Hiking in the desert for hours, especially in the summer months, always entails risk and that risk must be minimized.

In Loving Memory of Ariel Yitzchak Newman z"l
May 6, 1996-September 10, 2014
17 Iyar 5756-15 Elul 5774

While exertional heat illnesses (EHI) such as heat exhaustion and heat syncope (fainting) are not life-threatening, another type of EHI known as exertional heat stroke (EHS) can lead to death if not recognized and treated properly. EHS is a state of extremely high body temperature (>104°F/40°C) coupled with mental status dysfunction. EHS occurs when heat that is generated during exercise exceeds the body's ability to dissipate it at the same rate. The elevated body temperature causes widespread damage to the body's organs and tissues. These conditions most commonly occur during the hot summer months; however, EHS can happen at any time and even in the absence of high environmental temperatures and humidity.

When a hiker collapses from EHS, this indicates his body is already in acute distress. To prevent organ failure, his body temperature needs to be lowered to under 104°F/40°C within 30 minutes. Evidence indicates a high probability of survival and complete recovery if this is done immediately.

The person(s) responsible for the safety of the hikers must be aware of four things: 1) The vast majority of individuals from the US or other countries either have never hiked at all or are novice hikers, unfamiliar with the challenges hiking presents, especially the challenges of hiking in the extreme heat of the desert. 2) 18 to 25-year old men in particular often project an unfounded confidence in their strength and ability to withstand harsh, adverse conditions. They will often state they are "okay," not exhausted, and not thirsty when, in fact, they are. 3) Surprisingly, in many cases a person succumbs to EHS without any warning. 4) Just because others have hiked on a similar tiyul before and did not require medical treatment does not mean it could not happen now. They may have merely been lucky! Previous experience or lack of previous heat-related incidents doesn't reduce the level of risk for future heat-related illness. Heat illness is non-discriminatory; it can occur at any time even with the most experienced hikers.

The following are ten important guidelines to help minimize the occurrence of EHS:

1

ACCLIMATE, ACCLIMATE, ACCLIMATE to the heat. Extensive exercise should be gradually phased in over a 14-day heat acclimation period. For people unaccustomed to a hot climate, it takes time for the body to acclimate to such weather. Upon arrival, extensive physical exercise outside in the heat should be limited to 1-2 hours maximum for the first 5 days and no more than two separate 2-hour bouts of hiking (4 hours total) from days 6-14 (minimum 3-hour break between bouts).

This period is ideally continuous, without more than one day between exercise days. Do not include in the 14-day count any days where the participant was inside and did not spend any time in the outside heat/sun. Also, during that period, exercises to increase endurance and educational sessions regarding heat-related illness prevention must be conducted.

NOTE: If during this period any signs or symptoms of heat-related illness present themselves (such as core body temperature >104°F/40°C or mental dysfunction), exercise should be terminated immediately and medical personnel should be summoned.

2

Ensure the hike is appropriate to the skill and level of the hikers. Given that novice hikers may struggle with low physical fitness and maintaining a healthy weight, the first two or three hikes should be at the beginner level only. After that, the hike leader responsible for the safety of the novice hikers can reassess the skill and endurance levels within the group and adjust the difficulty of the hike accordingly. The hike leader should always plan the intensity of the hike according to the weakest member in the group and never according to the strongest one. Hike leaders constantly need to take into account all risk factors listed herein such as exercise intensity, hydration status, environment, and sleep, among others. There are various websites that can help anyone determine the skill level of the hike and the appropriateness of the particular hike for each season, including whether the particular proposed hike is safe in the summer. **Extra care and planning is mandatory for multiple-day hikes.**

Hiking on rough terrain is considered an intense physical activity. Being even slightly ill, dehydrated, sleep-deprived, unacclimated, unfit, or overweight can negatively influence your body's ability to cope with exercise-heat stress.

Ensure hydration. *This cannot be emphasized enough. Ensure you are hydrated before, during, and after each hike.* Ensure that each hiker has an adequate amount of water for the duration of that particular hike. Hydration is complex and dynamic, and specific fluid needs are different from person to person. Given the individual nature of fluid needs, it is recommended that individuals determine their individual sweat rate during an exercise session, preferably on the last acclimation day, prior to setting out for a hike in the desert.

