respiration. It is this tonus that keeps the lungs expanded and prevents atelectasis. The movements of respiration do not consist merely in the alternate contraction and relaxation of the thoracic muscles. In reality, as W. R. Hess expresses it, these muscles pass at each breath from one tonus level to another and back again. When respiration is depressed the tonus level of the entire musculature of the body is depressed also. The capacity of the thorax is greatly decreased by the relaxed and elevated diaphragm and the flaccidity of the other respiratory muscles. In the partially deflated lungs atelectasis readily develops, and, if infection is present, pneumonia may follow.

When, on the contrary, respiration is stimulated, as it is in normal muscular activity by an increased production of carbon dioxide in the body, or as it is by inhalation of carbon dioxide, the tonus of all the muscles of the body, and particularly those involved in respiration, is increased. The lungs are expanded, occlusion of airways is prevented, and any airways that have already been occluded are reopened. The normal drainage from the lungs through the airways is maintained, or re-established, and the development of a secondary pneumonia is prevented.

Even in the development of primary pneumonia low muscular tonus, partial deflation of the lungs, and the resulting atelectasis probably play an important part; for it is a well-recognized fact that lobar pneumonia may spread from patient to patient in the beds of a hospital, but that the physicians and nurses, who are moving about and keeping their lungs expanded, are relatively immune to the contagion.

If the length of this address permitted it could be shown that respiration exerts its chief effect upon the circulation also through its influence upon the tonus of the musculature of the body. This tonus is the chief factor in the veno-pressor mechanism—a mechanism largely distinct from the vasomotor system and scarcely less important. It is the tonus of the skeletal muscles which normally presses the blood out of the tissue capillaries into the veins and back to the right heart. Whenever respiration is stimulated, as it is by physical exercise, the increased tonus of all the contractile tissues increases the volume of the venous return, improves the heart action, and augments the circulation.

When, on the contrary, respiration and muscle tonus are depressed, the blood stagnates in the tissues, the venous return is diminished, the heart action is weakened, and the circulation is retarded. The extreme form of such depression is surgical shock. The inhalation of carbon dioxide after anaesthesia and operation, and in other conditions of lowered vitality, by restoring respiration and muscle tonus, counteracts both the depression of the circulation and the tendency to atelectasis and pneumonia.

Such in brief outline are the contributions which the physiology of respiration is making to the science and art of resuscitation. From the developments of the past few years it appears probable that in the near future all secondary pneumonias will be preventable.

CONCLUSIONS

In cases of drowning, asphyxiation, and other accidents, and after surgical anaesthesia, the prevention of secondary pneumonia is almost as important as the immediate resuscitation. Inhalation of carbon dioxide mixed with oxygen or with air is the most effective means of stimulating respiration. This inhalation has proved to be also a highly effective preventive—indeed, it is essentially the specific preventive—of the collapse of the lungs which leads to pneumonia. These two advantages have now been demonstrated by experience in large numbers of cases of carbon monoxide asphyxia, drowning, and other accidents. In the asphyxia of the newborn this inhalation is replacing

the old brutal and often ineffective methods of swinging, spanking, and dipping. In surgical clinics this treatment is used to counteract failure of breathing under anaesthesia, to restore a normal circulation, and especially to prevent post-operative pneumonia.

Respiration is closely associated with the tonus of the muscles, especially of the thorax. Depressed breathing and low tonus permit collapse of parts or the whole of a lung. From this collapse, if infection is present, pneumonia develops. If respiration and muscle tonus are stimulated by inhalation of carbon dioxide the lungs are kept open and the development of pneumonia is prevented.

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DIABETES INSIPIDUS FOLLOWING FRACTURED SKULL

BY

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HULL

Diabetes insipidus, a comparatively rare condition, has been recognized since 1674, when Willis noted that in a certain number of cases which were classed as diabetes mellitus the condition of the urine was different, in that it did not have the same sweet taste. This suggested to him a basis of differentiation. It was not until one hundred years later that Simmons described two cases of this disorder, and these were published in detail by Fitz. Following this, Frank referred to diabetes insipidus as "a long-continued abnormally increased secretion of non-saccharine urine, which is not caused by a diseased condition of the kidneys."

