Preventing Heat Injuries:

The Commanders' Guide

FOREWORD

The **incidence** of heat injuries has seen a general decline since 1987. It has, however, remained fairly constant at about 3.5 cases per 1000 population since 1995. The **"high risk" units** are the Training Schools (BMTC, SISPEC, OCS), Infantry units and Guards units. This is because of the transitional status from the comfort of civilian life to the tough military training of the basic trainees in BMT, while the Infantry and Guards units generally have a higher training intensity. In 1998, OCS and SISPEC have seen the largest increase in the percentage of heat injury cases amongst all units. The **time of the year** with the highest incidence of heat injuries are April to May which coincides with the period of the year with the highest Wet Bulb Globe Thermometer (WBGT) readings which represents an index of heat and humidity. The pattern for the **time of the day** with the highest incidence of heat injuries is a bimodal one with peaks at 0800 to 0959hrs and 1600 to 1759hrs. These peaks straddle the 1130 to 1530hrs period in which formal physical training is currently prohibited as stipulated in the TSR. In the early night hours of 1800 to 1959hrs, we have the third highest number of heat injuries.

Education of our Commanders and the proper supervision of training and heat injury prevention measures are key factors in preventing heat injuries from occurring. We hope that the material presented in this book will enable our Commanders to equip themselves with the knowledge required.

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Chapter 1
WHAT ARE HEAT INJURIES?

In this chapter:

- Definition
- Types of Heat Injuries

DEFINITION

A heat injury occurs when a soldier engages in physical activity to the extent where the heat production within his body exceeds its ability to lose heat adequately. This results in a rise in inner body (body core) temperature to the levels at which normal body functions are interfered with. This may lead to temporary or permanent disturbances in bodily functions.

Heat injuries kill

The three types of heat injuries:

- **Heat cramps** - are the result of excessive salt and water losses due to profuse sweating in soldiers whose bodies are attempting to rapidly lose heat. It presents as intermittent muscle cramps, which usually occur on the legs (calves and thighs).
- **Heat exhaustion** - is a more severe form of heat injury. It implies a significant loss of water from the body. The signs and symptoms are:
  - weakness,
  - exhaustion,
  - headaches,
  - dizziness and
  - profuse sweating with an elevated body temperature.
- **Heat stroke** - is the most serious form of heat injuries. It manifests with a body core temperature of 41^{o} Celsius and above. Soldiers may present with confusion, aggressive behaviour and may progress into a comatosed state. ***It is a medical emergency!***

Chapter 2
WHAT CAUSES HEAT INJURIES?

In this chapter:

- **Heat Gain and Heat Loss**
- **Acclimatisation**
- **Dehydration**
- **Physical Indicators of Dehydration**

Heat Injuries result from a failure in the system

The human body gains heat continuously through various channels. This gain is even more significant in a soldier exerting himself physically in a hot and humid environment. There are many processes through which body heat is lost. A soldier is able to regulate his body temperature and stay safe. However, factors such as acclimatisation, hydration and rest play a very important role. Lack of acclimatisation, poor physical fitness, obesity, illness and a lack of instinct to drink water adequately are major risk factors for heat injuries. These are all the factors, which may be present in a newly recruited soldier.

HEAT GAIN AND HEAT LOSS

HEAT GAIN

Heat gain by the body is due to:

- Heat generated within the body by muscle activity and other body functions. An example of work intensities of military tasks, as defined by US Army, is shown in Appendix A.
- Direct radiation from the sun's rays
- Heat transfer from the air
- High humidity which hinders the cooling of the body through the evaporation of sweat

HEAT LOSS

The body loses heat through:

- Evaporation of sweat
- Radiation of heat outwards from the body surface

- Transfer of heat from the skin to the surrounding air (convection)
- Breathing
- Urination

BODY HEAT REGULATION : "STAYING SAFE"

- In order for the body to lose heat adequately, regular rest in a cool or shady environment is also required. This allows the heat loss process to keep up with and "overtake" the heat gain process. Concurrent hydration is critical.
- High air temperature, high relative humidity and exposure to the sun make it difficult for soldiers to regulate their body temperature.
- Excessive clothing will prevent heat from being lost to the environment.
- When the environmental conditions and/ or clothing prevent the heat generated within the body from being dissipated, the body temperature will rise significantly. If this cycle is not stopped, heat injuries will occur.
- The heat injuries are commonly associated with hard work in hot weather. However, they can also occur in relatively cool conditions when soldiers are dressed in heavy protective clothing.
- The same principles apply at night as well. If there is inadequate cooling of the body during physical exertion at night, heat injuries can occur.

