Special Articles on Diagnosis.

(Contributed by Request.)

XLIV.

CHRONIC LEAD POISONING.

CHRONIC lead poisoning is the result of the absorption of small quantities of lead for a continued period, as opposed to acute lead poisoning, the result of taking a large quantity, for example, of the acetate, in one dose. Many of the manifestations of chronic lead poisoning may be so abrupt in their appearance that they are called acute, but the underlying pathological process is a long continued one.

There are two forms of lead poisoning seen in Australia: (i) Of adults, an industrial disease; (ii) of children, a house disease.

The latter is almost entirely, so far as is known at present, confined to north-eastern Australia, from the northern rivers of New South Wales up. The former is seen in certain industrial centres, where such operations as lead refining, enamelling and battery making are in progress. It is also seen to a less degree nowadays among painters, printers and plumbers.

Certain features are common to both diseases.

LEAD POISONING IN CHILDREN.

The forms of lead poisoning found among children are held to be the simple paralytic, the cerebral and the minor forms.

Certain features are common to all these forms:

(*a*) The patients are usually over two years and under eight years—the veranda age.

(*b*) The sexes are equally affected.

(*c*) There is an available source of lead, for example, powdering paint on walls, fences or railings.

(*d*) The means of transferring the lead to the mouth is by nail biting, finger sucking or drop catching.

(*e*) Usually there is a stage of preceding moderate ill health, lack of appetite, listlessness and pallor.

(*f*) Colic consists of a sudden spasm of pain, "doubling up" and coming on without warning, unaccompanied by diarrhœa, but sometimes by vomiting, and localized mainly to the upper part of the abdomen. John Hunter described it as "dry bellyache" and the description still holds. The pulse rate falls even to 40 to the minute. Firm abdominal pressure relieves, not increases, the pain. Colic must be distinguished from (i) acute intestinal obstruction of organic origin, for example, volvulus; (ii) entero-spasm giving rise to a transitory obstruction; (iii) acute appendicitis, distinguished by a rise in temperature and increase in pulse rate; (iv) simple dietetic upsets; (v) biliary and renal colic which are rare in childhood. The fact that in an attack of colic irregularities of the colon may be palpable often adds to the difficulties of diagnosis.

(*g*) Wasting, especially of the muscles of the face, occurs, apart from actual paralysis and of the subcutaneous fat. The infraorbital and buccinator muscles are specially affected.

(*h*) There are certain blood changes commonly seen in cases of plumbism, though they are not necessarily characteristic of this disease. A fall of erythrocytes to as low as 2,000,000 occurs and a greater proportional fall of hæmoglobin, so that the colour index is as low as 0·6. The red cells are altered. There may be poikilocytosis, anisocytosis with a general diminution in size of the cells, loss of central hæmoglobin so that the cell appears quoit-like, alteration in staining, either a general tendency to take the blue of the Jenner-Romanowsky stains rather than the eosin, that is, a polychromasia, and the classical stippling. The last is claimed to be characteristic of lead anæmia and by some the presence of more than 500 stippled cells per million is alleged to be pathognomonic of lead. Others are less dogmatic and hold that characteristic stippling may be produced by quite other agencies in childhood.[1] Conversely, the absence of stippling does not exclude plumbism. There is no characteristic alteration in the white cells. This may be a negative sign of slight value.

(*i*) In regard to the Burtonian blue line, two essentials are required: Sufficient circulating lead in the blood and a septic dental factor—no blue line is found in the absence of dental sepsis. The line occurs as a row of minute blue-black dots just at the gum margin. It is best shown by inserting a stiff white card between tooth and gum, raising the gum margin—Gibson's test. The blue line is not necessarily confined to the incisor teeth, it may occur at the gum edge of any septic tooth.

(*j*) Lead in the urine. This can be detected only by an expert chemist in a first class chemical laboratory. At least one litre of urine is required and it must be collected so as to be free from lead contamination, for example, lead foil on cork or bottle. A clear pickle bottle or, better still, a winchester is washed first with tap water, then with distilled water and finally with 20% hydrochloric acid in distilled water. Decomposition may be prevented by adding formalin, 20 cubic centimetres to the litre. Lead present above 0·05 milligramme per litre is regarded as pathological. The presence of lead in the urine does not necessarily prove that any lesion under consideration is due to lead poisoning, any more than a positive Wassermann reaction proves that an ulcer on the tongue is syphilitic and non-malignant. It does, however, indicate that lead, a tissue poison, is present in the body and is being excreted by the kidneys. Some patients with plumbism may show no lead in the urine and lead may be found in the urine of patients in whom no other manifestation can be found.

