a perfect fit, the intact skin broke down within six hours). Careful observation, in addition to the various patch tests, eliminated the possibility of artefact, except perhaps in Case V.

In every case except No. II careful inquiry was made as to the taking of any drugs such as sulphur or mercury, and it appeared that none of the patients was taking even a purgative or was under treatment for syphilis.

There remains the possibility of an allergic or pseudo-allergic cause. To incriminate the spectacle frames as a cause of an allergic skin response one must inquire: (1) Can the metal become ionized under conditions of wear? (Woods, 1933; Landsteiner, 1924.) (2) Do the history and mode of onset suggest allergy? (3) Does the lesion clear promptly on removal of the frames? (4) What is the response to specific patch tests? (5) Can this specific hypersensitivity be transmitted? (Prausnitz and Küstner, 1921.)

Lain quotes a company of manufacturing opticians who, after research, stated that they believed there was an electrolytic battery action between the dissimilar metals of the alloy in the presence of perspiration and aided by body heat.

Specimens of the frames were submitted to Lieut. Atkins, who reports as follows:

"The specimens were washed in absolute alcohol to remove traces of grease and then placed in distilled water, slightly acid as it always is, for several days. There was no trace of nickel by the most sensitive tests, and the surface remained bright. With sodium chloride in the water, between 1% and 2%, there was, however, slight reaction, so that after two or three days there was a marked pink with dimethyl glyoxine and ammonia with specimen 'C,' a definite but lesser pink with specimen 'A,' and no perceptible pink with specimen 'B.' It is possible that there would be still greater reaction if a complete frame was tested, due to one side being electronegative to the other. In this case the dermatitis might be earlier and more marked on one side. It is also obvious that this reaction requires the intermediary of sweat."

It will be noted that all the cases except II and V suffered from pityriasis sicca capitis, and all reported that they sweated very easily. The wearing of a respirator of course induces free perspiration under the rubber. In only one case was an inequality in the dermatitis noted—the worst case, No. III, in which the left side was earlier and more severely affected.

With regard to the second requirement, all these cases conform to the allergic types, with the exception of the doubtful case, No. V. Case II is the only one with a history of a previous intolerance, which explains the short latent period here. Case III also, with a brief latent period, had a breaking of the skin before the burning and itching, and may be explained as the mechanical effect of a bad fit which later became a true allergy, since, in the absence of mechanical irritation, the intact skin broke down in six hours. It does not seem necessary in any of these cases to appeal to the "silent sensitization" mentioned by Goldman, although the number of objects of everyday use which contain nickel is adequate—coins, badges, buttons, plumbers' fittings, parts of motor-cars, as well as the E.P.N.S. forms of tableware and cutlery.

The third requirement is fulfilled, since all cleared up promptly, only the most severe case taking more than a week to do so.

The response to specific patch tests is, as Goldman suggests, the vital test to detect the specific cause, and the results shown above strongly support the hypothesis that the nickel silver is the cause of a specific hypersensitivity. The tests were carried out with the standards laid down by J. Jadassohn and Bloch. Various tests were performed. Cases I to V were all patch-tested with a portion of the actual frames worn, and all were positive. Cases III, IV, and V were tested with portions of frames made by each of three different manufacturers. The results reveal no significant variation. Cases I and II were patch-tested with the separate elements of the alloy, and showed no reaction to the copper and zinc, but some reaction to pure nickel; there was a marked reaction to the alloy itself. The Prausnitz-Küstner reaction was tried in Cases I and VI. Both were negative. It is possible that the injected individuals did not perspire sufficiently.

Finally, a word might be said about occupational causes, but the wide variation in the civil and military occupations seems to rule this out.

Treatment

The occurrence of six cases in a short period of time from a fairly small group makes the question of treatment an important one from the military point of view. It is obvious that desensitization is too slow and uncertain a procedure for military use. The various methods employed by us have been discussed: it only remains to mention that rhodium and chromium plating proved a failure (Bettley and Lyle, personal communication, 1941).