The soldiers in their first 6 months of training are at higher risk

Acclimatisation stays with the soldier wherever he goes

ACCLIMATISATION

WHAT IS ACCLIMATISATION?

- Acclimatisation is the ability of the body to undergo physiological adaptations so that the soldier is able to cope better with the environmental and physiological heat stress.

FACTS ON ACCLIMATISATION

- Newly enlisted soldiers (e.g. BMT recruits) are generally not acclimatised adequately to heat. Social habits and norms such as the extensive availability of air-conditioning contribute to this observation. Therefore, soldiers in their first six months of training are at higher risk of heat injuries.
- Heat acclimatisation increases sweating (by 50-100%) and this enhances the evaporative cooling capacity of the body. Increased sweating, however, can lead to dehydration. As such, the soldiers can adapt to heat (i.e. they can acclimatise), but not to dehydration.
- Physically fit soldiers acclimatise more rapidly than the less fit.

DEHYDRATION

WHAT IS DEHYDRATION?

- Dehydration refers to the reduction of body water content to that below the normal physiological (and safe) level. Some degree of dehydration is inevitable when working in a hot and humid environment. This is due to water loss through sweating.

FACTS ON DEHYDRATION

- New soldiers are more prone to dehydration as they generally tend not to have a "drinking habit". They tend to drink water only when extremely thirsty and this is too late. Having not trained regularly in hot and humid conditions, they do not have an "instinct" to drink water beyond the point of thirst. They must be trained to do so.
- An individual under stress in a hot and humid environment may not sense dehydration at the early stages.
- Soldiers may maintain themselves at about 1.5 litres below their ideal hydration status without any sense of thirst, thus exhibiting "voluntary dehydration".
- The body may suffer dehydration of 1-2% of body weight and perform less effectively before the feeling of thirst is even noticed.
- Caffeine and alcohol beverages have diuretic properties, which increase the risk of dehydration through increased urination.
- Heat, wind and dry air increase the body's water requirements through loss of body water as sweat.
- At high altitudes (>2000 metres above sea levels) there is an increase in the rate of breathing due to reduced oxygen levels. The dryness of the atmosphere also increases water loss through breathing. However, the feeling of thirst becomes less felt, and the desire to drink is suppressed at an altitude.

Thirst is not a reliable indicator of dehydration. It may be too late.

New soldiers must form a "drinking habit"

- Soldiers often become dehydrated while travelling, especially if the trip is long. Water consumption is as important during travel as any other time.
- Soldiers who are well trained, fit and fully hydrated tolerate heat exposure more effectively than the less fit and dehydrated soldiers.

EFFECTS OF CLOTHING ON DEHYDRATION

- Excessive clothing can contribute to dehydration by impeding evaporation of sweat. This causes the body to produce more sweat in order to cool the body. This leads to rise in body temperature.
- Military clothing are worn for camouflage, for load carriage (i.e. for pockets) and for protection against wounds and insects.
- Insulation is not desirable but is an inherent characteristic of the protective clothing and the insulation decreases heat loss.
- Multiple layers of clothing, even if thin, will provide a considerable amount of insulation and, therefore, should be avoided.

As commanders, you must understand the physical indicators of dehydration. This will help you in the identification and confirmation of the level of dehydration in your soldiers:

Physical Indicators of Dehydration	
Skin	◆ Less elastic. ◆ On pinch test, the skin regains its shape slowly
Urine	◆ Reduced in volume and frequency ◆ Concentrated and darker
Sweat	◆ Higher sweat rate ◆ If sweat production suddenly stops despite continued heat exposure, dehydration has reached a severe level
Physical Work Capacity	◆ Reduced endurance ◆ Accelerated onset of fatigue
Heart Rate	◆ Faster heart rate ◆ Work seems increasingly more tiring and increases the heart rate rapidly
Appetite	◆ Suppressed appetite ◆ Food intake is reduced during water deprivation, and water intake reduced during starvation
Mental Indicators	◆ Less alert ◆ Increased lethargy ◆ Difficulty in concentrating ◆ Confusion ◆ Irrational behaviour

