Successful Resuscitation in Severe Accidental Hypothermia

A Case Report

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SUMMARY

Accidental hypothermia has a mortality rate of 30 - 80% and should always be borne in mind with comatose, hypotensive patients. It is a preventable condition when adequate safety measures are ensured. One should act in the case of early symptoms, because collapse may soon follow and evacuation of a patient on a stretcher is time-consuming, dangerous and a major undertaking.

In severe cases absence of respiration and circulation should not preclude resuscitation. Resuscitation should be continued until the patient is warm and all biochemical abnormalities have been corrected and intoxication has been ruled out. Resuscitation may be successful in primitive, adverse conditions, as illustrated by this case of a 13-year-old boy with cardiopulmonary arrest and a core temperature of only 25°C, who was successfully reanimated.

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Accidental hypothermia is not a frequent occurrence in South Africa when compared with the numerous reports which emanate from Europe and North America. Nevertheless, it remains a serious and potentially lethal condition, especially as far as deep-sea divers and mountaineers are concerned. Press reports during the past 2 months have indicated at least 6 fatal cases in South Africa, although only 2 of these were in mountaineers. Two deaths occurred on an open lorry at night, and 2 other persons who travelled on foot died during snowfalls. It is clear that there is much ignorance among the lay public regarding the dangers of hypothermia. Its importance in diving is evidenced by the fact that divers are required to be conversant with the dangers of hypothermia and are trained in its recognition and treatment.

The following case report illustrates the dangers of hypothermia during mountaineering when proper and adequate precautions are neglected.

CASE REPORT

A 13-year-old boy was rescued on the Boland hiking trail late one evening during June 1979. He was a member of a group of hikers who had started out from Sir Lowry's Pass early that morning. The first section of the trail covers a distance of 23 km through the Hottentots Holland mountain range. Initially, the weather was cold, with a fresh north-westerly wind but no rain, although weather predictions for that area indicated a gale-force wind, rain and low temperatures. This group was part of a much larger group of hikers who had originally planned the hike. About half of the group, including the leader, chose not to go in view of the weather predictions. Some 15 people nevertheless set out as a loosely organized group without a leader.

About halfway along the route the weather changed to the predicted gale-force north-westerly wind (the trail leads directly north, i.e. into the wind), rain, hail and low ambient temperatures. Two days later, snow was visible on the mountain. The group gradually broke up, the stronger and faster hikers moving ahead. Conditions gradually deteriorated. The boy, suffering from exposure and hypothermia, was placed inside his sleeping bag and left on the trail, while his two companions, themselves exhausted, summoned help from the nearest hut, about 4 km away. When found by a rescue party, the boy was clearly hypothermic. He had apparently tried to walk on his own and had left the path while in a confused state. He was deeply unconscious, with slow, irregular respiration and a slow, feeble pulse. At this stage it was already dark. He had been on the trail about 11 hours, and, according to his companions, had not eaten much during the day.

No attempt at resuscitation was made on the spot, since it was impossible in such conditions. He was covered in a 'space rescue blanket' of aluminium foil and transported to the nearest hut. His last moaning respiration was noted 20 minutes before arrival at the hut.

Examination on arrival showed him to be deeply unconscious, with apparent cardiopulmonary arrest, widely dilated, fixed pupils, and absent reflexes. His body was rigid and ice-cold. He was wearing long trousers, a shirt, jersey, rain-coat and ordinary shoes. His clothes were wet through.

Management

He was stripped of his wet clothing and immediate resuscitation was attempted with mouth-to-mouth breathing and external cardiac massage. His body was actively warmed with towels and blankets while avoiding rewarming of the limbs, since this may cause further lowering of the core temperature (the so-called 'after-drop') when vasodilatation occurs in the extremities, rushing cold blood to the body core. This may also precipitate ventricular fibrillation.[1,2] Maintenance of the airway presented some difficulty owing to rigidity of the

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jaw muscles, but, apart from this, ventilation was easy and adequate. Fortunately, regurgitation did not occur.

After about 55 minutes, feeble, irregular heart sounds at a rate of about 30 beats per minute became audible. There was no peripheral circulation. His condition gradually improved and adequate circulation and respiration were present after 90 minutes, although limb circulation was still absent. His body remained very cold. Gradually, inco-ordinated movements of the hands spread through the body, with preponderance of the extensor muscles, especially those of the back. The pupils were still widely dilated but responded sluggishly to light. He passed large volumes of dilute urine.

