Guidelines for Management of Obstacle Racing Related Medical Emergencies

1. OVERVIEW

Participation in obstacle sports can be athletically challenging and impose significant stresses on the cardiovascular, musculoskeletal and heat regulating systems. Energy demands can be increased by 10x to 15x resting demand. Successful running and negotiating obstacles require adequate acclimatization and training as well as fluid and fuel intake. On-going intensive exercise for several hours is associated with heat generation, high circulating lactate concentration, dehydration, and depletion of ATP. These factors may produce exercise associated collapse, exercise induced hyperthermia and heat stroke, hypothermia, shock, and cardiovascular morbidity (in predisposed individuals).

Each year a small proportion of athletes require hospitalisation for a brief period (up to 24 hours). International obstacle sports events must provide world class medical support comprising first aiders at each obstacle, 15-20 medical professionals (EMS, anesthetists, general physicians, sports physicians, and orthopedic surgeons) and comprehensive support by ambulance services. The competition environment is treated like a wilderness medicine setting.

The primary role of the doctor is to minimize risk to the athlete by identifying those athletes who can be treated with on site and allowed to continue and dispatching more serious cases to hospital. You will not be able to diagnose or cure everyone on site.

Every ambulance must carry a defibrillator and there should be large quantities of ice available to treat exercise associated hyperthermia in warm conditions. If intravenous fluids are required, there should be mobile cardiac ambulances on course.

All doctors should be provided with a simple kit comprising of analgesic medications, aspirin 300 mg tablets, GTN, antihistamine, a salbutamol inhaler, Vaseline gel, and a thermometer. Please bring your stethoscopes but I would not encourage your own kit of supply of drugs.

Most participants with medical conditions will have cuts, abrasions, blisters, or cramps. A small proportion will have present with exercise associated collapse which many first aiders and medical staff may not be familiar with. Exercise associated collapse is due to a combination of dehydration, lactic acidosis, fuel depletion, and vaso-vagal syncope. You can expect approximately 4% of competitors will suffer exercise associated collapse. Most patients can be managed on site; however, 2-4% of all cases require more intensive treatment with intravenous fluids, and aggressive cooling methods which may only be possible in a fully equipped accident and emergency unit environment.

Recommended management guidelines to treat exercise associated collapse are in Appendix 1. Casualties are broadly divided into topical, musculoskeletal, and constitutional. Topical and musculoskeletal problems typically account for 94% of all contacts and 4% of contacts are due to a constitutional problem, including exercise associated collapse.

Note: Most collapsed athletes can be managed with conservative measures.

2. GOALS OF THE DOCTORS

2.1. To provide immediate minor treatment and discharge patients back to the race when it is appropriate to do so.
2.2. To commence treatment and provide guidance or onward referral to medical specialities for care after the event at a location appropriate for the patient and their clinical condition.
2.3. To counsel athletes towards race termination when it is in the interests of their own health and wellbeing.
2.4. To assist those unable to complete the race due to medical reasons in reaching the finish area to collect their belongings, and aid (to a reasonable extent) in their return home.
2.5. To provide lifesaving interventions and transportation to definitive medical care.

3. MANAGEMENT GUIDELINES

3.1. TOPICAL

Blisters and skin abrasion are common. Blisters should only be drained under aseptic conditions and the skin left in place. Subungual haematomas (black nails) should be left to the podiatrists or chiropodists or A&E. Department and may be drained through the nail with a drill or heated needle.

3.2. MUSCULOSKELETAL

Cramps are common and may be severe. Single spasms respond to stretching the relevant muscle often best achieved by assisted walking. Repeated cramps need treatment with fluids and carbohydrate (usually oral). Massage does not help unless fluids are given first.

Very severe cramps in a collapsed athlete may require IV fluids and even IV Diazepam 1-5 mg. (monitor respiration) Magnesium sulphate has also been used (up to 5 grams iv, in 1g boluses over 10-20 mins.) NB- 1 gm Magnesium sulphate is equiv.to 4 mm Mg ++

Bone pain may indicate a stress fracture and the triathlete should be cautioned about continuing. Accurate diagnosis takes time.

3.3. CONSTITUTIONAL

Most athletes falling into this category present with collapse. The most frequent cause of collapse is Exercise Associated Collapse, but other causes of collapse may also occur, for example, cardiac arrest, intracranial haemorrhage, hypoglycaemia, epileptic seizures, anaphylaxis and severe asthma.

