If you deploy to Operation Iraqi Freedom next summer, before your Soldiers cross the border and head north, they will face an enemy that has defeated a significant number of Soldiers moving into theater this year. Between July and August 2004, the hottest months in Kuwait, 134 Soldiers were reported as heat casualties in Kuwait and were lost from training. It is likely that the actual number is underreported by as much as 80 percent, and the true number of injured Soldiers may be as much as five times higher. The rate of reported heat injury per week peaked at 20 per 10,000 Soldiers in mid-July. Each heat casualty was lost to his or her unit for two or more days out of an already tight training schedule. Three of the Soldiers were likely lost to the fight permanently. These three developed heat stroke, two from the same unit within days of one another. They survived but were evacuated from theater, unlikely to return.

As the medical brigade in theater, we know in advance the schedule of units moving into the northern Kuwait camps. We could tell regardless when a new infantry unit moves into theater because of the bump in the number of heat injuries. Level II medical facilities at the camps typically began seeing heat casualties within the first week of the unit’s arrival. The Soldiers we interviewed reported that they felt that exposure to heat in the summer months in the United States had prepared them sufficiently for deployment to Kuwait and Iraq. Nothing could be farther from the truth, as the conditions in the desert of Kuwait and Southern Iraq are not duplicated anywhere in the United States. We also heard more than once, “But I was drinking water, doc.” Adaptation to this harsh desert environment is more than a matter of simple hydration. Water consumption is only one part of the process.

Soldiers in the desert are exposed to environmental heat stress through a combination of factors. Soldiers training vigorously in desert environments wearing individual body armor (IBA) and Kevlar generate heat from burning up to 6,000 kilocalories a day. (One kilocalorie is the heat energy needed to raise one liter of water one degree Celsius.) The Soldiers generate a great deal of heat, but unfortunately, desert conditions do not favor heat loss, which normally would occur through a combination of four different mechanisms.

Convection is heat transfer by the movement of a gas or liquid over the body.
This is the primary means of the terrific heat loss that occurs with prolonged exposure of Soldiers to cool or cold water. A breeze feels cool in part from this effect. In the desert, the air may be as much as 30 degrees higher than the Soldier’s body temperature. This July, the average temperature in the major Kuwait training range was 115 degrees (46°C) with a high of 135° (57°C), and the wind was typically up to 15 mph - a combination that results in significant heat stress.

Radiation is heat transferred from objects whose temperature is hotter than the Soldier: the sun, sky, large metal objects, or the ground. In Kuwait, from April to October the UV Index (ultraviolet index, a measure of the sun’s irradiance in watts per meter squared) generally is in the “very high” to “extreme” range (8-11) and is typically 10 or 11. The mean UV Index across the southern United States in August is 7-9. The Soldier gains heat from the sun, from the heated desert sand, and the metal vehicles.

Conduction of heat is the transfer of heat through direct contact with an object. In the desert sands, heat is conducted through the ground and various combat equipment. For example, direct contact with surfaces exceeding 114 degrees produces pain and temperatures above that will burn in a very short period of time.

Heat loss from the body occurs primarily through the evaporation of sweat. The dry air of the desert, where the relative humidity is 10 percent, promotes the evaporation of sweat. However, sweat trapped near the body in cotton undergarments and uniform blouses below the IBA cannot evaporate due to lack of air circulation. While adequate hydration insures that the Soldier will sweat enough, the mechanism is thwarted by a saturated uniform. In Soldiers who have not acclimatized adequately, sweat production will actually decline if the skin is wet, further blunting these cooling mechanisms.

Several large infantry and combat support units trained in Kuwait this summer in preparation for operation in Iraq. Most suffered significant effects from the heat. One unit evacuated as many as 10 percent of its Soldiers to the Level II facility in a single day.

However, medical surveillance of armed forces in Kuwait (conducted by 8th Medical Brigade) indicates that the 2nd Brigade Combat Team (BCT) of the 2nd Infantry Division was able to avoid significant heat injury altogether. Under the command of Colonel Gary Patton, the 2nd BCT deployed to Kuwait in late summer of 2004 – peak months for heat injury. While a small number of Soldiers received intravenous fluids on firing ranges for treatment of volume depletion, there were no reported cases of heat exhaustion or heat stroke. The unit’s overall approach to heat injury prevention has been primarily based on acclimatization.

Acclimatization is the process by which the body gradually becomes physically conditioned to working under the extreme temperatures of a harsh environment. The human body adapts to extreme heat in a number of ways. First, the body’s basal metabolic rate declines during acclimatization. As a result, the baseline core temperature also lowers. The body sweats much sooner in reaction to heat exposure – at a higher rate and from more of the body surface (for example from the arms and legs.) The blood flow to the skin increases and thereby allows heat to escape by evaporation and convection. Second, the heart beats more slowly, while simultaneously pumping a greater volume of blood. Third, the blood pressure becomes more stable and the function of the heart muscle improves. Finally, fluid balance as regulated by the brain becomes more efficient as the thirst mechanism becomes sensitive. These mechanisms result in a higher total body water concentration and, ultimately, greater conservation of fluid.