(*k*) Albuminuria, usually unaccompanied by casts, is common in all degrees of lead poisoning, from the mildest abortive forms to the most severe paralysis. The amount varies from a faint cloud with salicyl-sulphonic acid to a heavy deposit of 0·5% Esbach. Actual renal damage to the extent of inefficiency is rare during the initial stages.

The Simple Paralytic Form.

In the simple paralytic form the following muscles are affected. In the lower extremities the peronei and extensors of the foot may give rise to the common foot drop. In the upper extremities the extensors of the wrist, especially the *extensor digitorum communis* and *extensor indicis* may be affected so that the wrist can be extended if the fist is closed (Gower's sign). Involvement of the trunk is rare, but paralysis of the diaphragm has been observed. Sometimes combinations of all forms of paralysis occur, for example, upper and lower limbs have been occasionally paralysed at the same time.

The features of the paralysis are as follows: Flaccidity is present. The paralysis is slowly progressive. It is a neuritic paralysis, picking out nerves and not segments. The reaction of degeneration is present when paralysis is complete. There is no sensory disturbance, apart from pain in affected muscles and on pressing nerve trunks. Usually complete recovery occurs, even after much wasting of muscle, but deformity, for example, *talipes equino-varus*, may persist requiring surgical treatment. Most striking of all, the paralysis is symmetrical.

This paralysis must be distinguished from:

(*a*) Diseases of muscles—the myopathies.

(*b*) Other forms of neuritis, such as alcoholic (very rare in childhood); arsenical (also rare) in which sensory changes are prominent; syphilitic, rare and not usually symmetrical; and diphtheritic, though the distribution is rather different, and a history of sore throat or nasal discharge can always be elicited; acute infective polyneuritis, another rare disease, in which sensory changes are very obvious.

(*c*) Spinal conditions: (i) Acute anterior poliomyelitis is distinguished by its acute onset in a previously healthy child, the more asymmetrical distribution and the segmental rather than the neuritic manifestation, and finally

[1] Dr. W. T. Nelson of the Commonwealth Serum Laboratories informs me that he is engaged on work which still further tends to cast doubt upon the specificity of stippling as a sign of plumbism.

by the fact that recovery does not tend to be complete. (ii) Progressive muscular atrophy, disseminated sclerosis and column diseases of the cord are rare at this age, and the distribution and nature of the paralysis are very different.

(d) Rheumatism, which has only a very superficial resemblance.

In most cases it is dangerously fallacious to use the results of treatment for purposes of diagnosis. It leads to arguing in a circle. Should, however, a patient with doubtful paralysis make a complete recovery when given rest in a zero position and treatment by magnesium sulphate and potassium iodide, it is often claimed that this supports the diagnosis of plumbism.

The Encephalopathic Form.

The mechanism of the encephalopathic form is at present in dispute. The essential feature is an increase in cerebral pressure owing to either an excessive production or a diminished elimination of cerebro-spinal fluid, which is normal in character in our experience, though Aub and Holt describe an increase of cells and globulin. *Post mortem* studies of the condition are lacking.

The excessive secretion may be due to increased activity of the chorioid plexus, the result either of direct stimulus by the circulating lead or indirectly through the products of nervous tissue degeneration.

Little has been said as to deficient elimination in this matter, but the lead may well have a direct action on the absorbing areas of the meninges. In any case the increased pressure is manifested by: Severe headache; squint, due to paralysis of the external rectus muscle of one side; papillœdema; secondary optic atrophy and blindness; convulsions of all degrees of severity. These may be indistinguishable from simple convulsions due to dietetic or other causes, for example, onset of any acute illness. They may be distinguished only by looking for possible sources of lead absorption; history of pallor, loss of appetite and headaches; blue line and blood changes; squint, papillœdema and greatly increased cerebro-spinal pressure on lumbar puncture. Of these the possible sources of lead absorption and a history of pallor *et cetera* alone may call the parents' attention to the condition. Rarely is there sufficient disturbance of vision to attract attention, unless the condition has been a long time in existence, by which time the damage may be great and irreparable.