3.3.1. EXERCISE ASSOCIATED COLLAPSE (EAC)

3.3.1.1. Pathophysiology

Exercise associated collapse is a term used to describe lack of postural tone that occurs after prolonged exercise, such that the participant cannot walk or stand upright without assistance. This is not synonymous with syncope which is also associated with loss of consciousness and may be associated with a more ominous outcome if treatment is not instituted immediately.

Exercise associated collapse is due to one or a combination of a) fluid and electrolyte loss through sweating; b) fuel depletion within skeletal muscle; c) lactic acidosis; d) altered baroreflexes causing vaso-vagal feature and e) hyperthermia or hypothermia depending upon environmental conditions.

Presenting symptoms include fatigue, muscle cramps, dizziness, nausea, and vomiting, abdominal pain, diarrhoea, feeling hot or very cold. Muscle cramps are due to fluid and fuel depletion and build of lactate within the skeletal muscle. Gastro-intestinal symptoms are due to bowel ischemia since blood is preferentially shunted away from the splanchnic circulation to skeletal muscle during exercise.

3.3.1.2. Assessment

The severity of EAC (other causes of collapse excluded) is graded on the following:

- Mental status (use Glasgow Coma Score)
- Heart rate, blood pressure and respiratory rate measurements (Oxygen saturations from the peripheral regions are not helpful)
- Ability to take oral fluids
- Severity of muscle cramps
- Continuing fluid loss from vomiting or diarrhoea
- Ability to mobilize (i.e. walk about)
- Presence of hypothermia or hyperthermia, which cannot be diagnosed by state of peripheral circulation but requires a RECTAL (CORE) temperature.

Ominous features include altered mental status, epileptic seizures, or neurological signs. ALL PATIENTS WITH THESE FEATURES REQUIRE CORE TEMPERATURE MEASUREMENT. PLASMA SODIUM MEASUREMENT (to check of exercise associated hyponatraemia) IS MANDATORY IF THE TEMPERATURE ALONE CANNOT EXPLAIN THE PRESENTATION. Plasma sodium measurements will be possible at the finish.

3.3.1.3. Management of EAC

1. Fluid redistribution or replacement to improve cerebral or core circulation. Lie patient supine and raise legs. Encourage oral fluids if the patient is conscious and able to drink. Patients who have altered mental status and are unable to drink or are vomiting excessively may require therapy with intravenous fluids provided there is no objective evidence of exercise associated hyponatraemia.
2. Replace body fuel. Sugary drinks or energy bars are useful in individuals who are not vomiting.
3. Treat temperature (see under hypothermia and hyperthermia)
4. Treat plasma sodium (see under exercise induced hyponatraemia).

3.3.2. HYPOTHERMIA

Hypothermia is defined as a rectal temperature below 35^{O}C. Cramps and mental confusion (particularly amnesia) are common. It occurs in slow moving athletes particularly on wet cold windy days. The diagnosis is made on clinical suspicion and by measuring core temperature.

3.3.2.1. Management

1. Strip athlete of wet clothing, dry and wrap in blankets and warm clothing and place in warm environment. Foil blankets over wet kit are useless.
2. Give glucose drink as even mild hypoglycaemia inhibits shivering. Severely confused cases merit iv glucose.
3. Warm drinks if available are helpful as are tent or ambulance heaters on a cold day.

3.3.3. HYPERTHERMIA AND EXERCISE INDUCED HEAT STROKE

Athletes can have a high core temperature while running, especially for shorter distances (under 40 minutes) when they often produce high exercise intensity and commensurately high heat loads. This usually settles rapidly but if it persists may indicate early heat stroke. Exercise induced hyperthermia may be due to ambient temperature, an increase in relative humidity, inadequate acclimatisation and training or hydration status.

Note: All World Obstacle Events must use the Event Alert System, see Appendix 2.

Persisting exertional hyperthermia is defined in triathlete as a rectal temperature above 40^{O}C more than 10 minutes after running. If neurological symptoms develop the diagnosis is heatstroke, a potentially lethal condition with progressive end organ damage and high mortality if not recognised and treated promptly. Heatstroke affects 1 in 10,000 marathon athletes.

Hyperthermia CAN OCCUR IN ATHLETES EVEN ON A COOL DAY and is perpetuated by cramps and shivering. It cannot be recognised from the state of the peripheral circulation since marked dehydration due to excess sweating may cause paradoxical features such as peripheral cyanosis and cool dry skin and shivering which may be misleading. All confused athletes should have a core temperature measurement as part of the initial assessment.

3.3.3.1. Diagnosis

Hyperthermia and confusion is diagnostic

3.3.3.2. Management

Heatstroke is serious and is associated with high mortality if treatment is delayed. Collapsed or confused athletes with hyperthermia should always be treated as potentially progressing to heatstroke and managed promptly with high priority until rectal temp <38^{O}C. Temperature should be lowered within an hour of presentation for the best outcome.

