REFRESHER COURSE FOR GENERAL PRACTITIONERS

CLINICAL EFFECTS OF EXPOSURE TO HEAT AND SUNLIGHT

II. HEAT EXHAUSTION AND SUNBURN

BY

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HEAT EXHAUSTION

Heat exhaustion commonly results from exposure to moist heat. The heat-controlling mechanism is not seriously affected and there is thus no great rise in body temperature. There is, however, always a change in the body water/salt balance, and severe cases are complicated by the appearance of circulatory insufficiency and shock. The degree to which the cardiovascular system is involved is variable, but such involvement may be profound, especially in hot moist working conditions.

Most cases in the Tropics occur at the hottest time of the year. All ages and both sexes are susceptible. Under suitable conditions the syndrome appears in both visitors and indigenous populations.

Predisposing factors are similar to those in heat hyperpyrexia (see Part I). Of particular importance are heavy muscular exercise, inadequate intake of water and salt, loss or absence of acclimatization to hot working conditions, and concomitant febrile illnesses, especially malaria and pneumococcal infections. Dry-bulb temperatures of the order of 100° F. (37.8° C.) or over, associated with wet-bulb temperatures of 90 to 97° F. (32.2 to 36.1° C.), are apt to precipitate the syndrome.

It may be difficult to determine from the history whether there is obvious water or salt deficiency, but consideration of the tremendous losses of fluid and salt that may occur during heavy work in hot conditions, such as are found in mines, will usually indicate the presence of deficiencies which can be confirmed by examination of the blood and urine.

Clinical Picture

The onset may be abrupt, but there is often a prodromal period of several days in which the patient complains of progressive headache and anorexia, frequently associated with nausea and mild vomiting. Fleeting cramps, particularly in the muscles of the calf and foot, are common. There is no change in sweating, but the urinary output is often low. Giddiness associated with unsteadiness of gait may be observed shortly before the onset. Visual and aural disturbances such as "spots in front of the eyes" and "ringing" in the ears are common.

On examination the patient is usually exhausted, restless, and anxious. In more serious cases he may be lightly comatose. Loss of consciousness and other central nervous system signs are, however, minimal compared with those in heat hyperpyrexia and are of short duration, responding readily to treatment. The oral temperature may be normal or slightly raised. The rectal temperature is seldom higher than 102° F. (38.9° C.). The skin is cold, moist, and pale as a result of vasoconstriction. Sweating may be profuse. The skin is inelastic from dehydration, the facies is pinched, the eyes are sunken, and the cheek bones are often very prominent. Breathing is rapid and shallow. In comatose cases it may be deep and stertorous. If vascular failure has developed there may be evidence of pulmonary oedema.

Most patients vomit freely. The vomiting is not always accompanied by nausea and may be very intractable. Large

quantities of chloride may be lost in this way. Vomiting usually precedes the onset of muscular cramps, which occur most commonly in the legs, thighs, and arms. Cramps develop in abdominal muscles only in severe cases. Occasionally there may be carpopedal spasms resembling those of tetany.

The pulse rate is nearly always very fast, though occasionally there may be noticeable bradycardia. In mild cases the systolic pressure may be below 90 mm. Hg, but the pulse pressure is low, since the diastolic pressure often remains high in relation to the systolic because of the prevailing peripheral vasoconstriction. Sudden change of posture from lying to standing has a severe effect; the pulse races, the blood pressures fall, and the patient may faint. When medical shock appears the pulse rate rises, sometimes to 150 to 200 beats a minute. The diastolic blood pressure falls rapidly to a point at which it may not be measurable. The systolic pressure falls less in proportion, so that the pulse pressure tends at first to rise. In severe cases, however, the pulse may be imperceptible at the wrist. Loss of circulating blood volume is indicated by haemoconcentration, the haemoglobin and red-cell count rising by as much as 150% with an associated increase in blood viscosity.

Urine.—The urinary volume is reduced, often to about 500 ml. or less in 24 hours. When shock has appeared there may be complete suppression of urine, which may be transitory or persist, leading to acute uraemia. The urinary concentrations of urea and chloride are low; in severe cases there may be no chloride present. The concentration of fixed bases is also usually low. Chloride loss is excessive in cases in which vomiting is severe; sodium loss may be excessive when diarrhoea is predominant. For practical purposes it is enough to judge the mineral deficiency in terms of urinary chloride concentration only. The urine may contain albumin and hyaline and granular tubular casts. In severe cases the latter may be present in large numbers.