The sweat rate can be ascertained by weighing the hiker before and after exercise with minimal clothing on. The difference in body weight is the amount of fluid the hiker would need. For example, consider a 150-pound hiker who exercises for 60 minutes and is 147.5 pounds after exercise. He lost 2.5 pounds = 40 ounces = 1.2 liters of fluid in the form of sweat. This hiker would thus need to pack approximately 3.6 liters of fluid to replace the amount he will lose in a 3-hour hike or else have another rehydration strategy in place before beginning the hike.

3

If calculating is not feasible, know that most inexperienced hikers, in the dry, arid desert, when the temperature can reach at least 96.8°F (36°C), should drink anywhere from ½ of one quart/liter to one quart/liter of liquid each hour. Be cautious though not to over-hydrate, which results in the dilution of blood and can cause hyponatremia (low levels of salt in the blood). Do not drink more than 1½ quarts/liters per hour or 12 quarts/liters per day.

Adequate fluid replacement is best achieved by drinking smaller amounts throughout each hour rather than drinking large amounts at once.

During the hike, drink water and avoid any carbonated or other liquids. Sports drinks are not required by novice hikers who have regular meals every few hours.

Do not skip meals. Eat regularly every 4-5 hours and consider foods high in electrolytes such as salty snacks (trail mix or pretzels) and fruits/vegetables (bananas, raisins, pickles). This will enable the hiker to replenish fluid loss, salt loss, and energy sources.

Also, on longer tiyulim the water may become so hot that hikers do not want to drink it. Be aware of this and be prepared to compensate beforehand, e.g., purchase insulated water bottles or bring frozen water.

Bringing enough liquid is NOT enough. Frequently reminding hikers to drink and asking how they are doing are insufficient to ensure the safety of young, inexperienced hikers who have no idea how fast they are dehydrating in the desert or on hiking trails. **The person responsible for safety must SEE how much**

the hiker has drunk. Water bottles with clear markings or packs with water bladders and flow meters are great ways for hikers themselves to know how much they are drinking and if they are possibly dehydrated.

Periodically, but not less than once an hour, the person(s) responsible for safety of the tiyul should monitor every individual for signs and symptoms of dehydration and ensure that fluids are being drunk regularly. In addition, a buddy system should be implemented where each buddy participant can help remind and check on the other for potential (hydration) problems. Each individual can also observe the color of his or her own urine to detect for possible dehydration. The darker the color, the less hydrated the body. If you are not urinating after several hours or are unable to urinate at all, this may indicate a more severe level of dehydration.

Going to the hospital for intravenous fluids is an indication of inadequate planning or supervision that must be avoided.

Additional Resources:
http://ksi.uconn.edu/emergency-conditions/heat-illnesses/exertional-heat-stroke/
http://www.hydrationcheck.com/wall_chart.php

4

Wear loose-fitting, absorbent or moisture-wicking clothing.

Hikers MUST wear clothing made of a fabric that "breathes." The type and amount of clothing worn can have a major impact on heat dissipation during hiking. Clothing generally represents a layer of insulation that imposes a barrier to heat transfer from the skin surface. When clothing interferes with the evaporation of sweat from the skin and cooling efficiency is reduced, skin and core temperatures will increase. For activity in extreme heat in the desert, loose-fitting, light-colored clothing (cotton is best) covering the entire body is optimal.

When hiking in daylight, wear a hat at all times in order to reduce heat absorbed from solar radiation. For best protection, the hat should have a UPF standard of very good (25-35) or excellent (40-50).

Wearing "waterproof" clothing or clothing made out of a material such as nylon, that retains heat and does not allow the body to evaporate sweat freely and normally, is very dangerous. (For the same reason, wearing multiple layers of clothing, based on the erroneous notion that they help keep the body cool, is also not advisable.)

This requirement should be included in the packing list that is sent from the yeshivot/seminaries and tour companies to the parents and tour participants so they can buy and pack the proper clothes for their time in Israel.

5

Ensure adequate sleep. This is a critical point! Sleep at least 6-8 hours every night, preferably under comfortable environmental conditions. Sleep loss has been shown to impair the body's ability to regulate body temperature adequately.

Jet lag impedes quality sleep. Being away from home and parents for the first time in a foreign country is exciting and impedes quality sleep. Other factors can further impede adequate rest such as: sleeping in a narrow, uncomfortable, and unfamiliar bed; sleeping outdoors for the first time; and trying to avoid biting bugs in the desert or woods at night. Additionally, two or more nights in a row of inadequate sleep is dangerous if everyone is hiking in a desert or woods for a number of hours and **especially if the desert hike will take more than one day.** Failure to be aware of this factor can be hazardous. Additionally, two or more nights in a row being with other young adults in the same situation can add to the excitement, further impeding quality sleep.

