SELF ASSESSMENT EXERCISES

Self assessment exercises in cold weather remote medicine

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The following questions are preceded by scenarios where you are providing medical cover in a variety of situations, all related to remote medicine in cold climates.

1. You are in the middle of a three month deployment to Norway, undergoing Arctic training with your unit. While on a 3-day exercise, a 24-year-old corporal presents to you with numb index and middle fingers on his right hand, having been fiddling for over twenty minutes with a frozen ski binding. His index and middle fingers look waxy over the area of the finger pulp and although feel hard superficially the deeper tissues feel pliable. You suspect he is suffering from "frostbite".

a. What is frostbite?
b. How would you classify frostbite?
c. Should you attempt to re-warm his fingers in the field?
d. How would you treat this condition given the circumstances?
e. What are the possible long-term effects to his hand?

2. You are with your battalion camped high in the mountains. It is very windy and a virtual whiteout. You have 4 medics in the battalion but otherwise the nearest medical help is 20 miles down the valley. You have one full oxygen cylinder in the RAP.

You are called one morning to see 3 soldiers who have been sharing a 4-man tent. After melting snow for breakfast and "wets" they were keeping the tent warm by leaving a stove on low heat. They were speaking and preparing food at 0600hrs when a sentry checked all tents. When you get there at 0730hrs you find all three unconscious on the ground having been dragged from their tent. Your medics and the soldiers are administering basic life support to 2 of them and trying to talk to one of them.

a. What is your first priority?
b. What is the likely cause of this disaster?
c. What are your treatment priorities for:
   - The unconscious casualties
   - The conscious casualty
d. How would you have prevented this from happening?

3. You return from a day in the field that proved to be more overcast and cloudy than usual. You are approached that evening by a member of your party who is complaining of painful, red, watery eyes.

Examination proves to be difficult, as the soldier is reluctant to open his eyes fully. You assess visual acuity in both eyes, which appears normal, and you observe marked conjunctival injection in both eyes. There is no evidence of foreign body or abrasions.

a. What is the likely diagnosis?
b. What are your priorities in treatment?
c. How would you prevent this condition from occurring?

4. You are asked to provide medical cover to a joint services expedition of twelve experienced mountaineers to the Himalayas, the object of which is to climb to Everest Base Camp. You are preparing your medical kit in readiness for the expedition.

a. Has any prophylaxis been shown to be effective in the prevention of altitude sickness?
b. What is the recommended maximum ascent rate at this kind of altitude if mountain sickness is to be avoided?
c. What other considerations are there when preparing medical supplies for this kind of venture?

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5. You are on deployment in Norway. You are providing the medical cover for a troop who are practising "ice-breaking" drills. This involves ski-ing into a hole in the ice of a frozen lake and extracting oneself, along with weapon, kit and skis, in the correct manner. One of the soldiers is unable to climb out of the hole and starts to struggle and panic. After a few minutes he starts gasping and rapidly becomes unconscious. He has just been hauled out onto the ice when you arrive but has by now been immersed for some minutes. You assess ABC and find that he is not breathing, and there is no pulse.

a. What is the likely diagnosis?
b. How will you attempt to resuscitate him?
c. How does this differ from normal protocols for resuscitation?
d. What is his prognosis?
e. What is the core temperature below which successful defibrillation is unlikely?

Answers to self assessment exercises

Question 1

a. "Frostbite" is now known as Freezing Cold Injury (FCI), a more up to date and more useful description than the traditional term. The term "trench foot" describes a condition now known as Non-freezing Cold Injury (NFCI). In FCI the water in the tissues actually freezes. If this process is slow the freezing is of extra cellular free water and cell death only occurs secondary to osmotic changes in the cells. If rapid tissue freezing occurs it is of intracellular water, which leads to immediate cell death.
b. Although older classifications exist, FCI is now classified as superficial (skin and subcutaneous tissues) or deep (muscles, nerves and bone). The predecessor to FCI is "frostnip" which presents with white and numb skin, which can resemble superficial FCI, but no cell death occurs.
c. Frozen tissues should only be re-warmed or thawed if they can be kept from re-freezing, as this results in more severe tissue damage. If this is impractical they should be left frozen - the decision will depend on each individual situation.
d. If there is likelihood of re-freezing they should be wrapped, padded and splinted to avoid further tissue damage during casualty evacuation. Once thawing can be guaranteed re-warming must occur as soon as possible. The injured part should be immersed in a water bath at 37-41 degrees Celsius. Adequate analgesia and a sterile dressing will also be required.
e. In this case he may have complete recovery (frostnip) or minor superficial tissue loss before healing. The area is likely to be very cold sensitive in future and may suffer from hyperhidrosis.

Discussion

This question concerns the complications of freezing cold injury, thankfully rare in the armed forces of today, due to a programme of education and prevention. Several factors are known to predispose to frostbite including impaired cerebral function, and alcohol - in a retrospective study of 79 cases over a 10 year period (1), 53% were under the influence of alcohol to some degree. The mechanism behind frostbite has many similarities to other inflammatory processes such as thermal burns or ischaemic reperfusion injury. There is a release of inflammatory mediators such as thromboxane and prostaglandins, and treatment with NSAIDs is therefore effective in decreasing this inflammatory process (2). The usual surgical management involves waiting for demarcation to take place and surgical debridement four to twelve weeks after demarcation. Other treatment modalities, such as the use of vasodilators, thrombolysis, hyperbaric oxygen and sympathectomy are discussed in a recent review article (2).