1. Cooling and fanning
2. Sponging the axillae, neck and groin with towels immersed in ice water.
3. Rectal temperature should be taken every 15 minutes until below 38^{O}C.
4. If treatment as listed does not produce a rapid fall in temperature, or the mental state does not improve, consider evacuation to hospital, MAINTAINING COOLING IN THE AMBULANCE AND ON ARRIVAL IN HOSPITAL.

Athletes with rectal temperatures of over 42^{O}C, typically responded to first aid measures instituted by healthcare staff. Cases presenting later in the process, (going directly to hospital) may take much longer to recover, possibly requiring over 48 hours in the intensive care unit. In some cases, athletes with heatstroke required intubation and ventilation.

IMPORTANT: A RECTAL (CORE) TEMPERATURE MUST BE RECORDED ON ANY SICK OR CONFUSED ATHLETES.

Privacy can be obtained while this is done using blankets or screens. If consent cannot be obtained because the athlete is confused or a minor, it is imperative to obtain such a reading, which should be obtained by a senior nurse and/or doctor exercising his/her duty of care. Under these circumstances, it is extremely unlikely a criminal or civil claim of indecent assault or battery would proceed.

3.3.4. EXERTIONAL HYPONATRAEMIA (Water Intoxication)

Exertional Hyponatraemia is a relatively common cause of death in endurance events and presents several hours after the start of the race from excessive fluid intake with headache, mental confusion and often vomiting and in severe cases, epileptic seizures. Core temperature rules out heat-stroke. There may be recognisable features of fluid overload with tight fitting rings, oedema, and clinical evidence of fluid overload (JVP raised, no features of hypovolaemia). It has become a major problem with non-elite athletes drinking too much fluid before, during and after the race.

For most labs, the diagnostic threshold for hyponatremia is any blood [Na^+] below 135 mMol/L regardless of the presence or absence of signs and symptoms.

Hyponatraemia usually presents after several hours of excessive water drinking but can occur with glucose electrolyte drinks. This condition may be aggravated by iatrogenic over- enthusiastic IV fluids, especially IV dextrose or dextrose-saline for "dehydration".

Intravenous fluids should NOT be given automatically to a well hydrated collapsed or confused athlete. Abbot iSTAT point of care analyzers which give sodium levels should be available at the finish area of the race and should be used in suspected cases of hyponatraemia. Assessment includes not only the sodium level but the general state of the patient and whether they are improving or deteriorating. The sodium level can continue to fall for some time after the last fluid intake.

3.3.4.1. Management

When confirmed, in severe cases with epileptic seizures or severe mental changes suggesting worsening cerebral oedema, exercise associated hyponatraemia should be treated with hypertonic saline (to correct sodium to a level of 125 mMol/L over 1-2 hours, and to normal level over the following 2-4 hours.)

It is recommended that a bolus of 100 ml 2.7% saline is administered to raise the sodium quickly and prevent cerebral oedema. Up to 2 further boluses of 100 ml 2.7% saline may be administered at 10 min intervals if there is no clinical improvement. Initiation of treatment in the finish area should only be performed under senior medical supervision while awaiting ambulance transfer to hospital i.e., it should not delay rapid transfer to hospital.

Unlike chronic hyponatraemia commonly seen in medical patients, where a slow restoration is required to avoid central pontine myelinolysis (CPM), CPM has NOT been reported in any case of EXERTIONAL hyponatraemia treated with hypertonic saline. Data suggest that normal saline may have no obvious benefit and is an illogical treatment for a fluid overloaded patient. Milder cases should be treated by withholding fluids (oral and iv) and awaiting the correcting diuresis. Fortuitously diagnosed asymptomatic hyponatraemia does not require

treatment other than encouragement to eat salty food and take salty drinks. They can also be given advice to report to hospital if they develop symptoms in the next few hours.

3.3.5. CARDIAC ARREST

Cardiac arrest occurs in 1 in 50,000 to 1 in 100,000 athletes in running races, usually in people with severe coronary artery disease.

Cardiac arrest protocols should be conducted in accordance with the latest guidelines by the Resuscitation Council (UK), American Heart Association (AHA), or equivalent. Successful resuscitation from cardiac arrest may also require treatment for hypovolaemia (judge partly on distance run and the heat index or wind chill) and hypoglycaemia (check glucose but see below).