Dehydration affects physical as well as mental capability

Chapter 3
"SOLDIER AT RISK" PROFILE

Timid soldier who would not report even if not feeling well

Poor state of health

Wearing thick clothing or additional layers of clothing in hot weather

Training whilst having fever or suffering from other illness e.g. diarrhoea, flu

Not having sufficient rest before, during and after the activity

Not drinking enough water

Newly enlisted soldier

The well motivated soldier who will not "fall-out" easily

Previous victim of a heat disorder

Performing strenuous exercises on a hot and humid day

Obese

Loss of fitness/ acclimatisation (e.g. after block leave)

Chapter 4
PREVENTING HEAT INJURIES

In this chapter:

- **Heat injury prevention factors**
- **6 Do's for Prevention of Heat Injuries**
- **Urine Guide**
- **Risk Recognition and Management**

Heat Injuries are totally preventable. When a heat injury occurs, it is an indication of failure in one or more components of the prevention system. This makes prevention at commander's level even more important. A good understanding of how to prevent heat injuries amongst all commanders will go a long way towards the reduction of the incidence of heat injuries. The following are important factors in prevention of heat injuries:

Heat injuries are preventable

HEAT INJURY PREVENTION FACTORS

- Acclimatisation
- Hydration
- Work rest cycle
- Shade
- Clothing

ACCLIMATISATION

HOW DOES ONE ACCLIMATISE?

- Acclimatisation to heat involves repeated exposure to heat, sufficient to raise the core body temperature by at least 1^{O} Celsius and to induce moderate to profuse sweating.
- During the first two days of heat exposure, light activities would be appropriate. By the third day of heat exposure, 3 km runs at the pace of the slowest participant are feasible.

Acclimatisation does NOT reduce, and may actually increase, water requirements

- Significant acclimatisation can be attained in 4-5 days. Full heat acclimatisation takes 7-14 days with carefully supervised exercise for 2-3 hours daily in the heat.
- The intensity of exercise should be gradually increased each day, working up to an appropriate physical training schedule adapted for the environment.
- Maintenance-level physical training programmes should be conducted in the morning or evening, during the cooler hours.
- Soldiers should attain the highest possible physical fitness level in a gradual and progressive manner.

HYDRATION

- Soldiers tend not to sense that they are dehydrated and must therefore be consciously reminded to replace the water that is lost through sweating.
- "Voluntary" dehydration can be minimised by providing cool, flavoured water and by providing sufficient time for drinking.
- It is the responsibility of the Commanders to ensure regular consumption of fluids by their soldiers.

TIPS ON HYDRATION

Palatability

- A palatable flavoured beverage will encourage the soldiers to drink fluids in quantities that may match their needs
- Water can be consumed in larger volumes at temperatures between 15-20^{o} Celsius
- The amount carbonated (fizzy) beverages that can be comfortably consumed is less

What to drink:

- Plain water in sufficient volume will help the hydration process
- Providing cool water with added electrolytes is difficult but will be helpful
- If the administration system allows it, attempts should be made to provide cool water with electrolytes. This will especially be useful for poorly acclimatised individuals such as recruits

The international guidelines, as advocated by the US and British Armies are:

- Heat exposure less than 90 minutes - Plain, cool water
- Heat exposure exceeding 90 minutes - cool, suitably flavoured carbohydrate-electrolyte beverage (concentration - no more than 8%, or 2 table spoons of sugar per litre)
- Heat exposure exceeding 240 minutes - Flavoured carbohydrate-electrolyte beverage supplemented with one tea spoon of salt per litre

Water is the most ideal drink

Beyond BMT, the soldier's instinct to drink must be maintained through supervision

What NOT to drink:

- Carbonated drinks (feeling of being bloated)
- Alcohol, coffee, tea (diuretic property)
- Commercially available Oral Rehydration Solutions (unpalatable, designed to replace fluid lost in diarrhoea, but not suitable for use during activities in heat)
- Carbohydrate-electrolyte beverage concentrations greater than 8% (delays water absorption)
- Hot drinks, when cooler ones are available
- Drinks of unknown ingredients

SALT

- For the first few days of acclimatisation, the soldiers may have an increased salt requirement because of an increase in salt loss through sweat.
- Once acclimatised, the soldier should obtain enough salt from his daily meals to make up for the amount lost during sweating.
- The only instance where extra salt should be added is during severe sweating or the early stages of training in a hot and humid climate for the unacclimatised soldiers.