Although this malady was definitely recognized by clinicians, nothing was known of its etiology except that it was not due to renal disease. The nineteenth century literature contains several articles dealing with experimentally produced diabetes insipidus. Claude Bernard, in his experimental puncture of the floor of the fourth ventricle, produced this syndrome, and believed that he had found a centre in the base of the brain which governed it. If diabetes insipidus is due to some disturbance of the pituitary, as we have every reason to believe, then the experimental work of Schäfer, Magnus, and Herring, and the deductions and observations of Cushing, are invaluable. Briefly, Schäfer, in 1902, proved that a polyuria in animals could be experimentally produced by the injection of pituitary extract. Other experimental work showed that the diuretic action of the pituitary extract was caused by the pars intermedia. At the same time, Cushing noted that in a certain number of his operation cases in which the pituitary body was subjected to manipulation a severe polyuria frequently resulted, which

lasted for several days. He believed that this was due to a hyposecretion of the posterior lobe of the pituitary.

A great number of pathological conditions are put forward as the cause of diabetes insipidus. The commonest of these are: tumours of the pituitary body, tumours of the base of the brain, head injury, acute infectious diseases, tuberculosis, and syphilis. The two main theories advanced as the cause of diabetes insipidus are: (1) the endocrine theory, and (2) the nervous theory. According to the endocrine theory the syndrome is manifested by a lack of pituitary hormone in the blood, due either to diminished production or to deficient absorption. According to the nervous theory, the condition is due to some disturbance of the hypothalamic region. Croll has shown that the pars intermedia of the pituitary is richly supplied with nerves. Greving and Pines have described nerve tracts from the hypothalamus to the pituitary: any interference with this nerve supply is evidenced by pituitary disturbance. Whatever may be the pathology, the determining factor is the functioning power of the pituitary body.

Records of some of the American hospitals show that there have been no authentic cases. Rowntree of the Mayo Clinic, Rochester, states that of 257,000 hospital admissions, 35 were indexed as diabetes insipidus, but on careful study he disregarded 11 of these. Fitz recorded an incidence of 14 cases per 100,000, and Williams's statistical review shows the incidence to be 19.2 per 100,000. It is more common in youth and in the male sex. Of 85 cases quoted by Strauss 57 occurred under the age of 25; and of 36 cases quoted by Moffat and Greenberger 28 were males and 8 were females.

The symptoms and signs of diabetes insipidus are varied. The diagnostic features of the condition are: (1) the uncontrollable thirst, and (2) the polyuria, the urine being of low specific gravity. The other features which may be present are a subnormal temperature, slow pulse rate, low blood pressure, somnolence, irritability, lack of appetite, constipation, and dry skin. These symptoms are by no means constant in every case. The patient may complain of none other than the thirst and polyuria, describing the condition more as a nuisance than as an ailment. On the other hand, some patients may become worried and depressed, and melancholia has been known to result. Ocular symptoms which may arise during the course of the disease are usually due to the pressure effects resulting from the tumour. X-ray appearances of the sella turcica are, as a rule, not very helpful, except in cases where there is tumour formation. The polyuria is invariably the first sign, and the thirst is consequent upon the polyuria. The quantity of urine passed varies considerably, as much as 20 pints being voided in twenty-four hours. It is of very pale colour, and the specific gravity is always low, practically never above 1010. The reaction is faintly acid and the percentage of solid constituents small. The prognosis depends essentially upon the causal lesion. If this is a head injury the prognosis is relatively good. If it is a tumour the outcome is fatal and the disease invariably of short duration. Where syphilis is the cause anti-syphilitic treatment gives beneficial results. In the idiopathic cases where no definite lesion can be detected the patient, although responding well to treatment, may drag on for years, and death may ultimately be due to some other disease. Hypodermic injection of pituitary extract gives the most satisfactory results. The urine is greatly diminished, the blood pressure rises, the pulse quickens, and irritability and somnolence disappear. One must be guided more by the alleviation of the thirst than by the quantity of urine passed. The amount of extract used varies, and, at first, is best given in two separate doses,