The headache is usually severe and frontal and continuous. It may be sufficient to change a bright child into a very dull one, who will sit holding his head and dreading to be disturbed. The relief of the headache by lumbar puncture is very striking.

Squint may be transitory, but is usually constant. Children seldom complain of diplopia—the image of the squinting eye is neglected and nothing is said. The paralysis is practically always of the external rectus; it may be bilateral, but is more commonly unilateral and disappears rapidly after lumbar puncture.

Papillœdema is a simple papillœdema, quite distinct from the hypertensive retinitis seen in advanced arterio-sclerosis. The swelling may be great, with comparatively little interference with vision, up to 10 diopters. Similarly, if the pressure is relieved by lumbar puncture, the swelling rapidly subsides until the pressure has been brought down to normal and remains there. A papillœdema of 10 diopters has been known to recover completely with such treatment alone.

Should there follow failure to treat the papillœdema (a neglected swelling of much less will cause atrophy and blindness) the discs assume the typical chalk white colour, the vessels shrink and the retina grows pale. The outlook is now hopeless. Such cases of blindness have occurred in a child treated three times for papillœdema; the fourth attack was left too long.

Differential Diagnosis.

Tuberculous Meningitis.—In tuberculous meningitis the child is usually feverish and too ill to get about. The child with lead papillœdema, on the other hand, is often alert and lively and afebrile. Kernig's sign, head retraction and, above all, the reactions of the cerebro-spinal fluid, distinguish it in the earlier stages, while in the later the obvious progress to a fatal issue provides an absolute, if late, distinction. Tuberculous meningitis is rare in Queensland and is extremely uncommon in children over two years of age.

Epidemic Encephalitis.—Epidemic encephalitis may be ushered in with slight or no rise in temperature, heaviness and, above all, squint or other cranial nerve signs. Papillœdema is of the utmost rarity, and its presence is always enough to cast grave doubt on the diagnosis.

The Neuro-Retinitis of Diabetes and Arterial Hypertension.—In diabetes the condition is a neuro-retinitis, not a papillœdema, and other signs of the disease, for example, high blood pressure, albuminuria or glycosuria will be present.

Cerebral Syphilis.—Choked disc may be the only sign in basal cerebral syphilis. It may be combined headache and squint, and secondary optic atrophy may occur, as well as primary optic atrophy with no other frank manifestations of syphilis. The alteration in the cerebro-spinal fluid as regards Wassermann reaction, cell count and globulin content must be always investigated.

Cerebral Tumour or Cerebral Abscess.—Differential diagnosis from cerebral tumour or cerebral abscess may be difficult in the absence of localizing signs. There may be a simple papillœdema, temporarily diminished by lumbar puncture, a puncture which produces only normal cerebro-spinal fluid under varying degrees of pressure.

Sometimes only the course of the disease may be sufficient to establish the diagnosis, but occasionally cerebral tumours temporarily cease to progress, or even retrogress, giving all the appearance of a cure.

In all cases of doubt the presence of some or all of the common features of lead poisoning may determine the diagnosis. These may, however, be absent, as it is held that the encephalic form of lead poisoning is a manifestation of rapid intake of relatively large quantities. Radiography of the skull and even ventriculography may be necessary to distinguish these conditions.

Minor Forms.

Breinl and Young, in *Annals of Tropical Medicine and Pathology*, described minor forms of lead poisoning as follows:

> The cases may be classed according to the severity of the symptoms. The very early cases have no definite symptom. Parents complain of a change in the character of the children within the last few years; whilst previously they have been normal and well behaved, lately they have become peevish and fretful, were very restless at night, and had lost their appetite completely. As a rule, only careful cross-questioning elicited the information that the child had been complaining of slight pains in the epigastrium and pains in the legs.
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> The breath was often foul and now and again ulceration was noticed in the mouth. According to the parents' statements the children were flushed in their faces and appeared feverish. All the symptoms referred to are very definite and may be considered as the commencement of any infectious disease.
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> Even in these early cases lead can be found in the urine, often in appreciable quantities, and without the chemical analysis the correct diagnosis would be very difficult.
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> In cases of slightly longer duration the pains in the abdomen, intermittent at first, have become more continuous. Constipation is the rule, but in rare cases a history of intermittent diarrhœa is given. Vomiting is only very rarely observed. The pains in the calf of the leg become more marked, the calf muscles are often so painful that the little patients cannot endure even the weight of the bedclothes, and at this stage the gait of the child becomes affected. The Burtonian line was observed only in a small percentage of the children.
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> A continuous line is not often found in children, but the characteristic minute black spots occur round teeth which are coated with a deposit of tartar, requiring the use of a hand lens for their diagnosis.