Question 2

a. With your medical and staffing levels this is a major incident, and as such, the first priority is triage. You must "do the most for the most". This should involve a quick check of all three casualties to ensure that the diagnoses made by your medics are correct and particularly that the two receiving basic life support have indeed suffered cardiorespiratory arrest.

b. The timings make considerations of hypothermia as a diagnosis extremely unlikely. The most likely diagnosis is of carbon monoxide poisoning.

c. The priority for the casualties who have arrested is to ensure effective basic life support is being carried out, and if possible institute some advanced life support within your means. Practically, you will not have a monitor or the means to defibrillate, but you will probably have advanced airway adjuncts and the means to gain IV access and administer adrenaline 1mg every 3 minutes.

The conscious casualty has the best chance of survival and should therefore probably be your treatment priority. He should receive the oxygen you have available at the highest concentration you can give it, and instigate casualty evacuation to the nearest facility as soon as is practicable.

d. Adequate ventilation of tents by opening flaps is mandatory when cooking with carbonaceous fuels.

Discussion

Most cases of carbon monoxide poisoning occur as a result of either faulty heating in the home or as parasuicide attempts using car exhaust fumes (3,4). There are also numerous reports of fatalities as a result of cooking in under-ventilated homes with carbonaceous fuels (5,6,7,8). The dangers of carbon monoxide when under canvas are probably under-recognised but camping fatalities have been reported (9,10,11).

The symptoms of CO poisoning are non-specific, flu-like complaints such as headache, dizziness, nausea, diarrhoea, vomiting, confusion and agitation, which can progress to coma and death.

When burning fuel in a confined space, adequate ventilation is imperative. Flame characteristics can give an indication of high CO production - this is especially important when melting snow, as the cold pan cools the flame, turning it yellow and leading to incomplete combustion with even greater carbon monoxide production than normal.

Patients suffering from CO poisoning should be removed from the contaminated area, and high concentration oxygen should be administered. The benefits of hyperbaric oxygen therapy are currently a point of some discussion, but if available it would be worth at least discussing the option of treatment with the local hyperbaric centre.

Question 3

a. "snow blindness"
b. protect the eye, prevent infection, analgesia
c. adequate provision of goggles or glasses with UV filter

Discussion

Exposure to ultraviolet radiation, such as the glare from snow, without UV protection can result in a painful superficial keratitis 6-12 hours following exposure. It tends to occur more frequently on overcast days as people are lulled into a false sense of security and often feel (wrongly) that they do not need to wear eye protection. The treatment aims should be to speed healing and protect the eye with an eye pad, prevent infection with chloramphenical ointment, and relieve pain with either homatropine 2% drops or oral analgesia (12). Prevention and education should be the priorities, as the condition is easily avoided if adequate protection with UV filter glasses or goggles is worn.

Question 4

a. Yes - acetazolamide 750mg and dexamethasone 8-16mg daily.
b. Not more than 500 metres per day.
c. Whether to take full medical kit including, for example, IV fluids and advanced airway management equipment.

Discussion

Altitude sickness, or acute mountain sickness, is a common phenomenon affecting people who usually live at low altitudes who fly around the globe climbing high mountains. The commonest symptoms are headache, anorexia, insomnia, nausea and fatigue. These symptoms usually occur during the first two or three days of being at high altitude, but are lessened by acclimatisation. Sometimes, acclimatisation is not possible, or not practised for some reason (for example time constraint on an expedition), and altitude sickness occurs. Above 4000 metres, if the ascent rate is higher than 500 metres per day, prophylaxis with either acetazolamide 750mg or dexamethasone 8-16mg has been shown to significantly reduce the incidence of altitude sickness (13). If the ascent rate is less than 500 metres per day, it is probably not worth while taking prophylaxis. It should be emphasised that an appropriate rate of ascent without having to take medical prophylaxis is the safest option and all attempts to achieve this should be made. The question of what to take on an expedition is commonly asked, and depends, of course, on what kind of expedition it is, who is going, what support facilities are available, and what it is practicable to carry. For excellent practical advice about expedition medicine, contact the Royal Geographical Society on (020) 7591 3000 or info@rgs.org.

Question 5

a. Hypothermic cardiac arrest
b. ABC and basic life support
c. It is the same as any other cardiac arrest, but efforts must be made to re-warm the casualty as basic life support is ongoing.
d. His prognosis from the hypothermic

cardiac arrest point of view is relatively good. This is one of the situations where CPR must be continued until re-warming is achieved - however long that might take.

e. Below about 30 degrees Celsius.

Discussion

"The patient isn't dead until they're warm and dead". Young otherwise healthy people can survive accidental deep hypothermia with little or no cerebral impairment even with prolonged circulatory arrest. This fact is illustrated in a study of 46 such cases (14,15), where 15 patients survived with no functional impairment.

Classical cardiac physiology texts tell us that as the body temperature cools, the heart suffers from predictable dysrhythmias - firstly bradycardia, then atrial fibrillation, ventricular fibrillation, followed eventually by asystole. The treatment of cardiac arrest in hypothermia is therefore to warm the body to a temperature above which sinus rhythm is possible, while providing basic life support to maintain tissue oxygenation. Re-warming should occur at a similar rate to the process of cooling (16) - for example, immersion hypothermia produces rapid cooling (within minutes), and so rapid re-warming (preferably by immersion in a warm bath at 37-41 degrees Celsius) is the most effective means of reversal. Ice breaking drills should always be performed in an environment in which rapid access to a warm bath is feasible.

Other mechanisms of hypothermia include urban hypothermia, which affects the elderly and may develop gradually over many days or weeks, and exhaustion hypothermia, which affects mountaineers, and occurs over a matter of hours, often associated with dehydration and depleted energy resources.

In-hospital treatment of hypothermic cardiac arrest is facilitated by interventions such as extracorporeal blood warming, and forced air surface re-warming (see 14,15,17).

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