as its effect lasts only about eight hours. As soon as the patient wakes in the morning he should be given a hypodermic injection of pituitary extract, and this is followed by a second dose in the evening. With the co-operation of the patient one can arrive at the correct dosage to keep the condition under control. With improvement, less pituitary extract can be given and the time between the injections lengthened. Feeding the patient on fresh pituitary gland may be useful. Such a method, of course, is not practicable in the smaller towns or villages. Motzfeldt quotes a case where he fed his patient on seven fresh glands daily. Under this treatment improvement was so marked that in eighteen months' time the condition could be kept under control with one gland per day. Lumbar puncture has been used in certain cases, especially in that type due to tumour formation and serous meningitis. Such treatment, of course, gives only temporary relief. Anti-syphilitic treatment in the syphilitic type of case gives satisfactory results.

HISTORY OF CASE

On October 6th, 1930, a male, aged 21, was admitted to a nursing home suffering from fractured anterior and middle fossae of the base of the skull as a result of a motor accident. (The x-ray photograph showed an extensive fracture, commencing high up in the right temporal fossa and running down into the base of the skull into the regions of the anterior and middle fossae.)

On admission he was in a dazed condition; both eyes were swollen and discoloured, and he bled from the right ear and nose. The following day he complained of loss of vision in the right eye, together with deafness in the right ear and headaches. During the first few days the patient showed signs of improvement. The quantity of urine passed was estimated at 45 ounces +, and of specific gravity 1014; there was only a trace of albumin. About a week after admission he became rather drowsy and irritable, and he complained of thirst. His urine was now 100 ounces + per day. No active treatment was instituted at this time. He was carefully observed from day to day, and on October 24th the thirst had greatly increased, the quantity of urine passed being 160 ounces +. He was very irritable, and at times drowsy. His bowels were constipated, and his skin dry; the temperature was 97°, pulse rate 48, respiration rate 12. He stated that his thirst was insatiable, and on one occasion, so great was his craving, he secretly got out of bed when he was unattended and drank the water in the wash-basin. On the 25th hypodermic injections of pituitary extract were commenced. The results were spectacular. The initial dose given was 1 c.cm. twice daily. His thirst diminished and the polyuria decreased, the total amount of urine passed in the twenty-four hours following treatment being 59 ounces. The temperature rose to 98.4°, the pulse rate gradually increased to 68, and his respiration rate to 14. With the co-operation of the patient the dose of pituitary extract was diminished to 3/4 c.cm., given the first thing on awaking in the morning and the last thing at night. This, the patient stated, gave him total relief from all his symptoms.

He was discharged on November 10th, 1930, with instructions to carry out the pituitary treatment under his own medical adviser's observation.

The case presented illustrates many important and interesting features. I believe that the cause of the diabetes insipidus in this patient was the fracture involving the middle fossa; presumably it passed through the sella turcica and in some way injured the pituitary body. It is probable that, as a result of haemorrhage, there was pressure on the pituitary gland, causing interference with its function. The fact that the condition was not manifested until a week after the accident proves that the pituitary body was not directly injured at the time of the accident, and that its dysfunction was caused by something else. This, in my opinion, is a very useful point in the prognosis, which, had the disorder been due

to a direct injury, would have been very much worse. As this haemorrhage is absorbed so will the function of the pituitary increase, and the patient already shows signs of improvement in that less pituitary extract is required to control the thirst and polyuria. The necessity for early recognition of diabetes insipidus cannot be too strongly emphasized, as the polyuria in time has a deleterious effect upon the kidneys and bladder. Pituitary extract hypodermically is without doubt the treatment of choice, but it must be remembered that it is not a cure. The treatment must be maintained and the co-operation of the patient sought.

In conclusion, I desire to express my indebtedness to Mr. Blair for the facilities he has afforded me in observing this case.

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CONGENITAL PYLORIC STENOSIS*

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Although the morbid anatomy and clinical features of congenital hypertrophic stenosis were clearly defined by Hirschsprung in 1888, no striking advance in the treatment of the condition was effected till the introduction in 1913 by Rammstedt of the simple operation of section of the sphincter. Till then treatment was essentially medical. Surgical intervention was only given a chance in obstinate cases and was associated in general with a mortality rate of about 50 per cent., although a few operators using Loreta's method of dilatation quoted better results. With Rammstedt's operation the reported mortality varies from 5 to 25 per cent., and it has become almost the standard method of treatment.