6

Make certain the Wet Bulb Globe Temperature (WBGT) Index is below 89.0°F (31.7°C). The WBGT is not the same as a simple temperature measurement. The WBGT measures the heat stress in direct sunlight and takes into account: temperature, humidity, and heat from the sun. There are consumer handheld devices to measure the WBGT. The WBGT index assumes everyone has sufficiently and properly been acclimated over the minimum 14-day period. Additionally, if other heat illness-related factors are present (e.g., lack of quality sleep, previous day(s) exertional hiking, improper clothing, hiking during the hottest part of the day, pace of the hike, incomplete recovery from the prior day's hike, participants out of shape/overweight, or experiencing an underlying illness), consider hiking only when the WBGT is at even lower levels.

In instances when a WBGT monitoring device is unavailable, use Chart A below. Note: these are estimates, derived only from using temperature and relative humidity. Also, Chart A assumes a very clear sky (maximal solar load), and atmospheric pressure of 1ATA (760 mmHg). Depending on the radiant heat load from the sun and the wind, the actual WBGT reading could be different from what is on the chart.

- **After determining the WBGT using your handheld device, or Chart A, refer to Chart B below for the recommended Work/Rest Cycle and Water Intake Per Hour:**

CHART A: FAHRENHEIT

Wet Bulb Globe Temperature (WBGT) from Temperature and Relative Humidity

Relative Humidity (%) \ Temperature in Degrees Fahrenheit	68.0	71.6	75.2	78.8	82.4	86.0	89.6	93.2	96.8	100.4	104.0	107.6	111.2	114.8	118.4	122.0
0	58.6	60.9	64.3	65.5	67.7	69.9	72.1	74.3	76.4	78.5	80.6	82.6	84.7	86.6	88.6	90.5
5	59.6	62.1	65.6	67.0	69.3	71.7	74.0	76.4	78.6	80.9	83.1	85.3	87.5	89.9	92.1	94.2
10	60.7	63.3	66.9	68.4	70.8	73.3	75.8	78.2	80.7	83.0	85.5	88.0	90.3	92.8	95.1	97.6
15	61.7	64.5	68.1	69.6	72.2	74.8	77.4	80.0	82.6	85.2	87.8	90.2	92.8	95.4	98.0	
20	62.7	65.6	69.4	70.9	73.6	76.3	79.2	81.8	84.5	87.1	89.8	92.5	95.2	97.8		
25	63.8	66.7	70.5	72.2	75.1	77.8	80.6	83.4	86.2	89.0	91.8	94.6	97.4			
30	64.8	67.6	71.7	73.4	76.3	79.2	82.1	84.9	87.8	90.8	93.6	96.6	99.4			
35	65.6	68.6	72.7	74.6	77.5	80.5	83.5	86.4	89.4	92.4	95.3	98.3				
40	66.7	69.6	73.8	75.7	78.8	81.8	84.8	87.8	90.9	94.0	97.0					
45	67.5	70.6	74.8	76.8	79.9	83.0	86.1	89.2	92.3	95.4	98.6					
50	68.4	71.5	75.8	77.8	81.1	84.1	87.4	90.5	93.7	96.9						
55	69.3	72.4	76.7	78.8	82.1	85.3	88.5	91.9	95.1	98.3						
60	70.1	73.3	77.7	79.8	83.2	86.4	89.8	93.1	96.3	99.6						
65	70.9	73.8	78.6	80.9	84.2	87.5	90.8	94.1	97.5							
70	71.7	75.0	79.5	81.7	84.9	88.6	91.9	95.3	98.6							
75	72.4	75.9	80.3	82.7	86.1	89.6	92.9	96.4								
80	73.2	76.7	81.2	83.6	87.1	90.4	93.9	97.4								
85	74.0	77.4	82.0	84.5	88.0	91.5	94.9	98.5								
90	74.7	78.2	82.9	85.3	88.9	92.3	95.9	99.4								
95	75.5	78.9	83.6	86.1	89.6	93.2	96.8									
100	76.1	79.7	84.4	86.9	90.5	94.1	97.7									

NOTE: This chart is calculated using temperature and humidity, assuming a very clear sky (maximal solar load), and atmospheric pressure of 1ATA (760 mmHg). Chart A was developed by Professor Yoram Epstein to be used in Ariel's Checklist for hikers in Israel.