The patient was then gradually warmed in the glow of the fire and his body was turned frequently (similar to spit roasting), taking extreme care to prevent thermal injury which could easily occur in underperfused, cold parts of the body. Five hours after commencement of resuscitation, it was considered safe to place the patient, still deeply unconscious, in a down sleeping bag and allow gradual warming by the glow of the fire. It was impracticable for a normothermic person to join the patient in the sleeping bag, which is an ideal way of warming a hypothermic patient, owing to his severe inco-ordinated movements.

Eight hours after commencement of resuscitation he suddenly sat up, but immediately collapsed again. He awoke 30 minutes later and was given copious amounts of fluid with glucose. He was severely confused and slept fitfully until the morning, awaking frequently to take warm fluids. His vital signs remained satisfactory.

The next morning, about 14 hours after starting resuscitation, no obvious clinical abnormalities could be detected, apart from the absence of circulation in the fingers and toes. It was possible to transport him to a large hospital. Two days later he was discharged in a normal condition. His mother could detect no physical or mental changes in him.

A second member of this party, a 12-year-old boy, also suffered from hypothermia and exposure, with severe mental confusion and inco-ordination. His core temperature was probably in the vicinity of 33°C, and resuscitation presented no problems. He responded rapidly to external heat applied in a similar way as in the case described above, and was able to take hot fluids orally. A third member of the party, one of three who apparently lost their way in the storm and left the path, could not be found by rescuers until the next morning. He died of exposure and hypothermia and was found about 11 hours later.

DISCUSSION

In a sense this case is unique, not because resuscitation of a severely hypothermic patient is rare (many successful cases have been reported), but because of the absolute lack of facilities or trained staff apart from myself and some other hikers who knew something of the theory of cardiopulmonary resuscitation. This illustrates the fact that resuscitation may be successful, even in adverse conditions. Obviously, one would have liked to transport the patient to an area suitable for resuscitation, such as an intensive care unit or an operating theatre, but this was physically impossible at the time.

There are some points which merit discussion.

Body Temperature and Diagnosis

There was no available means of measuring body core temperature. Considering the clinical appearance, the core temperature was probably below 25°C. If it is below 31°C, a progressive paralysis of the central nervous system occurs, and below 28°C, most patients are unconscious. Areflexia and apnoea occur at much lower temperatures.[1] The diagnosis of hypothermia was obvious, but this is by no means always the case, since the normal clinical thermometer does not register a temperature much lower than 35°C, which is regarded as diagnostic. The diagnosis of hypothermia should always be considered when dealing with comatose, hypotensive patients, even, and sometimes especially, when an obvious cause seems apparent.[2] Acute alcoholism is a good example. This is the most common predisposing condition to accidental hypothermia in the USA. The mechanisms are obvious: ethanol, or more correctly, histamine in alcoholic beverages, is a vasodilator, depresses the central nervous system, and causes hypoglycaemia. It also predisposes to trauma and exposure.

Duration of Arrest and Resuscitation

Roughly 25 minutes could have elapsed between clinical arrest and commencement of resuscitation. The nature of the circulatory arrest was not definite, since a definite diagnosis can only be made by means of an ECG. This was, however, not important because no other means of treatment were available. The total duration of circulatory arrest was probably about 80 minutes. Bristow *et al.*[3] described a case in which arrest lasted for 3½ hours, with subsequent full neurological recovery. Coniam[1] and Reuler,[2] in separate recent reviews, stress the fact that an unconscious patient who is cold and rigid, with fixed, dilated pupils and undetectable pulse or respiration should not be certified as dead without adequate attempts at resuscitation. 'No patient is cold and dead until he is warm and dead.' Death may only be diagnosed retrospectively, i.e. when active resuscitation and rewarming to at least 35°C, including correction of biochemical abnormalities and exclusion of intoxication such as by ethanol and barbiturates, still do not lead to resumption of vital functions. Severe cooling greatly increases survival time after cardiopulmonary arrest, and resumption of normal cardiac function below 28°C is unlikely.

Methods and Rate of Rewarming

Opinions are divided as to the rapidity of rewarming and the choice of the technique employed. Techniques of rewarming include active external methods, such as application of warmed blankets and towels and a water bath. The latter may interfere with external cardiac

massage, should this suddenly be required. Warming blankets should be used with care to prevent thermal injury. Rewarming the limbs should be avoided for the reasons mentioned. Active core rewarming may be accomplished by using heated intravenous solutions, peritoneal irrigation with warmed dialysis fluid free of potassium, rectal lavage with warmed fluid, inhalation of warmed, humidified air and active blood warming by either haemodialysis or extracorporeal blood warming. Haemodialysis may also be indicated in cases of intoxication, e.g. barbiturate poisoning.