Blood.—The whole blood and plasma chloride concentrations are low in most cases, especially where vomiting has been severe. Blood urea nitrogen is frequently raised above normal and may attain a figure of about 100 mg. per 100 ml. even in cases in which there is no obvious renal failure. When acute uraemia develops the blood urea nitrogen rises rapidly as the uraemia develops.

Sweat.—The secretion of sweat is not restricted, as it is in hyperpyrexia. In most cases the chloride content is raised and the amount of salt lost is thus considerable. The high chloride concentration of the sweat persists for some time into convalescence.

Course and Prognosis

The death rate is low in uncomplicated and correctly treated cases. Shock greatly increases the risk to life, but with adequate and prompt treatment even the shocked patient will usually recover. When urinary suppression has developed the outlook is bad. Even in the most severe cases, however, recovery is usually at the most a matter of a few days, and with correct treatment may be only a matter of hours.

Provided the water/salt balance is adjusted and, where necessary, acclimatization is re-established there is no tendency to recurrence.

Diagnosis

A history of exposure to heat, particularly under hot working conditions, must be demonstrated. Predisposing factors are usually evident. It is essential in all cases to exclude malaria (especially falciparum) and other febrile illnesses. The presence of concurrent disease does not affect the treatment required for adjustment of the disturbances of water/salt balance or shock.

Treatment

Heat exhaustion is essentially a condition of dehydration associated with mixed water and salt deficiency, complicated in severe cases by vascular failure and acute reduction of effective blood volume. Treatment must aim at replacing fluid and salt as required and readjusting the blood volume.

All cases should be treated in bed. Mild cases will recover very quickly and may be allowed to return to work in a few days. They should be given a fluid diet in the first instance which ensures that they receive 5 to 6 pints (2.8 to 3.4 litres) of fluid in the first 24 hours. The salt requirement, normally 25 to 40 g. a day, can be administered orally in drinks or capsules. In severe cases parenteral replacement of fluid is of immediate importance. If the degree of dehydration is severe and there is extreme salt deficiency the first injections of isotonic saline must be given quickly—for example, the first pint (half litre) in 15 minutes, the next in 20 minutes, and the third in an hour. Thereafter fluid can be given at the rate of a pint every four to six hours up to a total of five pints (2.8 litres) in the first 24 hours. After three pints (1.7 litres) of isotonic saline have been given it is better to continue if necessary with either alternate pints of isotonic glucose and isotonic saline or a mixture of equal quantities of these solutions. An initial pint of plasma administered in half to one hour is needed in shocked patients. Conscious patients should be encouraged to drink saline fluids by mouth. A fluid intake/output account should be kept in all cases, and the urinary chloride content should be checked at intervals during infusion.

Recovery in most cases is very rapid. Parenteral administration of fluids is seldom required after the first 24 hours. In an adequately treated case the plasma chloride may return to normal values in under 48 hours. The urinary chloride concentration recovers more slowly.

SUNBURN

Sunburn is a reaction which follows exposure to ultra-violet light of wavelengths of 2,900 to 3,200 Å. Heat waves play no part in ordinary sunburn, which may readily appear after exposure to "cold" light, such as that reflected from water or snow. Heating the skin may, however, make it more sensitive to the active light.

The degree of burning depends on many factors, including the duration and intensity of the exposure. The area exposed is important; certain areas, such as the skin of the back and thighs, the back of the neck, and the popliteal fossae, are particularly susceptible. Blondes are affected more rapidly and more severely than brunettes or coloured individuals, in whom the pigmentation affords protection. Some protection is also provided by sweating and by slow acclimatization, which intensifies the degree of skin pigmentation, especially in brunettes, and to some extent increases the thickness of the horny layers of the skin. There is some evidence that the physiological state of the individual may affect the reaction to exposure; sunburn, for instance, is more easily acquired in the immediate premenstrual state.

Clinical Picture

Acute sunburn follows exposure after a latent period of half an hour to some hours. The first sign is erythema of the exposed parts, which may be only slight and transient, accompanied by some itching and a burning feeling in the affected areas. More severe cases develop acute erythema with oedema of the skin, which after a few hours develops

vesicles and bullae filled with clear fluid. The affected area is surrounded by a considerable erythematous flare. If the skin of the face is affected there is often concomitant severe conjunctivitis. In the absence of secondary infection, which may follow the rupture of blisters and bullae, the inflammatory reaction subsides, and desquamation and peeling follow, leaving irregular areas of hyper- and hypo-pigmentation.

Healing is usually rapid and complete, but complications are common, especially local secondary infection, which may be severe and resemble impetigo. The affected area often shows subsequent increased sensitivity to active light, which may persist for long periods. Herpes and telangiectases may appear in the healed areas.

