

Accidental Hypothermia in Medico-Legal Practice*

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Accidental hypothermia has become a growing problem in Great Britain during the last 20 years and is a direct outcome of the increasing aged population. During a cold winter a few years ago it was estimated that some 10,000 old people were admitted to hospitals in a hypothermic state, that is, with body temperatures below 95 F.

The term accidental hypothermia is used in preference to the older description "exposure to cold" or "freezing to death," as a susceptible subject may develop hypothermia in an environment which is warm to the healthy individual. For example, during this last winter a lady was examined who was a patient in a geriatric ward, where the temperature was controlled at 72 F. The lady was a little obese and was confined to bed. It was noticed by the ward doctor during his morning round that she did not seem very well. He examined her and at once noticed that she felt cold. Her rectal temperature was 90 F.

Hypothermia may develop at the two extremes of age: in the premature or marasmic infant or in the senile adult. It may, of course, sometimes be present in middle age if the subject is suffering from certain degenerative conditions or from the effects of alcohol or drugs which act on the central nervous system.

A medico-legal pathologist is particularly interested in any specific changes he may elicit at post-mortem examination on patients dying in the hypothermic state. In many parts of Great Britain autopsies are carried out on all persons who die suddenly, even if the cause of death is believed to be a natural one, and on all those where some unnatural condition, such as hypothermia, may have hastened death. It is from the post-mortem examinations on known deaths in the hypothermic state that the criteria for the diagnosis of hypothermia at autopsy have been elicited.

The post-mortem appearances of fatal hypothermia are different in the neonatal and senile groups, so each group will be described separately; where pertinent, brief mention will be made of some of the ante-mortem symptoms.

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The Neonatal Group

The hypothermic infant is usually premature. He has a characteristically pink face and extremities, the arms and legs are oedematous, the abdomen is distended due to paralytic ileus, and bullae are often present on pressure areas. The patient is vomiting as a result of the ileus, and invariably has hypoglycaemia. If the child is admitted to the hospital with a temperature below 90 F, his chances for survival are slight. X-ray examination of the abdomen of a hypothermic infant will show well-marked fluid levels.

Other conditions, besides prematurity, may predispose to the development of neonatal hypothermia. These include: congenital heart disease, congenital abnormalities of the central nervous system, neonatal asphyxia, respiratory distress syndrome in the newborn, intracranial birth injuries, and administration of analgesics to the mother.

It is clear that any condition which produces hypoxia predisposes to the development of the hypothermic state. It has been shown that the normal metabolic responses of the healthy newly born infant to cold can be inhibited by reducing the oxygen in the inspired air.

Post-Mortem Examination

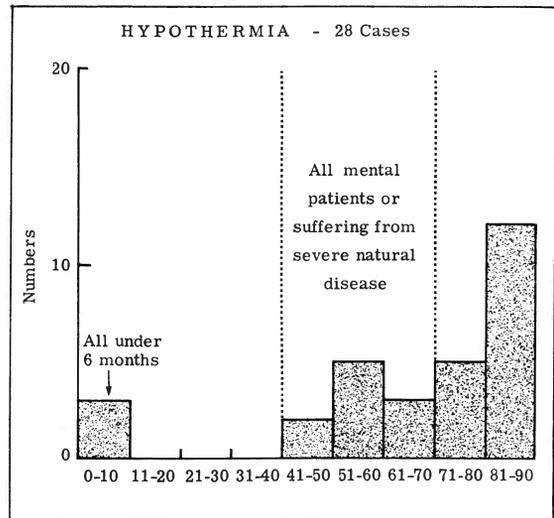
Post-mortem examination, besides showing the external signs described above, will exhibit sclerema neonatorum. About one-third of the cases will show intrapulmonary haemorrhages apparently due to the inhalation of gastric contents; but the gastric and pancreatic changes which are such a feature of the adult case may be lacking, although Sly (1964) has reported a case of perforation of a gastric ulcer in a case of neonatal hypothermia. Peritoneal and pleural effusions are also found at autopsy.

The Senile Group

The senile hypothermic patient (Figure) is usually over 70 and often over 80 years old. In a number of cases the hypothermic state develops without there being any gross physical disease other than old age. The loss of temperature control almost appears to be part of the aging process. There is often a history of the patient falling about during the months preceding the onset of the hypothermic state, suggesting the presence of micro-degenerative lesions in the brain.

The fact that these patients have lost normal temperature control has been demonstrated by placing them, after recovery, in a cooler environment with other patients of the same age. The recently recovered hypothermic patients will start to cool, whereas the others will remain normothermic.

It will be seen from the Figure that there is a small group of persons aged from 40 to 70 years in this series of fatal hypothermic cases. All of these persons were suffering from either physical or mental disease. These



conditions included rheumatoid arthritis, schizophrenia, and premature senility (Alzheimers disease). Some of these diseases may, of course, be significant in the senile or over 70 age group.

Unless there is a sudden exposure to cold, the hypothermic state would appear to develop at least over several days, although history is often lacking. The fully developed case of senile hypothermia is characteristic, and so resembles myxoedema that it is possible that, in the past, many primary cases of hypothermia have been diagnosed as being secondary to hypothyroidism. The blood chemistry, however, shows none of the changes associated with myxoedema, and after recovery from the hypothermic state by simple warming all the gross myxoedematous features disappear without the exhibition of thyroxin. As hypothermia lowers resistance to infection a number of patients die, after they have been rewarmed, from bronchopneumonia. However, many of the patients who are admitted to hospitals with temperatures over 80 F recover.