The symptoms in these children are mainly those of general ill health; there is nothing definite, but the mother complains that the child is listless, has no appetite, will not play, cries without provocation and is losing weight. He may sleep badly, enuresis is not uncommon and slight abdominal pain, not amounting to actual colic, is often present. Headache is a very variable symptom.

On examination there is at first little to be found. The child is peaky, pale and often flabby. He usually cries at any manipulation, but no source of pain or frank tenderness may be found in the limbs or abdomen. Sometimes there is evidence of mouth breathing, there may be a faint blue line on the gums of septic teeth and there may be a slight suspicion of wrist drop or foot drop. The patients with headache rarely have papilœdema. The symptoms are very similar to those described by Mathew in mild cases of industrial plumbism.

Evidences of possible lead absorption are always present and should be sought for diligently, even if the child's own home affords no supply; there may be a neighbour's, a fence on the way to school or, in one case, a bridge rail. Nail biting, finger sucking and drop catching (in wet weather) are the commonest methods of collection.

The conditions which may be mistaken for minor plumbism are: Minor degrees of chronic sepsis—of teeth, sinus or tonsils; congenital syphilis; intestinal worms; chronic intestinal indigestion (John Thomson); thyreoid deficiency in mild degrees; cœliac disease; pink disease; acute leuchæmia. I have seen all these conditions ascribed to lead, some by myself, some by others.

Diagnosis is not made easier by the fact that congenital syphilis, thyreoid deficiency and possibly some throat affections are greatly benefited by potassium iodide, while many patients with chronic indigestion are relieved of much sluggish bowel content by a short course of magnesium sulphate. The only possible method of avoiding mistakes is to keep all these possibilities, as well as lead absorption, in mind when examining the child with chronic ill health and to use every method of diagnosis before deciding on a line of treatment.

LEAD POISONING IN ADULTS.

Lead poisoning in adults is in many respects very similar to that of children. There are certain differences: (i) Age, in that young workers are more affected than the more elderly. (ii) Sex. Abortion is very common among pregnant women, while amenorrhœa, dysmenorrhœa and menorrhagia also occur. (iii) Source of lead varies with the industry—in lead refineries from the dust, in battery making from the fumes.

It is notable that whereas in the older trades lead poisoning has diminished through altered methods, for example, the linotype in printing and the cellulose spray in carriage painting, new industries have arisen in which the risks are as great, if not greater, for example, rubber manufacture and accumulator making. In adults the greatest part, by far, of the poisoning takes place from inhaled lead as opposed to the apparently ingested lead of the child.

Mild Forms of Adult Plumbism.

The initial period of ill health, pallor, lassitude, wasting and lack of appetite are common to both adult and child. The blood changes are the same in each. The blue line in the adult is often as seen in the child, a narrow blue line, but where severe pyorrhœa is present there may be a broad blue band, five or six millimetres wide, extending back from the gum margin. Urinary changes occur similar to those in children.

On the foregoing is based Badham's standard of diagnosis of mild forms, namely:

A definite sign of a lead intake determined by the presence of a blue line or lead in the urine in an amount exceeding 0·05 milligramme per litre, together with one or other of the following signs of intoxication:

1. The presence of stippled red cells to the number of over 500 per million red cells, with no other blood changes and with or without symptoms of lead poisoning.

2. The presence of stippled cells in number less than 500 per million red cells, with symptoms of lead poisoning.

3. The presence of stippled cells with other blood changes, such as changes in the shape or size of the red cells, polychromasia, reduction of hæmoglobin to 80% or less, and reduction of red cells below four and a half million, with or without symptoms of lead poisoning.

The symptoms of mild lead poisoning are taken as abdominal pain, constipation, headache, debility and tremor.

Severe Lead Poisoning in the Adult.