From all points of view the most satisfactory solution was the adoption of the correcting wafer applied to the respirator eyepiece for use during gas attacks and of gold or shell frames at other times. When the refractive error is too high for satisfactory correction by a wafer the best expedient is to cover the frames in the manner prescribed for Case I. This involves only the use of easily obtained materials, and can be renewed by the soldier himself. It does not affect the gas-tightness of his respirator.

Summary of Conclusions

We conclude that dermatitis arising from the use of Army spectacles is an allergic phenomenon resulting from a prior electrolytic battery action which ionizes some of the nickel in the presence of the acid sweat and dissimilar metals, aided by the body heat.

Our acknowledgments and thanks are due to Brig. Sir Stewart Duke-Elder, K.B.E., for his interest and assistance in obtaining the cellulose varnish; to Brig. R. Cormack, O.B.E., D.M.S., E.A. Command, for permission to publish; and to Col. (now Brig.) W. K. Morrison, A.D.M.S., West Scotland Area, for permission to carry out the experimental part of the investigations.

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CEREBRAL FAT EMBOLISM AFTER ELECTRICAL CONVULSION THERAPY

BY

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Electrical convulsion treatment is rightly regarded as the safest of the shock methods available so far. Only a few fatal accidents have been reported in the literature (Alpers and Hughes, 1942; Ebaugh, Barnacle, and Neuburger, 1943; Napier, 1944). The last-mentioned author described 5 cases, which he considers to be the only deaths in England and Wales; in none of them had a microscopical investigation of the C.N.S. been carried out. According to Alexander and Löwenbach (1944), three possible mechanisms may account for the fatal outcome. The first is direct action of the electric current upon the brain tissue through which it passes, resulting in vasoconstriction and blanching of the tissue. They demonstrated this in animal experiments, but to obtain this effect shocks were necessary which in amperage, duration of flow, and density of current far exceeded those used in electric-shock treatment in human patients. The second mechanism is excessive stimulation of the vago-vasomotor centres of the medulla, causing generalized circulatory disturbances. This mechanism becomes operative only if the electrodes are placed in too posterior a plane, allowing the current to flow through the hind-brain. It is conceivable that some of the conflicting experimental results in animals

could be explained in this way. The third group is concerned with patients whose impaired cardio-circulatory-respiratory system cannot stand up to the excessive demands imposed by a convulsion.

The present case does not fall into any of these categories. It showed pathological changes which are of some practical and theoretical interest, and for this reason its publication seems to be justified.

Case History

The patient, a man aged 53, was admitted to Springfield Hospital as a certified patient on March 31, 1944. He had recently taken 108 aspirin tablets, as he thought he was being followed by hundreds of plain-clothes detectives. His physical condition was good. He had sustained gunshot wounds at the back of the right knee during the war of 1914-18, and now complained of severe pain in this knee, with inability to straighten the leg. The local lesion did not appear to be entirely responsible for this disability, and, indeed, under sodium amytal and suggestion therapy the patient was able to walk about freely without pain. Prolonged somnifaine narcosis was given from April 30 to May 15, but no lasting improvement resulted. Psychotherapy and occupational therapy were continued until December.

FIG. 1.—Frontal cortex. Scharlach R stain. ($\times 130$.)

At 10.10 a.m. on Dec. 5 an electric convulsion was instituted by a standard commencing strength of 120 volts alternating current for 0.3 second. After a latent period of one second a very strong fit lasting 55 seconds resulted. He made a fair recovery and was able to answer questions, but was pale and restless and complained of pain in the back. At 10.30 a.m. he collapsed and was given first 5 c.cm. and then 4 c.cm. of nikethamide. He improved and was able to take some tea at 11 a.m. He vomited the tea, and at 11.45 a.m. more nikethamide was given with intranasal oxygen and carbon dioxide. Again there was a slight improvement, but he collapsed at 12.45 p.m., and from that time remained unconscious, pale, and restless. Respiration was rapid and the pulse rapid and thready. At 3 p.m. his blood pressure had dropped from 148/90 to 110/90, and a pint of reconstituted blood serum was given slowly with 5 c.cm. of nikethamide. His condition steadily deteriorated and he died at 10.50 p.m. the same day.