Autopsy Findings

The external features of a patient dying from hypothermia not only include oedema of the face and limbs, but also the presence of red erythematous areas on the limbs and sometimes on the face. Bullae may appear on the heels or other pressure areas.

The internal examination is usually conclusive even though the cooling may have been rapid.

Submucosal Haemorrhages and Ulceration of the Alimentary Tract

Gastrointestinal lesions were present in roughly 90 per cent of the 28 cases examined. The lesions are seen most frequently in the stomach, less commonly in the duodenum, and occasionally in the oesophagus. The lesions are initially numerous submucosal haemorrhages, black in color due to the presence of altered blood. These haemorrhages vary in size from 1 mm to 2 cm, but are usually in the range of 1-2 mm. They are most constant in the pyloric half of the stomach. If death is delayed, the mucosa over the haemorrhages sloughs leaving shallow ulcers. These ulcers may be difficult to see by direct vision but become readily apparent by transmitted light.

The duodenal haemorrhages tend to be larger and sparser. In one case in this series there was a perforation of an acute duodenal ulcer; minimal vital reaction was present. There appears to be no reason to separate the ulcer from other "Curling's ulcers" of the duodenum.

Microscopy of the gastrointestinal lesions does not add much to the gross examination. The striking feature is the absence of vital reaction.

Pancreatic Changes

Gross pancreatic lesions were present in 82 per cent of the cases in this series. The changes varied from the occasional focus of fat necrosis to a frank haemorrhagic pancreatitis with fat necrosis, not only involving the whole pancreas, but also the tissues immediately adjacent. Fat necrosis away from the immediate vicinity of the pancreas was never observed. The localization of the changes would appear to be due to the inhibitory effect of cold upon the released enzymes (Nasbeth, Goodale and Reif, 1960). In cases which recover under treatment, the presence of pancreatic dysfunction is shown by the raised serum amylase.

The microscopical changes depend upon the severity and duration of the hypothermic state. In general, one finds areas of necrosis and haemorrhage with some leucocyte infiltration. If the hypothermia has been recurrent, areas of chronic pancreatitis may also be identified.

Myocardial Changes

Fatty changes in the myocardium appear to be invariable. Micro-infarcts may be found in a proportion of cases. Experimental hypothermia in dogs reveals similar changes and, in a proportion, severe fibrosis with heteroblastic bone formation may occur. It has been shown that, in hypothermia, ventricular fibrillation is likely at an early stage of the cooling if myocardial ischaemia is also present.

General Changes

Fat, or an increase in fat, is found in the kidneys, adrenals, and liver; and micro-infarcts have been recorded in all organs except the liver. These micro-infarcts are caused by the haemoconcentration and "packing" or "sludging" of the red cells in the capillaries.

Associated Natural Diseases

Natural diseases, other than general senile degenerative changes, were found in a high percentage of the cases of hypothermia examined. The principal diseases identified were:

Cardiovascular

Hypertension	6
Advanced coronary occlusion	5
Advanced aortic stenosis	2

Respiratory

Cor pulmonale	5
Suppurative bronchopneumonia	7
(All these cases had recovered or almost recovered from the hypothermic state and had developed the pneumonia as a complication.)	

Psychiatric and Mental Disease

Known mental disease (eg schizophrenia)	4
Presenile dementia (Alzheimer type)	3
Senile dementia	2

Cerebral Lesions

Trauma	1
Natural cerebral haemorrhage	1
Parkinson's disease	1

Other Conditions

Oesophageal ulceration and stenosis	3
Chronic gastric ulceration	1
Cirrhosis of liver	2
Result of crime	2

Uncomplicated senility has not been included. Concomitant heart disease was present in 57 per cent of the cases, but in only half these cases was the disease considered so advanced that it could cause sudden death at any time without the complication of hypothermia.

The younger group (40—70 years) suffering from known mental disease had all wandered away from their institutions, lived "rough," and were found dead in the open.

Several other contributory factors have been recorded in the literature. These are all diseases where the basal metabolic rate is lowered or causes immobility or wasting. The most important cause, however, is

clearly senility, especially when this is associated with Parkinson's disease.

Drugs

Many drugs in the hypnotic and tranquilizer group have been cited as precipitating agents of the hypothermic state. Routine toxicological analysis is desirable in fatal cases, but, except for acute exposures, the time which normally passes between the commencement of the hypothermic state and death is so long that the chances of recovering most of the drugs are rare. It should be remembered that alcohol is especially dangerous.

Summary

The autopsy findings in 28 cases of fatal hypothermia have been described. Hypothermia, in temperate climates, is one of the complications of longevity. The hypothermic state may be precipitated by a wide range of natural diseases, especially chronic cardiac disease.

The classical case of hypothermia may be recognized at post-mortem by the myxoedematous appearance of the patient and the presence of gastric and pancreatic lesions.

References

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- SLY RM: Perforation of a gastric ulcer in a premature infant exposed to cold. *Amer J Dig Dis* NS 9: 525, 1964