Colic is very constant and has to be distinguished from: (i) Colic due to acute abdominal catastrophes, for example, perforated viscus, acute intestinal obstruction, acute pancreatitis. (ii) Biliary or renal colic. (iii) Root pains of spinal disease. (iv) Tabetic crises.

The "jerks and gums" are as important in abdominal diagnosis today as in the past. The pulse is slow in lead colic and the other signs of lead poisoning are present.

The general characteristics of paralysis are as in children. The most common form is wrist-drop, owing to the frequency with which the *extensor indicis* and *extensor communis digitorum* are affected. The interossei are also often paralysed at this stage. Next in order of frequency come the shoulder muscles, especially the deltoid, then those of the leg, especially the peronei. Least of all are the muscles of the trunk, larynx and diaphragm.

Acute anterior poliomyelitis is uncommon in adults and does not present the same difficulty in differentiation as it does in children. The chief resemblance is to the other toxis neuritides, alcoholic neuritis being the most common. Though much the same groups of muscles are involved, the sensory changes are very prominent and the other almost constant signs of plumbism are lacking.

Similarly, these signs will serve to differentiate it from such diseases of the nervous system as progressive muscular atrophy, tabes, disseminated sclerosis and the myopathies. Lead encephalopathy rarely takes the form seen in childhood; its usual manifestations are headache, delirium, mania, psychic depression, coma or convulsions.

These, especially if associated with lesions of the cranial nerves, may simulate cerebral tumour, cerebro-spinal syphilis, cerebral hæmorrhage, epilepsy, chronic alcoholism, uræmia, eclampsia and hysterical or neurasthenic conditions.

The correct diagnosis is made only by finding on the one hand other signs and/or symptoms of plumbism or, on the other, features opposed to it, for example, changes in the spinal fluid. But it must also be constantly remembered that some of these conditions, for example, syphilis or alcoholism, may coexist with lead poisoning and a cerebral hæmorrhage is a perfectly possible end result of lead arterio-sclerosis.

Even without any of the foregoing frank manifestations, there is in almost every sufferer from plumbism, child or adult, a degree of dulness, sluggishness and inability to concentrate, often combined with restlessness and irritability.

Late Manifestations of Plumbism.

The relationship of nephritis and arterio-sclerosis to lead poisoning is still a matter of dispute, both in children and adults.

As regards adults, lead poisoning is one of the few ætiological factors admitted by Fishberg in his discussion on the causes of essential hypertension, while Badham sums up the matter as follows:

> Our limited knowledge of the sequelæ of lead poisoning is no greater than when Legge and Goadby wrote: "Unless it were established that granular kidney nephritis were present in a worker before commencement of lead employment, we think it would be useless to endeavour to prove that the condition was independent of lead, despite its comparative frequency as a cause of death apart from employment."
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> With the present limited knowledge of the manner of onset of arterio-sclerosis and nephritis among lead workers, it is impossible to determine the cause and origin of such degenerative changes in a lead worker. It is comforting to the physician to know that there is a history of past colic or palsy in any individual adjudged to be affected by arterio-sclerosis and/or

nephritis caused by his work, but it is probably fallacious to think that such an easy means of selection picks out those by their trade from those whose inherited vascular make-up leads to early degenerative change.

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British Medical Association News.

SCIENTIFIC.

A MEETING OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION was held at the Medical Society Hall, East Melbourne, on November 12, 1930, DR. R. G. McPHEE, the President, in the chair.

Obstetric Abnormalities.

PROFESSOR J. C. WINDEYER read a paper entitled: "The Diagnosis and Treatment of Some Common Obstetric Abnormalities" (see page 551).

DR. FRANK NYULASY expressed high appreciation of Professor Windeyer's extremely interesting and instructive address, with its fine illustrations, and then said he would confine his remarks to but one of the many topics dealt with, namely, the occipito-posterior presentation. To begin with, he would remind members of the extraordinary differences of opinion and practice to be met with among leading authorities on this familiar subject.