Severe sunburn is accompanied by general signs and symptoms which may appear soon after the local signs become manifest, and which may be very serious if the exposure has been excessive. There may be malaise and headache, and nausea and vomiting often occur. In severe cases fever is the rule. In the worst cases fatal shock may develop. The general signs last a few hours to some days, depending on the severity of the burning and on the development or otherwise of sepsis.

Treatment

The affected area should be cleaned with calamine lotion or liquid paraffin, not with soap; antiseptic and analgesic ointments should be avoided. Calamine lotion should be applied freely. Badly affected small areas may be treated with the application of cold calamine or aluminium acetate (1%) compresses. Compresses should not be used on large areas. Blisters should be ruptured and the exposed areas painted with calamine lotion to which may be added 0.5% crystal violet. After the first inflammatory stage has subsided, calamine or zinc creams will usually rapidly heal blistered areas.

Where secondary infection is established the area should be bathed several times in the day with weak mercuric chloride (1/4,000) or similar solutions. Where sepsis is severe general treatment with antibiotics or sulphonamides, depending on the prevailing organism, may be required.

The local application of antihistaminic agents is useless, but these drugs, given orally, may sometimes relieve the itching and burning sensations which can be so troublesome.

General treatment consists of avoidance of further exposure and the administration of sedatives. Severely burnt individuals may require barbiturates or morphine. Severe sunburn must be treated like other burns and cradled and protected according to the area affected.

Prevention

The most sensible thing to do about sunburn is to avoid it. Ordinary glass will screen most of the active wavelengths. Some degree of acclimatization may be acquired even by fair-skinned individuals by regular controlled exposure, which ultimately results in increased skin pigmentation.

Considerable protection may be afforded by the use of chemical screens, which are designed to protect against both ultra-violet and infra-red light, or against ultra-violet only. Ordinary cosmetic face powders and creams have protective properties which may be specifically increased by the addition of certain substances that absorb the active ultra-violet wavelengths. These compounds include tannic acid (5%), quinine hydrochloride (5%), *p*-aminobenzoic acid (10%), and salol (10%) made up in a vanishing-cream base or dissolved in commercial spirit. Protective creams or solutions should be rubbed into the skin every three to four hours during exposure, and after swimming, especially in sea-water.

A combination of intelligent acclimatization and the use of creams will protect against sunburn, particularly in dark-skinned individuals. In the latter there is often little risk of sunburn on moderate exposure, and rapid pigmentation can be produced by treating the skin with materials which screen off the ultra-violet but not the infra-red wavelengths.

Vegetable oils act in this way, especially sesame oil. Mineral oils are not satisfactory. Thomas suggests the following as a "sun-tan" oil:

Methyl salicylate	..	..	10%
Sesame oil	..	..	50%
Liquid paraffin	..	..	40%

It should be noted that none of these creams, lotions, or oils will protect against the development of certain of the more chronic effects of exposure, especially those arising from sensitization. Care should be taken to avoid undue interference with sweating, which may result from too lavish and persistent use of protective creams and occasionally may precipitate hyperpyrexia due to interference with heat loss (see Part I).

The use of creams, etc., containing specific agents such as *p*-aminobenzoic acid must be watched carefully, since skin sensitivity to the chemical agent may be present, particularly if the area has been previously exposed to sunlight.

Chronic Effects of Sunlight

The more persistent effects of sunlight on the skin occur usually in individuals frequently exposed to the active light. They include atrophy of the epidermis, irregular patchy pigmentation and depigmentation, and solar keratitis (wart-like local hyperplastic areas which may go on to the development of basal-cell or squamous carcinoma). Many individuals habitually exposed to sunlight develop plaque-like, pinkish, excoriated, and scaly lesions varying from 1 to 3 cm. in diameter which appear on the exposed parts, especially the cheeks and the anterior region of the neck. Pruritus is common in these cases, and the plaques are often seen in association with more generalized polymorphic eruptions (summer prurigo) stimulated by exposure to the "sunburn" spectrum (2,900–3,200 Å). These eruptions are exacerbated on exposure during the summer and remit in the winter. They develop especially on the face, appearing as an itchy papular vesicular eczema which may become chronic and does not respond easily to treatment.

Solar urticaria in the form of non-confluent urticarial wheals and erythema may develop after the mildest exposure to sunlight, especially in individuals who have been sensitized by previous exposure to acute sunburn. The active radiations are infra-red.