3.3.6. CHEST PAIN

Any athlete presenting with chest pain must be assessed fully for acute coronary syndrome, although chest wall, lung and oesophageal pathologies should be considered as appropriate. All doctors should have a supply of aspirin 300 mg chewable tablets and GTN. All ambulances must have AED devices with a lead II monitoring screen. All paramedic and mobile response units must have cardiac monitoring capability, as well as a full supply of ALS drugs and opiates. The ITUs at the finish will also be fully equipped to deal with ACS.

3.3.7. OTHER MEDICAL EMERGENCIES

Athletes may have known or latent co-morbidity including asthma, cardiac and cardiovascular disease, diabetes, epilepsy. Known medical conditions must be listed as part of the registration process for each athlete and be instantaneously available in the athlete database by race number and name. A reasonable range of medications and monitoring equipment shall be supplied to medical units, including the finish area where most medical events occur. There must be mobile cardiac ambulances that can access any part of the course within 3 minutes of being called.

3.3.8. OTHER MEDICAL ISSUES

3.3.8.1. Diabetes Glucose Testing

Diabetic athletes have been advised to carry their own glucose meters to monitor blood levels. Race day medical staff are asked to help them if requested.

3.3.8.2. Treatment with Intravenous (IV) fluids

IV fluids are only indicated in athletes with severe EAC who are hypovolaemic with a low BP even when nursed in the head down position and who cannot drink or tolerate oral fluids, or who have continuing fluid loss from vomiting or diarrhoea, or who have significant hyperthermia (see above). Even with these athletes an iSTAT measurement should be made if possible, to assess the situation and exclude the diagnosis of hyponatraemia).

3.3.8.2.1. Choice of IV fluids

Initial restoration in these circumstances should be conducted with Hartman's solution or normal saline. In adults, up to 1 Litre IV solution can be given over 20-30 mins, but following this the ability to absorb oral therapy should be re-examined and the advice of a senior medical officer sought before embarking on a further 1 litre of IV. salt solution if clinical signs of hypovolaemia persist.

Dextrose containing solutions should only be given after circulating volumes have been restored and/or measured hypoglycaemia exists (Blood glucose less than 4 mM/L). This is most likely to occur in athletes with type 1 or type II diabetes who have "overdosed" their hypoglycaemic agents, especially insulin, but can rarely occur in non-diabetics and is an aggravating factor in hypothermia, as it may interfere with the shivering reflex. Intermittent blood sugar analyses should be conducted to avoid rebound hyperglycaemia but note finger prick techniques may give inaccurate results under very cold conditions.

5% Dextrose solution does not provide sufficient glucose substrate to be useful so 10% dextrose should be given with care and regular inspection of the infusion site to detects extravasation and potential skin damage. Concentrations above 10% will slough the skin if extravasated outside the vein and should ideally only be administered through central venous access catheters.

Dextrose solutions may worsen existing hyponatraemia due to "water intoxication."

Such patients may also benefit from fluid and calorie replacement if they fall ill near the end of the race but be aware of HYPONATRAEMIA or WATER INTOXICATION patients who may well become worse if given any IV fluid load (see use of hypertonic saline below). This condition has in the last few years become more common in marathon races and is discussed below.

3.3.9. MEDICOLEGAL ISSUES

The medical defence unions generally indemnify insured medical professionals providing they are acting competently and within the limits of their training and experience. Since event conditions vary, healthcare professionals must follow internationally established protocols and seek advice from senior staff whenever there is doubt about the correct diagnosis or treatment to be followed. All diagnoses, decisions and treatments must be carefully documented to avoid future medico-legal consequences.

Doctors must have reached UK level SpR 4 (or equivalent) in seniority to work autonomously. More junior doctors will be required to work under the supervision of doctors at a minimum level of SpR 4

3.3.10. DOCUMENTATION OF CASUALTIES

Casualty cards must be filled in for all medical contacts no matter how trivial. Document the athletes name, race number and time of discharge. Print your name legibly. Athletes requiring hospitalisation should have an Ambulance form including information on presentation, working diagnosis and management up to the point to dispatch to the hospital.