CHART A: CELSIUS

Wet Bulb Globe Temperature (WBGT) from Temperature and Relative Humidity

Relative Humidity (%) \ Temperature in Degrees Celsius	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
0	14.8	16.1	18.0	18.6	19.8	21.1	22.3	23.5	24.7	25.8	27.0	28.1	29.3	30.3	31.4	32.5
5	15.3	16.7	18.7	19.4	20.7	22.0	23.3	24.6	25.9	27.2	28.4	29.6	30.9	32.2	33.4	34.6
10	16.0	17.4	19.4	20.2	21.6	23.0	24.3	25.7	27.1	28.4	29.7	31.1	32.4	33.8	35.1	36.4
15	16.5	18.0	20.1	20.9	22.4	23.8	25.2	26.7	28.1	29.6	31.0	32.4	33.8	35.2	36.7	38.1
20	17.1	18.7	20.8	21.6	23.1	24.6	26.2	27.7	29.2	30.6	32.1	33.6	35.1	36.6	38.2	39.7
25	17.6	19.3	21.4	22.3	24.0	25.5	27.0	28.6	30.1	31.7	33.2	34.8	36.3	37.9	39.5	
30	18.2	19.8	22.0	23.0	24.6	26.2	27.8	29.4	31.0	32.7	34.2	35.9	37.4	39.1		
35	18.7	20.3	22.6	23.6	25.3	26.9	28.6	30.2	31.9	33.5	35.2	36.8	38.5			
40	19.3	20.9	23.2	24.3	26.0	27.6	29.4	31.0	32.7	34.4	36.1	37.8	39.5			
45	19.7	21.5	23.8	24.9	26.6	28.3	30.1	31.8	33.5	35.2	37.0	38.7				
50	20.2	22.0	24.3	25.5	27.3	29.0	30.8	32.5	34.3	36.1	37.9	39.6				
55	20.7	22.4	24.8	26.0	27.8	29.6	31.4	33.3	35.0	36.8	38.6					
60	21.1	22.9	25.4	26.6	28.4	30.2	32.1	34.0	35.7	37.5	39.4					
65	21.6	23.2	25.9	27.1	29.0	30.9	32.7	34.5	36.4	38.2						
70	22.1	23.9	26.4	27.6	29.4	31.4	33.3	35.1	37.0	38.9						
75	22.5	24.4	26.9	28.2	30.1	32.0	33.8	35.8	37.7	39.5						
80	22.9	24.8	27.4	28.7	30.6	32.5	34.4	36.3	38.2							
85	23.3	25.2	27.8	29.2	31.1	33.0	35.0	36.9	38.9							
90	23.7	25.7	28.3	29.6	31.6	33.5	35.5	37.5	39.5							
95	24.2	26.1	28.7	30.1	32.0	34.0	36.0	38.0	40.0							
100	24.5	26.5	29.1	30.5	32.5	34.5	36.5	38.5								

NOTE: This chart is calculated using temperature and humidity, assuming a very clear sky (maximal solar load), and atmospheric pressure of 1ATA (760 mmHg). Chart A was developed by Professor Yoram Epstein to be used in Ariel's Checklist for hikers in Israel.

CHART B

Heat Stress Category (WBGT)	Moderate Work		Hard Work	
	Work/Rest Cycle	Water Intake Per Hour	Work/Rest Cycle	Water Intake Per Hour
White ≤76.9°F (≤24.9°C)	60/15 MINUTES	300 ml (1/3 qt)	40/20 MINUTES	500 ml (1/2 qt)
Green 77-81.9°F (25-27.7°C)	60/15 MINUTES	750 ml (3/4 qt)	40/20 MINUTES	1000 ml (1 qt)
Yellow 82-84.9°F (27.8-29.4°C)	40/20 MINUTES	1000 ml (1 qt)	30/30 MINUTES	1000 ml (1 qt)
Red 85-88.9°F (29.5-31.6°C)	30/30 MINUTES	1000 ml (1 qt)	**Exercise is forbidden. Very high risk for heat casualties.**	
Black ≥89°F (≥31.7°C)	**Exercise is forbidden. Very high risk for heat casualties.**			

- Chart B was developed by Professor Yoram Epstein to be used in Ariel's Checklist for hikers in Israel.
- Environmental heat stress categories are given in Wet Bulb Globe Temperature values.
- These are minimum rest periods. You may plan for more rest but not less.
- Fluid recommendations are just general guidelines and may vary based on many factors. People should monitor individual fluid needs.