These chronic conditions are often very refractory to treatment and require specialist advice. Protection against exposure is most important. In the case of summer prurigo active rays may be filtered by suitable physical agents, such as lotions containing quinine, tannic acid, and *p*-aminobenzoic acid, but it must be remembered that sensitivity may exist to the chemical agent used.

Next Refresher Course Article.—"Quarantine and Isolation," by Dr. R. E. Smith.

Nova et Vetera

PERSONAL HYGIENE IN ANCIENT ROME

A Translation of Galen's Hygiene (De Sanitate Tuenda). By Robert Montraville Green, M.D. With introduction by Henry E. Sigerist, M.D. (Pp. 277. £2 2s.) Springfield, Illinois: Charles C. Thomas. Oxford: Blackwell Scientific Publications. 1952.

Galen (130–200 A.D.) was the most voluminous medical writer of ancient times. The bulk of his surviving works, which are entirely in Greek, exceeds that of all the others combined. Apart from the Hippocratic Collection, almost all known of ancient anatomy, physiology, hygiene, and internal medicine comes from or through Galen. From him, too, we have, directly or indirectly, the bases of our medical vocabulary. Hardly any of this vast and varied literature is available in English. First in the field was the late Dr. A. J. Brock, of Edinburgh, who translated Galen *On the Natural Faculties*, a work on the general principles of physio-

logy. Professor R. M. Green now comes next with Galen's *On Hygiene*. The writer of this review has in the press Galen *On Anatomical Procedures*, which is on practical physiology and anatomy, while Mrs. May, of Cornell University, is preparing Galen's great theoretical treatise *On the Uses of the Bodily Parts*. When we have also a specimen of one of Galen's works on treatment the English reader will have access to a fair selection of the works of the greatest medical writer of antiquity, some 1750 years after his death.

The work which Professor Green presents is concerned with living wisely and well in the purely animal sense. Beyond advising serenity of mind and such occupations as reading and study, Galen has here nothing to say as to the ordering of the mental and spiritual life. The book gives an impression of such excessive concentration on details of physical health as, in a modern man, would be regarded as pathologically valetudinarian. This is characteristic of his age and society, for Galen is advising the idle rich, and nothing that can lead to a sense of physical well-being is omitted. No minutiae of massage, of exercise, of diet, of the bath, or of repose are too small for consideration. This has the advantage of giving an insight into the habits of the wealthy in "the great age of peace" of the Antonine Emperors. Life in Rome then seemed more secure and settled than perhaps at any time or place in history.

Galen's instructions extend literally from cradle to grave. "The new-born infant should be powdered and wrapped in swaddling clothes, that his skin be made firmer than the parts within. For during pregnancy everything was equally soft, since nothing of a harder nature touched it, and no cold air came in contact with it, whereby the skin would become tougher and denser than the other parts of the body. But when the baby is born, his natural covering should be best prepared by us for exposure." (Much shortened.) So he goes on through childhood to puberty, when he especially advises various forms of exercise and a careful diet, all minutely described, for "as the trainer is the attendant of the gymnast, so the cook is of the physician."

Galen often includes case-histories. He devotes several consecutive chapters to the hygiene of old age, making this the earliest work on geriatrics. One of his patients, Telephorus, a studious man, lived to be 100. "He used to bathe twice a month in winter, and once a week in summer, and three times a month in the intervening seasons of spring and fall. When he did not bathe he was anointed about the third hour, with brief massage. Then he used to eat barley boiled in water mixed with the best raw honey, and this alone sufficed him at first. And he also dined at the seventh hour or a little sooner, eating vegetables first, and then fish or game. But in the evening he ate only bread moistened in diluted wine." (Shortened.)

The overweight patient who fell into Galen's hands was in for a severe discipline. "I have made any stout patient moderately thin in a short time by compelling him to do rapid running, then wiping off his perspiration with very soft or very rough muslin, and then massaging him maximally with diaphoretic unguents, and then to the bath. After which I did not give him nourishment immediately, but bade him rest for a while, then to the second bath, and then gave him abundant food of little nourishment, so as to fill him up but distribute little of it to the body." (Shortened.)

Galen is anything but concise, and seldom uses two words when he can use twenty. Nor is it always possible to treat seriously his tirades against those who differ from him on some minor point, though in this work he is no more than pleasantly discursive and is less often stirred by controversy than is his wont. The translation is faithful, erring sometimes a little on the side of too exact literalness—a good fault—but it would bear far more annotation than it has received. Professor Sigerist contributes an attractive preface. Dr. Licht, who is arranging for a series of translations of Galen, adds a life of Galen, translated from the standard work of Daniel Leclerc. The presentation of the book is excellent, but it cries aloud for an index.

CHARLES SINGER.