Generally, it seems appropriate to rewarm slowly when hypothermia is of gradual onset and more rapidly when the onset is rapid, as in cases of immersion in cold water. A rate of rise in temperature of 0,5 - 1°C per hour is advised, although Kügelberg *et al.*[4] suggest that rapid rewarming is safe in all cases when extracorporeal techniques are employed. Obviously, we used the methods available to us, i.e. the glow of a fire and warm towels.

It is appropriate to summarize aspects of the early recognition of hypothermia, its management, and above all its prevention.

Prevention

Pugh,[5] in a classic report of hypothermia in similar conditions to ours, makes certain suggestions, some of which are given below.

Adequate clothing: Warm clothes with waterproof top clothes (e.g. oilskins) are essential to safe hiking in any mountain area. Apparent warm weather does not nullify this statement, because sudden changes may occur, with a precipitous drop in temperature. A 'space rescue blanket' should also form an essential part of the kit, and spare dry clothes should be carried.

Nutrition: Exhaustion of glycogen reserves in both muscle and liver occurs rapidly with extreme exertion which characterizes hiking, more so when the kilojoule intake is limited. An adequate supply of easily digestible food (e.g. glucose sweets) should be at hand and kept dry, and should be taken at frequent intervals. When early hypothermia complicates exhaustion, the rate of metabolism increases (as the core temperature decreases to about 33°C; thereafter, the metabolic rate decreases rapidly) in order to try to compensate for heat loss, and kilojoule demands increase.

General organization: Obviously, inexperienced people should never attempt a hike of this nature. Careful planning of the kit is important. Hikes should be cancelled if poor weather conditions are forecast, and groups should never split up or leave a path without indicating this.

Early symptoms: The period between the onset of symptoms and collapse can be relatively short. Therefore, early symptoms (e.g. slowing, inco-ordination, decreased mentation) should be treated immediately.

Management

1. Cover the patient with a 'space rescue blanket' or other adequate cover to prevent further heat loss, and immediately transport him to an area suitable for resuscitation, preferably an operating theatre or intensive care unit. If possible, wet clothing should be removed and replaced with dry clothing.

2. Commence cardiopulmonary resuscitation *en route* or as soon as possible, if required.

3. Start rewarming the body as soon as possible.

4. Treat an underlying condition, e.g. drug overdose, later, when reasonable rewarming has taken place.

5. Defibrillation in the case of a patient with a core temperature of below 28°C is not advised, since it is seldom successful.

6. Restore the fluid balance. A severe diuresis, as was seen in the patient, is typical, because depression of enzyme activity in the distal renal tubules causes failure of tubular reabsorption. A tremendous 'third space' type of fluid loss into the tissues also occurs, further decreasing the blood volume. In addition, rewarming causes vasodilatation with aggravation of the relative imbalance between the capacity of the vascular compartment and the blood volume. These factors together cause hypovolaemia, hypotension, and thus oliguria in the recovery phase. If a central venous line is inserted, care should be taken to keep this out of the heart, since fibrillation may be precipitated in an already irritable myocardium.

7. Observations should include pulse rate, blood pressure, core temperature measured rectally, ECG and level of consciousness. A chest radiograph should be taken. Laboratory investigations should include pH and blood gas measurements (the latter corrected to 37°C), haemoglobin concentration, white blood cell count, urea and electrolyte levels, glucose level, blood culture, serum amylase (necrotic pancreatitis is a consistent finding at necropsy), and screening for barbiturates and salicylates. Hyperglycaemia is a common finding and should not be treated unless dangerous levels are observed.

8. In general, drugs should be avoided, because their activity will be attenuated during hypothermia but may cause problems as the temperature increases. Massive doses of corticosteroids may be beneficial, if not to stabilize lysosomal enzymes, then at least to replace inadequate steroid production due to cold. In the case of the latter, massive doses are obviously not required. Steroids may also prevent cerebral oedema, a possible cause of death. Prophylactic use of antibiotics to prevent respiratory infection is generally advocated.

9. Continue treatment at least until the body core temperature is close to normal and the biochemical disturbances have been corrected.

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