IN THE FIELD

- Recruits must be trained to drink water regularly beyond the point of thirst. Where possible, cool drinks should be provided administratively, especially during high risk activities (e.g. Route Marches).

- Beyond BMT, the soldier's instinct to drink must be maintained through supervision.
- Commanders must ensure that each soldier always has at least one full water bottle in reserve and that he knows when and where water resupply will be available.
- Plan to provide water resupply at intervals of no more than three hours.
- Prevent the heating up of water in jerry cans by reducing direct exposure to the sun.
- Drinking adequately is the soldier's personal responsibility but it is the commander's responsibility to supervise and to make the soldier aware of this.

When shade is available, use it

WORK/ REST CYCLES

- Body temperature can rise rapidly due to the combination of sustained activities and excessive heat. To prevent a dangerous increase in body temperature, heat production must be minimised by reducing the pace of work and increasing the duration of rest. This is especially important in very hot and humid conditions.
- The maximum possible sweat rate (approx. 2 litres/hour) is higher than the rate of water absorption from the gut (approx. 1.5 litres/ hour). This makes the pre-activity hydration and rest during activity even more important.
- The Training Safety Regulations (TSR) provide guidance on work-rest cycles for some specific activities (e.g. Route Marches).

Even dehydrated personnel will continue to produce urine, called "obligatory urine"

CLOTHING

- Soldiers should wear light clothing whenever possible.
- Soldiers should not be allowed to wear unnecessary layers of clothing.

6 Do's for Prevention of Heat Injuries

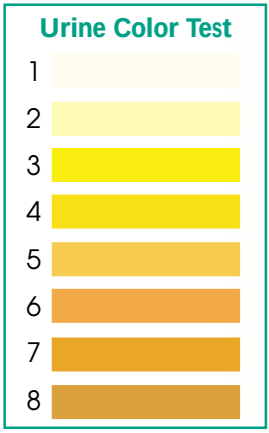
- **Do** drink water until you are no longer thirsty and then a little more
- **Do** rest well before and in between strenuous exercises
- **Do** loosen your clothing while resting
- **Do** report sick if you are not feeling well before, after or during strenuous exercises
- **Do** avoid exercises if medical leave is granted
- **Do** remember the 7R's of the first aid for heat injuries

URINE GUIDE

- If the body is in the water balance, the urine would a pale straw colour.When water loss from the body exceeds water intake, the kidneys need to conserve water, making the urine much more concentrated with waste products and subsequently darker in colour.
- Teach your soldiers to monitor hydration status by noting the colour and volume of their urine.
- Even dehydrated personnel will continue to produce urine, called "obligatory urine".

- When dehydration is inevitable for operational reasons, obligatory water loss in urine can be reduced by avoiding diuretics like coffee and tea.

URINE COLOUR CHART



- Dark yellow urine is a sure indicator that the soldier is dehydrated and that the fluid consumption must be increased.
- The aim is to produce urine no darker than colour 3 of the Urine Colour Chart. Desire to urinate less than twice per day and/ or producing urine darker than colour 3 in the chart indicate severe dehydration; the soldier must start drinking immediately.

RISK RECOGNITION AND MANAGEMENT

- The commanders must be familiar with the Risk Assessment Matrix outlined in the next few pages. It describes the risk factors, remedial actions and commanders' role in preventing the heat injuries.

Minimise risk, maximise performance and results

RISK ASSESSMENT MATRIX

CAUSAL FACTOR	REMEDIAL ACTIONS	COMMAND ACTIONS
Inadequate Physical Conditioning (Lack of Acclimatisation)	◆ All soldiers should be physically prepared for training from day 1. Training must be progressive as per approved syllabus ◆ Additional training is required to prepare the soldiers for tough overseas training e.g. jungle training in Brunei	◆ Commanders should note progress of the soldiers ◆ "Weak" soldiers should be identified when training is conducted. (A "weak" soldier is as described below under "illness") ◆ Remedial training should be conducted for "weak" soldiers
Ignorance of Heat Injury Symptoms	◆ Soldiers must be taught to identify and understand the symptoms of heat injuries, and be familiar with the necessary safety precautions, including 7 R Management Model ◆ Soldiers must be made aware that heat injuries can kill or cause permanent damage to health. It is even more important to know that heat injuries CAN be prevented	◆ Commanders should be well versed in heat injury symptoms and remedial actions ◆ They must teach the soldiers to look out for symptoms of heat injuries, and to take the appropriate remedial actions ◆ All soldiers must be made familiar with 7R management model

