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Hypothermia in the Aged

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Body temperature is maintained by a balance between heat production and heat loss. Temperature regulation consequent to exposure to a cold environment appears to be modified in elderly persons. An evaluation of the physiological adjustments made by older individuals is presented. It is apparent that hypothermia can develop in the older population as a consequence of modifications in both behavioral and physiological responses to cold exposure. With the growing awareness of an energy shortage with consequent lower ambient temperatures in homes, there is a need to obtain adequate information as to the physiological capabilities and adaptive potential of elderly individuals to a cold stress.

Introduction

The incidence of hypothermia of the elderly is uncertain, but estimates of over 20,000 deaths annually as a result have been made for Britain alone (*1*). These estimates, along with the prospects of fuel shortages in the future, make the problem of old and the cold one demanding more attention by physicians and researchers alike.

Body Temperature

Body temperature is maintained in a balance between heat production and heat loss. The production of body heat depends upon: food intake; bodily activity, both voluntary movement and shivering; and thyroid function, which controls heat production at rest (*2*). Body heat loss depends on environmental temperature, clothing, subcutaneous fat, peripheral blood flow, and respiratory heat loss. Temperature-regulating mechanisms of the body include both increased heat production and decreased heat loss; the principal ones in response to cold being shivering and peripheral vasoconstriction, respectively.

Hypothermia

Hypothermia is the condition produced by a failure of the temperature-regulating mechanisms in response to cold, which results in a significant decrease in body temperature. Hypothermia is generally regarded as body temperature below 35°C (*3–6*). According to degree, hypothermia may be classified as mild (to 30–32°C), moderate (to 22–25°C), or deep (to 0–8°C) (*6*).

Physical Characteristics

The physiological characteristics of the hypothermic individual differ with the degree of hypothermia. At a temperature of 35–32.2°C the body reacts by shivering and vasoconstriction of peripheral vessels (*4, 5*), diuresis (*4*), and the hormonal stress response (*6*). A decreased heart rate, increased peripheral resistance, and hyperglycemia due to epinephrine release and decreased glucose utilization are also believed to occur (*3, 6*). At a body temperature of 32.2–24°C shivering is not observed, tissue metabolism is depressed, pulse rate and respiratory rate are depressed, and blood pressure is often low or unrecordable (*3–5*). Edema is often present and atrial fibrillation is common, as is a decreased release of all hormones (*4, 6*). Sludging of the red blood cells in the microcirculation, causing thrombosis, decreased platelet count, increased clotting time, decreased renal blood flow, and decreased reabsorption of bicarbonate contributing to metabolic acidosis are also reported to occur (*3, 6*). When the body temperature falls below 24°C, more serious disturbances of the functions of vital organs with multiple arterial thromboses affecting heart, intestines, and pancreas (*4*), as well as ventricular fibrillation (*5, 6*) produce what is more likely to be a fatal outcome.

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Clinical Features

Clinical features of the hypothermic patient have consistently shown depressed ventilation, depressed pulse rate, and low blood pressure (*2, 3, 5, 7*). Electrocardiograms are reported to show fibrillation, conduction defects of the PR and QTC intervals with a widening QRS complex (*2*), as well as a J wave at the junction of the QRS and ST segments (*2, 3*). Murphy reported dehydration was an important feature in all eight cases he presented (*2*). Often noted in the faces of hypothermic patients was a puffy appearance resembling myxedema. Death from bronchopneumonia can occur even though body temperature was brought back to normal and antibiotics and corticosteroids were administered (*5*). Autopsy reports show pancreatic necrosis in several cases (*2, 3*).

Treatment

Suggested treatment of the hypothermic is moderately rapid rewarming, provided blood pressure can be maintained (*2*). Covering the patient and allowing spontaneous rewarming in the less severe hypothermic is advised (*7*). It is thought that the depletion of epinephrine from the adrenals may cause the inability to rewarm spontaneously after long-lasting deep hypothermia (*6*). A safer treatment of the outdoor hypothermic casualty is to camp and to allow him to rewarm spontaneously before moving him, unless the distance is short (*8*). The high risk of bronchopneumonia in elderly hypothermics necessitates the administration of broad-spectrum antibiotics (*5*).

Exogenous and Endogenous Factors

Factors that promote hypothermia include: adverse weather conditions (*7, 8*), being wet through, inexperience and lack of training in the cold, low level of subcutaneous fat, and exhaustion (*8*).

Clinical features which may give a predisposition to hypothermia include: endocrine conditions (myxedema and hypopituitarism); neurological disorders (falling attacks and cerebrovascular accidents); mental impairment and confusion states; conditions causing vascular collapse, especially myocardial infarction; severe infections, especially pneumonia; and drugs affecting the temperature regulation of the body (*4*).

Hypothermia and the Aged

Sensitivity to Cold

A question that has been brought up by investigators has been the sensitivity of the elderly to the cold, since many have found elderly living in thermal environments considered less than optimal for thermal comfort (*1, 9–12*). It has been reported that older people are less sensitive to the cold (*9, 12, 13*). However, in a winter survey of the elderly, Fox et al. found that the individuals he classified as the low temperature group said their hands were colder and both low temperature groups said they wanted to be warmer but economic reasons prevented this in many cases (*10*).

Diet

Deficiencies in diet are also believed to promote hypothermia, and many of the elderly hypothermics are reported to be deficient in food and fluid intake (*2*). This is a problem deserving immediate attention, as many of the elderly are reported to have insufficient food of the right kind—lacking protein, calcium, iron, vitamin C, and the B group of vitamins (*1*).