Warning!! Do not read Chart B in isolation. These guidelines are for healthy, relatively fit hikers. For novice, less fit, un-acclimated, sleep-deprived, or overweight individuals, the tour leader should refer to Moderate Work as Hard Work.

Cancellation or Delay of Hike

- If the WGBT is ≥89.0°F (31.7°C), recommend cancellation or delay of hike until cooler.
- If the hikers are novices and not fit, recommend cancellation or delay of hike until the WBGT drops to <85.0°F (29.5°C).

7

Ensure adequate work/rest cycles - This is a key factor against overheating. During exercise when the ambient temperature is high, the body produces heat at a rate that is usually in excess to the rate of heat dissipation. The only way to cope with this situation is to allow adequate rest periods during exercise (see Work/Rest Cycle in Chart B above). Even if all the participants are in good shape and no other risk factors exist, if the WBGT is 83.0°F (28.3°C), for example, there should be rest (in the shade preferably) at least 20 minutes for every 40 minutes hiked. If other heat illness-related factors are present, e.g., lack of quality sleep, previous day's exertion, improper clothing, hiking during the hottest part of the day, incomplete recovery from the previous day's hike, pace of the hike, participants are out of shape/overweight, or are experiencing an underlying illness, etc., the resting period must be increased or occur more frequently. Using the same example of the WBGT at 83°F, if a few of the factors exist, the hikers should rest 30 minutes for every 30 minutes hiked. **The more rest, the better/safer the experience is for everyone.**

8

Avoid hiking in the desert at the hottest part of the day or, at a minimum, greatly extend the length and frequency of the rest periods. Plan to hike during the early hours of the day when ambient conditions are more favorable, with lower temperatures and less intense solar radiation.

9

Bring a variety of resources to help anyone suffering from the heat. Ensure there is at least one person who is adequately trained in medical assistance, particularly heat-related illness, and educate yourself on the common signs and symptoms of heat illness. Bring at least one portable tent or bed sheet to create shelter from the sun when there isn't any other shelter. Also, cooling towels can be helpful.

In case of suspected heat exhaustion, attempt to cool and hydrate the individual *immediately*. If exertional heat stroke is suspected (disorientation, confusion, balance issues, collapse) and the individual has to be cooled immediately, find or provide shade and use copious amounts of water (for example, from a river or creek, if available). The hike leader should ensure that excess water is present. This has proven to be very effective under field conditions. If it is known that copious water will not be immediately available, the hike leader should carefully plan either to 1) ensure water refill stations are strategically located throughout the hike or 2) alter dramatically the route or intensity of the hike prior to the start of the expedition to ensure that heat illness risk is at a minimum. Remember, in many cases, there are no warning signs for EHS; hence, precautions must be taken in advance.

In the event of heat stroke, first attempt to call for help using a satellite phone or cell phone, remove the individual's clothing, and then begin cooling the body while wetting it. Consider carrying a lightweight tarp or sheet for protection from the sun; additionally, consider bringing along towels for wetting and fanning to help hasten water evaporation which reduces body temperature. Any hikers with suspected heat illness, especially heat stroke, should be cooled down immediately and evacuated to a nearby medical center. Flares and loud, piercing whistles should be on hand to help first responders locate the hiking group in case other methods of search and rescue fail.

10

Emphasize repeatedly to everyone before and during the hike that it is perfectly fine, and actually mandatory, to speak out at any time if they are not feeling well. Hikers must feel completely comfortable speaking their mind if they believe their health is at risk. Safety is always the most important aspect of any hike. As an acclimatized and fit hiker, the leader may experience environmental conditions very differently from the participants. Furthermore, individuals who feel sick or have an underlying illness or medical condition that may put them at greater risk, should tell the hike leader and refrain from all exercise. Remember, ending a tiyul (at any time before or during the hike) is always better than compromising anyone's health or, G-d forbid, any person's life. Hiking should be fun, so let's do everything we can to ensure everyone's safety and enjoyment.

Korey Stringer Institute
University of Connecticut
Preventing sudden death in sport

Advisor: **Robert A. Huggins**, PhD, ATC
Advisor: **Douglas J. Casa**, PhD, ATC

Advisor: **Professor Yoram Epstein**,
Heller Institute of Medical Research,
Sheba Medical Center, Tel Hashomer, Israel