e. Use the emergency response system (telephone number 911) in urban areas.

6. Instructions to Runners

a. Advise each race participant to print name, address, telephone number, and medical problems on the back of the race number (pinned to the body). This permits emergency personnel to quickly identify unconscious runners. Inform emergency personnel that this information exists.

b. Inform race participants of potential medical problems at pre-race conferences and at the starting line. Signed registration forms should clearly state the types of heat or cold injuries that may arise from participation in this event.

c. Provide pre-event recommendations regarding training, fluid consumption, clothing selection, self-care, heat acclimatization, and signs or symptoms of heat/cold illness (88).

d. The race director should announce the following information to all participants by loudspeaker immediately prior to the race:

- Current and predicted maximum (or minimum) temperature, humidity, wind speed, and cloud cover;
- The WBGT category and the risks for hyperthermia or hypothermia (see Appendix 1);
- Location of aid stations, types of assistance, and fluid availability;
- Signs and symptoms of heat or cold illness;
- Recommended clothing;
- The need for fluid replacement before, during, and after the race;
- The policy of race monitors to stop runners who are ill;
- A request that runners seek help for impaired competitors who appear ill, who are not coherent, who run in the wrong direction, or who exhibit upper-body swaying and poor competitive posture;

- A warning to novice runners entering their first race that they should run at a comfortable pac and run with a partner;
- Warnings to runners who are taking medications or have chronic illnesses (asthma, hypertension, diabetes, cardiovascular problems).

This position stand replaces the 1987 ACSM position paper, "The Prevention of Thermal Injuries During Distance Running." This pronouncement was reviewed for the American College of Sports Medicine by members-at-large, the Pronouncements Committee, and by: Arthur E. Crago, M.D., Stafford W. Dobbin, M.D., Mary L. O'Toole, Ph.D., FACSM, LTC Katy L. Reynolds, M.D., John W. Robertson, M.D., FACSM.

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Appendix 1: Measurement of Environmental Stress

Ambient temperature is only one component of environmental heat or cold stress; others are humidity, wind speed, and radiant heat. The most widely used heat stress index is the wet bulb globe temperature (WBGT) index (96):

$$WBGT = (0.7\ T^{wb}) + (0.2\ T^{g}) + (0.\ 1\ T^{db})$$

where T^{wb} is the wet bulb temperature, T^{g} is the black globe temperature, and T^{db} is the shaded dry bulb temperature (28). T^{db} refers to air temperature measured with a standard dry bulb thermometer not in direct sunlight. T^{wb} is measured with a water-saturated cloth wick over a dry bulb thermometer (not immersed in water). T^{g} is measured by inserting a dry bulb thermometer into a standard black metal globe. Both T^{wb} and ^{T} are measured in direct sunlight.

A portable monitor that gives the WBGT index in degrees Celsius or degrees Fahrenheit has proven useful during races and in military training (28, 44, 87, 96). The measurement of air temperature alone is inadequate. The importance of humidity in total heat stress can be readily appreciated because T^{wb} accounts for 70% of the index whereas T^{db} accounts for only 10%.

The risk of heat illness (while wearing shorts, socks, shoes, and a t-shirt) due to environmental stress should be communicated to runners in four categories (see Fig. 1):

- Very high risk: WBGT above 28°C (82°F); high risk: WBGT 23-28°C (73-82°F);
- Moderate risk: WBGT 18-23°C (65-73°F);
- Low risk: WBGT below 18°C (65°F).

Large signs should be displayed, at the start of the race and at key points along the race course, to describe the risk of heat exhaustion and heatstroke (Fig. 1). When the WBGT index is above 28°C (82°F), the risk of heat exhaustion or heatstroke is very high; it is recommended that the race be postponed until less stressful conditions prevail, rescheduled, or canceled. High risk [WBGT index = 23-28°C (73-82°F)] indicates that runners should be aware that heat exhaustion or heatstroke may be experienced by any participant; anyone who is particularly sensitive to heat or humidity probably should not run. Moderate risk [WBGT index = 18-23°C (65-73°F)] reminds runners that heat and humidity will increase during the course of the race if conducted during the morning or early afternoon. Low risk [WBGT index below 18°C (65°F)] does not guarantee that heat exhaustion (even heatstroke, see ref. 5, 32) will not occur; it only indicates that the risk is low.

The risk of hypothermia (while wearing shorts, socks, shoes, and a t-shirt) also should be communicated to runners. A WBGT index below 10°C (50°F) indicates that hypothermia may occur in slow runners who run long distances, especially in wet and windy conditions. Core body temperatures as low as 92°F have been observed in 65°F conditions (74).