Insufficient Hydration	• Soldiers should be trained to make it a practice to drink at least 6 litres of water daily • During hot weather and when training is intense, water intake should be increased up to 10 litres daily • During lunch break, soldiers should be encouraged to drink as much water as possible to replace water loss • During rest periods, soldiers must be encouraged to drink at least 500 ml of water to replace the water loss • Water loss is the heaviest at the end of the day and must be sufficiently replaced, especially when training is to continue at night • It must be emphasised to the soldiers that night training, especially during hot and humid weather, can also cause heat injuries. Water consumption regime should be maintained during night training too	• Constantly remind the soldiers of the need for sufficient water intake • Comply with the water parade prior to conduct of strenuous activities (as per TSR Chapter 3, Section 2, para 11) • Monitor that the soldiers drink enough water during lunch and rest periods. Use the re-supply water containers as an indicator • Be sure of the water supply: it is the most basic need in hot climates

Insufficient Rest	• The human body requires rest t avoid stress and 'overheating' • Mandatory sleep and rest periods are important • More rest periods are required when training in extremely hot and humid weather and in difficult terrain [e.g. during bi-lateral training(Ex Kocha Singa) in Thailand.] • Rest should be encouraged in a shaded area, whenever possible	• Commanders must constantly assess the weather and terrain hazards and their stress on soldiers' conditions • Commanders should be flexible in granting more rest time when circumstances dictate
Illness	• Soldiers who were ill, especially those who had flu or diarrhoea, and those who have not been training due to some physical injuries, would be weaker. They should seek medical advice before being allowed t participate in any strenuous activity • Soldiers should also be asked t declare any current medical problems that may impede their ability to cope with the training, and be asked t seek medical advice	• Commanders should constantly be aware of the physically condition of the soldiers. Those who had recent illness or other physical injuries should be monitored during training • Soldiers who had previous history of heat injuries should be closely monitored

Ineffective Training Program	• Training programmes should avoid stretches of continuous 'high key' physical activities • Distance from barracks to training ground should be taken into account since rushing between the barracks and training areas can tire the soldiers even before the training commences	Proper programming of training is a commander's responsibility
'Gung - ho' soldiers	These soldiers over- estimate their ability to withstand tough training, and hence contribute to their own physical and heat injuries	Commanders should identify such soldiers and restrain them without dampening their enthusiasm

'Timid' Soldiers	These soldiers would not speak up even if not feeling well, for the fear of being 'marked'	Commanders should learn to differentiate these soldiers from the 'idlers and twangers'
Over demanding commanders	These commanders demand more from the soldiers, albeit out of good intentions, to constantly attain "higher standards" e.g. controlled drinking of water during tactical exercises, increased tempo of physical exertion such as moving longer distances at high pace	Commanders should curb such tendencies. Soldiers should be trained within "normal" standards before aiming for "high" standards. Gradual progression, work-rest cycle, and respect for each soldier's individual physical ability are the key factors to be considered when setting the goals

Chapter 5
MANAGEMENT OF HEAT INJURIES

In this chapter:

- General Management
- 7 R Management Model

GENERAL MANAGEMENT

- All soldiers must be familiar with the 7 R Management Model, which is outlined in the next page.
- At the first indication of potential heat stress, get your soldiers to stop training, get into the shade, rest and rehydrate.
- Early intervention is critical.
- Although early symptoms of heat stress can be controlled by rest, shade and hydration, commanders MUST ensure medical evaluation of heat casualties.
- The occurrence of a heat casualty should be considered as a warning sign as the entire unit may be at impending risk.
- As a part of the unit's heat injury prevention requirements, the soldiers must be well trained in the heat injury 7R Management Model.