Activity Levels

A low level of activity can also predispose an individual to hypothermia. This makes the elderly especially vulnerable, as many elderly are bedridden. Bodily activity was decreased in all cases of elderly hypothermics reported by Murphy and Faul (*2*).

Endocrine Disorders

Endocrine disorders may also give predisposition to hypothermia. Impaired heat production is one feature of hypothyroidism, a common ailment of the elderly (*5*), although Wollner reports hypothyroidism accounts for only a small number of cases of accidental hypothermia (*14*). Rosin et al. found red-cell uptake of ^{131}I was in the hyperthyroid range in nine hypothermics although serum protein-bound iodine (PBI) was abnormally low in three (*15*). The high results in the red-cell uptake test may be the result of the associated metabolic acidosis.

Drugs

The temperature-controlling mechanism in the hypothalamus can be affected by drugs, which may predispose an individual to hypothermia (*2, 4*). Chlorpromazine and other phenothiazine tranquilizers, barbiturates, and alcohol are some of these. Tranquilizing and antidepressive drugs are *now being prescribed extensively for the elderly (4)*

and should be a concern for physicians, especially during the winter months.

Thermoregulation and Serotonin

Serotonin levels and metabolism in the CNS play an important role in thermoregulation, and dietary tryptophan is the sole source of this transmitter. Numerous aging phenomena, including a progressive loss in thermoregulatory capacity, might be the result of alterations observed in monoaminergic neurons with age. When the time required for body temperature to be restored to 37°C after a 3-min ice water immersion was used as an index to senescence in rats, investigators found middle-aged rats maintained from weaning on a tryptophan-deficient diet had recovery times comparable to values reported for adult controls. Rats maintained from weaning on tryptophan-deficient diets also have greatly reduced body weight gains compared to rats on normal diets. Segall and Timiras suggested that tryptophan deficiency may stop the "biological clock" that controls both growth and aging (*16*). It is interesting to note that humans exposed to cold have been reported to have depressed tryptophan concentrations (*17*).

Response of Aged to Cold

Vasoconstriction

It has been shown by several investigators that the elderly do not show the normal vasoconstriction to conserve heat in the cold (*5, 15, 18, 19*). Elderly survivors from accidental hypothermia had low resting central temperatures and on exposure to cold they fell progressively and abnormally colder, showing impairment in temperature regulation (*14, 20*). This would not seem to be the sole result of low level of subcutaneous fat, as Lee et al. found a greater reduction in rectal temperature in the aged than young at a given subcutaneous fat thickness (*18*). When different age groups were exposed to 16°C for 60 min, finger blood flows were highest in the oldest group, indicating that age is accompanied by a decrease in the peripheral vascular reactivity to cold stress (*19*). However, this is not universally accepted, as Spurr et al. found a more intense vasoconstriction in older subjects in response to cold (*19*) and Horvath et al. found that peripheral vasoconstriction occurred more rapidly in the old (*13*). Fox et al. found a decrease in hand temperature with age which shows a greater attempt to conserve body temperature, but in the individuals below 35.5°C they found a slightly warmer hand temperature, which indicates some degree of thermoregulatory failure (*10*).

The decreased vascular reactivity to cold reported in some old people might be better considered as a predisposition to hypothermia rather than a natural consequence of the aging process, since several investigators that report decreased vasoconstriction in response to cold use elderly that have shown they are predisposed to hypothermia in that they once were hypothermic (*14, 20*) and investigators that use "normal" old subjects actually report a more rapid and intense vasoconstriction in response to cold (*13, 21*).

Shivering

It is generally agreed that the elderly exhibit a depressed or delayed response to cold (*2, 4, 5, 13–15, 18, 20*). Most of these investigators feel that this represents an impairment in heat production which promotes a hypothermic state (*4, 5, 14, 15, 18, 20*). Reports that no increased heat production occurs in unacclimatized individuals in the cold in the absence of shivering lend evidence to this belief (*22, 23*). However, it is not agreed that shivering is beneficial in maintaining body temperature. Horvath et al. found shivering to be only about 11% effective in protecting against total heat loss (*24*). Burton and Bazett feel shivering is an inefficient method of maintaining body temperature, as increased circulation must accompany increased activity of the peripheral muscles, which causes an increase in effective conductivity and leads to increased heat loss (*25*). A decreased shivering response to cold may be beneficial to only those who have developed a more efficient means to maintain body temperature. Horvath et al. showed a lesser fall in body temperature in elderly subjects in the absence of any rise in metabolism in the cold (*13*), and investigators have reported cold acclimatization results in a depressed or delayed shivering response to cold (*26–29*).

Conclusion

There is a great need for further studies on hypothermia and the aged, as many questions have not yet been answered satisfactorily.

Fox et al. found that deep body temperatures in old people were not correlated to room temperature, which he claims indicates that for the group as a whole thermoregulatory mechanisms were maintaining the core temperature homeostasis although at a lower level than in younger individuals (*10*). This lower maintenance of core temperature could

be due to a lower level of resting metabolic rate that Wagner and Robinson report in the elderly (*19*) or perhaps the result of a combination of decreased activity, deficient diet, and cold environment.

It has not been clearly shown whether a decreased capacity for vascular response to cold occurs with age and, although a decreased shivering response in the elderly to cold has been shown, this has not been shown to be clearly disadvantageous. Clearly, investigators need to determine whether old people are deficient in their thermoregulatory mechanisms or whether the high incidence of hypothermia that seems to occur in the elderly might be the result of low activity, drug administration, cold environments, and deficient diets, as these exogenous factors may be much easier to control.

These are the unanswered questions to which researchers need address themselves if we are to prevent hypothermia in an epidemic proportion in our elderly population, in a world most certain to be faced with energy shortages in the future.

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