The process of acclimatization for the Soldiers of the 2nd Brigade, 2nd Infantry Division began in Korea before their deployment. They trained all summer in Korea in the field, though high temperatures and high humidity, in IBA with SAPI (small arms protective insert) plates and Kevlar. On a typical August day in Korea, the temperature is 88 degrees (31°C) and the relative humidity ranges between 60 and 90 percent. When the unit reached Kuwait, they began split cycle operations. All units were given a few days off to get settled and recover from jet lag. Administrative meetings and equipment issue occurred in air conditioned tents.

### Table 1 - Strategies for Heat Acclimatization

1. Mimic the deployment climate if possible.
2. Ensure adequate heat stress in preparatory training:
   a. Train to the point of sweating
   b. Using exercise and rest to modify the heat strain
   c. Schedule 4-14 days of heat exposure
   d. Train in the heat at least 100 minutes a day
3. Begin at least one month prior to deployment:
   a. Be flexible with training
   b. Build confidence in Soldiers
   c. Pursue optimum physical fitness in the current climate
   d. Integrate acclimatization into training schedule
4. On arrival to desert:
   a. Start slowly at reduced training intensity and duration
   b. Increase heat exposure and training volume gradually
   c. Acclimatize in the heat of the day
   d. Train in the coolest part of the day
   e. Use work/rest cycles or interval training
   f. Ensure that Soldiers eat and sleep adequately
   g. Provide special monitoring for Soldiers at increased risk
      i. Poor physical training
      ii. Excessive body weight
      iii. Skin conditions like severe acne
      iv. Soldiers on medications
      v. Soldiers with other illnesses (“cold” or “stomach flu”)
      vi. Soldiers with previous heat injury

When training commenced, it was conducted from 0400-1100, breaking every afternoon, and then resuming in the cooler, early evening hours. Maintenance operations were also conducted at night, as it was too hot to work around heavy metal during daytime. Soldiers deployed in excellent physical condition, and continued fitness programs were conducted in early morning and evening, scheduled around other training.

Soldiers received personal training on the heat threat. They learned to recognize the symptoms of early heat insult in themselves and their fellow Soldiers, and were empowered to take action. Leaders saw many examples of Soldiers taking buddy actions at the first sign of heat impact, rather than allow it to develop into a serious casualty. For example, Soldiers were allowed to check themselves off of the firing line to sit in the shade when they began to feel effects of heat.

An untrained, ill-informed Soldier might have tried to “Soldier” through this, and become a heat casualty. In fact, research has demonstrated that the poorly conditioned Soldier and the exceptionally fit Soldier are both at risk to become heat injuries. The former becomes a heat casualty from poor conditioning. The latter becomes a casualty from attempting to allow excellent conditioning to compensate for inadequate acclimatization. Medical providers and key leaders in the 2nd BCT are well aware of the pitfalls of both profiles.

The unit also took the usual steps to stress hydration. Every Soldier was issued a camelback. It was a mandatory part of the uniform for the months prior to deployment while still in Korea. In addition, cold water and Gatorade were available to the Soldiers. Importantly, these disciplines were modeled by the leaders at every level. An additional example of leadership emphasis was the stress placed on the use of lip balm and sunscreen. Special unit patches were sewn on the desert camouflage “boonie” caps to encourage all Soldiers to wear them to reduce exposure to direct sunlight. Strategies for successful acclimatization are summarized in Table 1.

Overall, the 2nd Brigade Combat Team took more time to acclimatize and thus was better prepared for the desert environment than any other unit we observed in the summer of 2004. The strategy they applied was one that could be easily duplicated by any unit deploying to the desert, particularly in the summer months. It is based on acclimatization, a process that begins at home station well before the mobilization process. The key leaders in 2nd BCT aggressively planned for acclimatization of all personnel in their training schedule both in Korea and in Kuwait. Command emphasis on basic measures to reduce unnecessary heat exposure is necessary for overcoming the heat threat and involves empowering Soldiers to monitor their own progress to the greatest extent possible using the buddy system. Heat injury prevention begins with effective leadership role-modeling behavior. In a combat environment with so many unpredictable hazards, heat injury prevention is a force multiplier worthy of command emphasis.

Useful References

- Medical Aspects of Harsh Environments, Volume 1. Pandorf KB, Burr

 nineteenth-century military officer who served as Surgeon General of the United States Army. He is a veteran of Desert Shield/Desert Storm and as a civilian, is the Chief of Gastroenterology at Loma Linda University in Loma Linda, California.

Colonel Chuck Callahan is the Chief of Professional Services of the 8th Medical Brigade (Forward) in Kuwait. He is a former infantry officer, who is currently stationed at Tripler Army Medical Center where he serves as Chief of the Department of Pediatrics and the Pediatric Consultant to the Surgeon General.

Captain Matt Hing is a graduate of Uniformed Services University of the Health Sciences, Class of 2001. He completed internship in Family Practice at Tripler Army Medical Center in 2002. He is currently assigned to the 2nd Brigade Combat Team, 2nd Infantry Division as the Brigade Combat Team Surgeon.