Appendix 1: Assessment of Collapsed Athletes

(Collapse = inability to walk unassisted) To be used in conjunction with Triathlon Medical Guidelines)

Assessment (repeat abnormal observations every 15-30 min)
- Mental state
- Blood glucose
- Serum Na (1 hourly if abnormal)
- Rectal temp (essential if confused, say they feel cold or not responding to Rx)
- BP and pulse (any postural drop)?
- Assess state of hydration
- dehydrated dry mouth, no saliva, low skin turgor, low JVP
- overhydrated, tight rings, tight shoes, oedema. Normal pulse and BP
- Ability to take oral fluids
- Presence of diarrhoea or vomiting
- Improving or deteriorating

Probably Benign (exercise associated collapse EAC)
- Occurred at end of race (after running)
- Awake and alert
- Rectal temp >36 <39
- Presence of postural hypotension, but feels OK if legs elevated.
- Recover quickly with oral fluids and carbohydrate elevation of legs and pelvis
- Muscle cramps settle rapidly

Could Be Serious
- Occurred before the finish (while running)
- Confused, or mood change (aggressive)
- Presented with a fit or loss of consciousness or amnesia
- Persistent vomiting and or diarrhoea
- Severe headache
- Rectal temp <35 or persistently >39
- Hypoglycaemia
- Hyponatraemia <130
- If well hydrated (tight ring, oedema, high JVP) check Sodium
- Persistent cramps or rigors

Serious
- Comatose or violently aggressive and disorientated
- Severe hypotension and tachycardia.
- Rectal temp <35 or >40 and not responding to treatment
- Chest pains or rapid irregular heart rate
- Signs of stroke or CVA
- Worsening cramps or rigors
- Headache and malaise getting worse
- Fit or Fits unless known Epileptic
- Deteriorating level of consciousness
- International Obstacle Sports Federation

Appendix 2: The Event Alert System

Adverse conditions for exercising in the heat are most usually related to heat stress. This alert system can also be used to warn of potentially dangerous situations, such as cold, storms and tornadoes.

Heat Stress Calculation

Heat stress is calculated using a Heat Stress Wet Bulb Globe Temperature (WGBT) Meter. This Meter measures the WGBT Index, expressed in either degrees of Celsius or degrees of Fahrenheit, depending on how you want your device to report. The WBGT Index is calculated using a standardized mathematical formula that uses the following variables:

+ Ambient temperature (the usual "weatherman forecast" temperature)
+ Relative humidity
+ Solar radiation "sunshine on a dark surface"
+ The cooling effect of wind (wind chill)

The color codes correspond to specific parameters of the WBGT Index, with each color changing as the severity of the WBGT Index rises.

+ Green – low risk – a WBGT Index of less than or up to 84.9^{O}F (29.3^{O}C)
+ Yellow – moderate risk – a WBGT Index of between 85^{O}F to 87.9^{O}F (29.4^{O}C and 31^{O}C)
+ Red – high risk – a WBGT Index of between 88^{O}F to 89.9^{O}F (31.1^{O}C and 32.1^{O}C)
+ Black – extreme risk – a WBGT Index of more than 90^{O}F+ (32.2^{O}C)

Event Alert System (EAS)

ALERT LEVEL	EVENT CONDITIONS	RECOMMENDED ACTIONS
EXTREME	EVENT CANCELLED/EXTREME AND DANGEROUS CONDITIONS	PARTICIPATION STOPPED/FOLLOW EVENT OFFICIAL INSTRUCTIONS
HIGH	POTENTIALLY DANGEROUS CONDITIONS	SLOW DOWN/OBSERVE COURSE CHANGES/FOLLOW OFFICIAL INSTRUCTIONS/CONSIDER STOPPING
MODERATE	LESS THAN IDEAL CONDITIONS	SLOW DOWN/BE PREPARED FOR WORSENING CONDITIONS
LOW	GOOD CONDITIONS	ENJOY THE EVENT/BE ALERT

IMPORTANT: A WBGT thermometer must be available and used at all World Obstacle events.

Include information in your race packet and your event communications about the Event Alert System. Display signs or flags at your packet pick-up that coordinate with the current conditions, so people are aware of what to look for on course.

Place the EAS near your start line to indicates the current Event Alert code. Take readings every 2 hours during the event and change the color codes on signs or flags as the WBGT Index readings change. Place highly visible EAS signs or flags at the start and at aid stations, and instructions should be given if the EAS code is red or black. Ensure you have a system in place and a volunteer ready to update the EAS codes as weather conditions on the course change.

If the course needs to be closed to due to "black" conditions, follow these guidelines:

+ Have a course closure plan in place.
+ Announce that the race has been shut down due to dangerous heat/weather conditions.
+ All Event Alert System signs on the course will be changed to the black color code.
+ Inform all on-course personnel, course marshals, and aid stations of the course shut down so that they can then communicate the information to participants.
+ Require ALL AID STATIONS TO REMAIN OPEN until the course has been cleared of participants and the aid station receives official instructions to close down.
+ Follow-up with participants following the event to remind them that safety is paramount and apologize for making the tough call to cancel the event due to dangerous weather conditions.