As soon as the first heat casualty occurs, assess the status of the whole unit

All soldiers must be familiar with the 7 R Management Model

7 R MANAGEMENT MODEL	
Recognise Symptoms	✓ **R**ecognise early signs and symptoms of heat illness: Weakness, tiredness Nausea, vomiting Headache, dizzy Disorientation, confusion Inability to work Red, confused look ✓ When in doubt, treat as a heat injury
Rest casualty	✓ **R**est the heat injury stricken soldier in the shade to cool down
Remove Clothing	✓ **R**emove all clothing
Resuscitate	✓ **R**esuscitate with cardiopulmonary resuscitation (CPR) if the soldier has collapsed (heart beat and/ or breathing stopped) ✓ If not sure about correct technique, get someone who knows
Reduce temperature	✓ **R**educe the victim's body temperature as fast as possible by applying wet towel or by pouring water on his body.
Rehydrate	✓ **R**ehydrate the soldier if he is conscious, by giving him water
Rush to hospital	✓ **R**ush the soldier to the nearest medical facility

Chapter 6
COMMANDERS' ROLE

In this chapter:

- Before Exposure to Heat
- During Exposure to Heat
- After Exposure to Heat

BEFORE EXPOSURE TO HEAT

- Plan the training programme well
- Know your men well and identify those who are at higher risk of heat injuries
- Ensure that your men are well rested and well hydrated (as per TSR chapter 3)
- Ensure that they have had their meals
- Ensure that ill soldiers report to the medical officer
- Check on the attire of the men for excessive layers
- Ensure that a water parade (at least 500 ml) was conducted the night before, not less than 2 hours prior to sleeping
- Ensure that they drink at least 500 ml of water not less than 30 minutes prior to activity

DURING EXPOSURE TO HEAT

- Observe the soldiers for early signs of heat injuries, especially those at higher risk
- Ensure that the soldiers hydrate regularly beyond the point of thirst
- Ensure adequate rest, as stipulated in the TSR
- Ensure that they drink at least 500 ml of water during rest periods to make up for the fluid loss

Soldiers do best what the commanders emphasise

Ensure that ill soldiers report to the medical officer

- Ensure that they drink not less than 1 litre of water during the mid-day pause
- Ensure that there is timely and adequate water resupply and water points

AFTER EXPOSURE TO HEAT

- Observe and check the soldiers for signs and symptoms of impending heat injury
- Send suspicious cases to the medical officer
- Ensure that the soldiers drink beyond the point of thirst after the activity and get adequate rest
- Ensure that the soldier consumes not less than 6 litres of water a day in total, and not less than 10 litres a day during intense training in hot weather

LAST WORDS

- The commander's role and judgement in acclimatisation, training intensity and hydration is of utmost importance in preventing heat injuries.
- The responsibility for soldiers' health safety is heavily dependent on commanders' vigilance and instinct.
- A commander must know his soldiers' weaknesses in order to minimise their risk of heat injury.
- The key to the prevention of heat injury is knowledge and education on the risks, causes, and preventive measures.
- Immediate first aid and evacuation of a soldier suffering from a heat injury is critical.

HEAT INJURIES ARE PREVENTABLE.

Heat injuries are preventable

Work Intensities of Military Tasks

Work Intensity	Activity
Very light	▼ Lying on ground ▼ Standing in Foxhole ▼ Sitting in 3 tonner ▼ Guard duty ▼ Driving a 3 tonner
Light	▼ Clearing rifle ▼ Walking on hard surface/3.7 kmh with up to 30 kg load ▼ Manual of Arms
Moderate	▼ Walking on loose sand/ 3.7 kmh without load ▼ Calisthenics ▼ Walking on hard surface/ 5.6 kmh with up to 20 kg load ▼ Scouting patrol ▼ Crawling full pack ▼ Foxhole digging ▼ Field assaults ▼ Pick and shovel
Heavy	▼ Walking hard surfaces/ 5.6 kmh with up to 30 kg load ▼ Walking hard surface/ 7.2 kmh without load ▼ Emplacement digging

Source:

Sustaining Soldier Health and Performance in Southwest Asia: Guidance for Small Unit Leaders, USARIEM Technical Note 95-1, 1994.

This handbook was developed based on the following references:

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This publication is one of the educational materials of the Army's Heat Injury Prevention Task Force. It was researched and written by the Soldier Performance Centre, with input from the Army's General Staff Inspectorate. Comments are welcome, and should be addressed to:

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