Post-mortem Examination.—The body was well nourished. There were no external burns or abrasions. Two old scars were seen behind the right knee; they were superficial and not attached to deeper structures. A careful examination of the spine, ribs, pelvis, and skull failed to reveal any fracture. There was no bruising, deformity, or crepitus to suggest a fracture in any of the long bones. The meninges were congested; several small petechial haemorrhages were seen in the midbrain and in the frontal regions. Apart from congestion, which was most pronounced in the lungs, there was no significant macroscopic change in the other organs. Only the brain was sent for histological examination to the Central Pathological Laboratory.

Histological Investigation of the Brain.—Numerous blocks from all regions were examined by the usual neurohistological methods. No significant pathological changes could be demonstrated with methods which stain nerve cells, nerve fibres, and the glia. No petechial haemorrhages were seen in any of the slides, which indi-

cates that those noticed macroscopically were only few in number. There was, however, a considerable degree of congestion of all capillaries and veins. The fat stain revealed a surprising change. As Figs. 1-3 unmistakably show, many capillaries were blocked by fat emboli. These fat emboli occurred to a varying degree in all regions of the brain, including the cerebellum. They were more frequent in the grey matter than in the white.

Discussion

The diagnosis of cerebral fat embolism is established by the histological evidence and also clinically suggested by the so-called "free interval"—although it was not entirely free of

FIG. 2.—Occipital cortex. Scharlach R stain. ($\times 130$.)

FIG. 3.—Medulla. Scharlach R stain. ($\times 120$.)

symptoms and there is some doubt whether it ended with the first collapse about 20 minutes after the convulsion or with the second final collapse about two hours later. The characteristic petechial haemorrhages of the skin were absent; in the brain only a few were encountered.

Cerebral fat embolism has not yet been described after electrical convulsion treatment. It has been found, however, by Nightingale and Meyer (1940) in a patient dying after shocks produced by triazol, and by Nielsen and Ingham (1940) after treatment with leptazol (cardiazol). In the last-mentioned case fractures of both femora were responsible, while in Nightingale and Meyer's case no fracture was noted, although a vertebral fracture could not be excluded. In the present case the patient complained of backache, but despite careful post-mortem search no fracture of the limbs, spine, or any other osseous

part of the body could be detected. It is therefore necessary to consider other possible causes of fat embolism.

Apart from fractures, widely recognized causes of fat embolism are severe contusion, deep laceration of skin, severe burns, operations on adipose persons, and forceful orthopaedic manipulations (Strauss, 1933). Concussion as a causative factor has been recognized for 70 years (Robb-Smith, 1941a), and its significance has been stressed also by Silverstein and Konzelman (1940), but it should be remembered that most of the evidence is of an experimental nature (Strauss, 1933). The claim made by Robb-Smith (1941a) that blast alone may cause fat embolism has not been confirmed by subsequent authors (Zuckerman, 1941), but, if found, it should be regarded as a complication.

Convulsions and violent exertion during certain types of psychoses such as delirium tremens are occasionally mentioned as a possible cause of fat embolism (MacCallum, 1936), but the fact that fractures are more often produced by epileptic convulsions than was known in the past tends to qualify the significance of these older views. We were unable to trace any reference to this point in modern neurological treatises. One of us (A. M.) has investigated five brains from epileptics dying suddenly during or after convulsions. In four of these he failed to find fat emboli in the bodily organs, including the brain. Occasionally intravascular substances staining light pink with Sudan and usually not occupying the whole lumen of the vessels were encountered. They were also found, however, in other conditions, including carbon monoxide poisoning and tuberculous meningitis. These lipoidal substances, whatever their significance may be, are not likely to be of an embolic nature. It is possible, however, that they may have been confused with fat emboli by earlier investigators. Only in one case of death after epileptic convulsions was true fat embolism of the lung and, to a lesser degree, of the systemic circulation found. This was in a patient suffering from lipoidosis of the Hurler type (gargoylism)*. The liver and spleen were enormously enlarged, and contained an abundance of fatty substances, which may have been an important facilitating factor, just as the danger of fat embolism is increased in operations performed on adipose persons.