It is noticeable in the literature, however, that the swing-over to surgical treatment has by no means been general, particularly in Germany and Denmark. As late as 1927 Professor Monrad of Copenhagen reported 228 cases of the condition all treated medically and with an over-all death rate of only 14.4 per cent. It may therefore be a matter of dispute how far the extended use of the operation has reduced the mortality. One undoubted advantage it has by common acceptance—namely, the shortening of the period of treatment. The wide variation in the mortality reported by various observers shows that the problem is affected by several factors. Both pre-operative and post-operative treatment influence the result as much perhaps as the method of operation.

The fact that I am allowed to open this discussion is, I think, evidence of how far in this country radical surgical treatment has been accepted. I would emphasize, however, that the surgeon plays only a small, if important, part in bringing these cases to a successful issue. The direction of the pre-operative and post-operative treatment requires the greatest judgement and care of a skilled paediatrician if satisfactory results are to be obtained. As opener I propose to outline the general points in relation to diagnosis. I shall consider in some detail the operative

technique and its bearing on results, leaving it to those who follow me to consider in detail the more difficult medical and biochemical problems on which they are so much better qualified to speak.

SYMPTOMS AND DIAGNOSIS

The cause of the pyloric hypertrophy remains a matter of speculation. The fact that it is commoner in males than in females (4:1) and in the first-born is accepted. Although obstructive symptoms are seldom in evidence till the second week of life, it would seem probable from the size of the tumour even at the earliest stage that the hypertrophy develops during intrauterine life. The youngest patient I have operated on for the condition was 18 days old, and the oldest was 6 months. It does not seem to me to be necessary to discuss whether spasm and stenosis of the pylorus should be distinguished. In my experience some degree of hypertrophy is present in all cases, and even in its fully developed form symptoms are produced by spasm and not stenosis in its true sense.

The points determining diagnosis are, I think, well established, and do not provoke controversy. It is based on the presence of repeated projectile vomiting, visible peristalsis of an enlarged stomach, coupled with wasting and constipation developing about the second week of life in an infant till then apparently normal. A tumour may be felt at the pylorus, but evidence of this is certainly not necessary to establish the diagnosis. I have noticed at operation wide variation in the size and consistence of the tumour and also in the depth at which it lies under the liver. Radiography gives interesting pictures for study and definite evidence of the degree of obstruction, but it is not essential as a routine diagnostic method.

WHEN TO OPERATE

The decision as to when a case should be operated on is no doubt difficult, and will vary with the facilities available. My own impression is that once the full range of symptoms above described is established, the sooner operation is carried out the better will be the results. I think my colleague, Dr. Jewesbury, who has passed on to me the majority of the 150 cases I have operated on, takes this view. If serious emaciation has developed, the risk of operation is certainly gravely increased.

TREATMENT BEFORE OPERATION

Pre-operative preparation should, I think, consist in regular washing out of the stomach for a few days and the administration of subcutaneous glucose saline for a similar period. Regular small feeds of a suitably diluted milk given at two-hour intervals are continued. I do not know how far the administration of atropine is useful, and I shall be interested to hear the views of those who follow me on this subject. To them I shall leave the fuller discussion of this problem and the strictly medical treatment, as they are better qualified to express an opinion.

OPERATIVE TECHNIQUE

It is clear that the choice and administration of the anaesthetic in these infants with so frail a hold on life is a matter of importance. Gray and other surgeons at the Great Ormond Street Hospital consider gas and oxygen to be the best. In Germany chloroform seems to be popular. It was used by Kirschner, who records 15 cases without any deaths. Pauchet prefers local anaesthesia. In my own experience light ether anaesthesia given on an open mask has been satisfactory. It is certainly simple to give and readily controllable. In two cases in which death

* Read in opening a discussion in the Section of Diseases of Children at the Annual Meeting of the British Medical Association at Eastbourne, 1931.