For instance, Professor Hastings Tweedie, a past master of the Rotunda, in the third edition of his text-book stated that with the os fully dilated and the membranes ruptured he made no attempt in delayed cases to turn the occiput forward either by the hand or the forceps, but "attended to the common cause of failure of flexion, namely, uterine inertia." This was treated with a mixture of chloral and opium, or morphine given hypodermically. When the patient awoke, vigorous pains came on and the head frequently rotated to the front and was delivered spontaneously. Tweedie said: "If the head does not rotate, it does not matter much; put on forceps and pull it out slowly and carefully."

Dr. FitzGibbon, another ex-master of the Rotunda, expressed similar views. Thus he said: "If at the beginning of labour the head is still above the pelvic brim, efforts may be made to change it into the nearest occipito-anterior position. This is most difficult and not necessary." During the second stage, if the occiput had rotated into the hollow of the sacrum, pressing on the fundus and encouraging the patient to bear down would push the head forward and complete delivery in quite a number of cases. If it failed after a reasonable trial, delivery was completed

Professor Whitridge Williams, perhaps the most famous of the American obstetricians, said that in a small proportion of cases manual rotation could not be effected and it then became necessary to apply forceps with the occiput still posterior. Downward traction was then made till the head impinged on the pelvic floor; the occiput was then slowly rotated to a transverse and then to an oblique anterior diameter. The forceps were now taken off, reapplied and delivery effected.

Dr. Nyulasy remarked that Professor Windeyer had ignored the question of forceps rotation and he quoted with significant approval a recent paper by Dr. Douglas Miller, Physician to the Edinburgh Royal Maternity Hospital.

In the course of his very able paper Dr. Miller said that "forceps rotation for occipito posterior cases demanded a high degree of manipulative skill and should be attempted only by the expert." On the other hand, Robert Watson, of Belfast, after about thirty years' experience, in a letter to *The British Medical Journal* in June, 1930, wrote: "The manœuvre is simplicity itself. There is no feat in obstetrics so essential in general practice, easier to perform or more effective. Deep chloroform anæsthesia is desirable throughout. You diagnose the position of the head, lay your blades on as squarely to its sides as possible, lock the instrument and keep it locked, then (in a pause between pains, and gently) push the fœtus back towards the uterus till its head feels free. Now, still gentle, you give the forceps a half turn (like a key in a lock) and proceed to deliver. The original instruction—to bring the head down until it is fixed and then withdraw the reversed forceps and apply them again—is unnecessary. More, it may do harm. Heads can revert too easily. Thus in all but exceptional cases it is safer and easier not to unlock the forceps. The facility with which delivery can be effected with them in this manner is a shock to one's notions about the parts and the art, but a salutary shock, for modern obstetrics tends to become paralysed with exuberant theory."

In supporting Dr. Watson's method, Dr. D. C. Williams, in the same journal, wrote: "I always use Kielland's forceps, and with this instrument rotation of the occipito-posterior position is so easy that the presentation offers no more difficulty than the ordinary anterior presentation. It is hard to understand why Kielland's forceps has not taken the place of the axis traction forceps in this country . . ."

In his own practice, Dr. Nyulasy continued, he generally preferred manual rotation when interference was necessary, but in exceptional cases he had used forceps rotation with distinct advantage.

DR. B. MILNE SUTHERLAND expressed his appreciation of Professor Windeyer's address. The professor had presented his subject in broad outline, omitting minute details, and it was evident that he had cultivated a sense of touch which was beyond the capacity of most practitioners. Referring to occipito-posterior positions, the presence of excessive *liquor amnii* or abdominal fat might make the diagnosis of position exceedingly difficult. Failure to rotate was usually due to rotation through less than half a semicircle, the head tending to rotate back into the hollow of the sacrum. It was necessary to rotate through three-quarters of a semicircle at least. Walcher's position was of great assistance only in getting the head through the brim into the pelvic canal; it tended to contract the outlet, and the position should be changed to the lateral or the lithotomy as soon as the head was in the canal. Not infrequently the head was found in the transverse position, and he considered that there was a definite danger in rotation by forceps. The process must be a careful operation with no degree of force.

DR. FELIX MEYER expressed appreciation of the paper, both in its material and manner expressing the author's wide experience and authority. Books were occasionally written by men who had the courage of the opinions of others, and so contained shibboleths which had been handed down from writer to writer. It could be learnt from Professor Windeyer's teaching of the management of occipito-posterior positions that trauma should be reduced to a minimum. He considered that Professor Windeyer's treatment of this problem was most lucid and convincing.