Opinion is still divided on the role of the blood lipoids in the formation of fat emboli. The most fully substantiated instance of haemic origin appears to be alkali poisoning (Robb-Smith, 1941b), followed by either hyperlipaemia or lipoproteolysis. Macfarlane, Oakley, and Anderson (1941) were able to produce *in vitro* free fat from blood to which *Cl. welchii* toxins had been added. Winkelman (1942), surveying previous experimental evidence, seems to favour the haemic hypothesis in view of the presence of large amounts of fat in the lungs and brain following mild injury or fracture of the smaller bones of the body, which are not likely to release a supply of free fat sufficient to cause widespread embolism. It is interesting that hypercholesterolaemia occurs in a large proportion of cases submitted to electrical convulsion treatment as well as after spontaneous convulsions (Katzenelbogen, Baur, and Coyne, 1944).

At the present stage of our knowledge it is impossible to say which of the factors surveyed above has been operative in our case. Although there was no evidence of a fracture of bone or contusion or laceration of other fat deposits of the body, it must be admitted that an unobtrusive mild fracture or any other of the common sources of fat embolism might have been overlooked. So far, this case should be regarded as an exceptional complication of electrical convulsion therapy.

In reporting the above case it is not our intention to point out any increased risk associated with this form of shock treatment. It is well, however, in future post-mortem investigations of sudden and unexplained death after electrical convulsion therapy, to keep the possibility of fat embolism in mind, particularly if a fracture has been produced. One of us (D. T.) has made a previous observation of death produced by electric shock treatment: the patient was a female schizophrenic aged 42. During the first treatment a current of 130 volts, lasting 0.3 second, was given after lesser applications had failed to produce a convulsion. The fit lasted 58 seconds. After 3

hours the patient was still unconscious. At intervals until she died, 19½ hours after the fit, she almost regained consciousness. At the necropsy no injuries, burns, or fractures were found. There was acute pulmonary oedema throughout the lungs. The liver was slightly fatty, the uterus was absent, the meninges were congested, and the brain was macroscopically normal. No histological investigation was carried out.

The absence of a free interval before the onset of the terminal symptoms militates against the diagnosis of fat embolism in this case, although atypical cases have been recorded. Excessive vago-vasomotor stimulation (the second group of Alexander and Löwenbach, 1944) might be an alternative explanation.

Summary

A case has been described in which sudden death after electrical convulsion therapy was caused by cerebral fat embolism.

Neither a fracture nor any of the other recognized causes of fat embolism were found post mortem. Other possible causes of fat embolism have been considered, but no final decision is justified at the present moment. The problem calls for special clinical and pathological attention in similar cases.

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PELLAGRA IN A MORPHINE ADDICT

BY

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Quite apart from those areas where it is endemic and due to inadequacy of the local diet, or where it is associated with alcoholism (Deeny, 1942), pellagra has been recorded in a variety of conditions interfering with digestion and absorption. It is not uncommon in chronic psychotics and in cases with peptic ulcer—classes of patient who may limit their diet voluntarily. Cases in which morphine appears to have been the chief factor are rare (Bean, Spies, and Blankenhorn, 1944). We therefore record the following instance.

Case History

The patient, the widow of a medical practitioner, was said to have been a morphine addict for 12 years. She took the drug in the form of 1/3-gr. tablets hypodermically—at one time as many as 20 a day. Latterly she had taken only 12 a day. In one particular week she had taken 200 tablets. The usual amount was about 100 a week. She also took large quantities of aspirin. There was a history of dyspepsia but no radiological evidence of peptic ulcer, and it is certain, in view of her behaviour, that her frequent complaints of pain were efforts to obtain morphine.

Since the addiction developed she had taken little food. She ate no vegetables and little fruit. Occasionally she ate a lamb chop, but no other meat, no milk (except in coffee), and no eggs. Her diet consisted almost exclusively of white bread and butter, a little cheese, a little bacon, tea, and marmalade. She became very thin, in contrast to her former plumpness.

She had had attacks of diarrhoea at intervals for three years. These were controlled "only by morphia." She had had brown patches on her skin off and on for years, and used to be distressed

* This case will be published in full, together with two other cases affected by the same condition.