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Contents September, 1947

SCIENTIFIC:

Additional Diagnostic Considerations in Acute Closed Head Injuries

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ALTHOUGH the clinical appraisal of the level of consciousness and the consecutive changes that take place in this state is by far the most important diagnostic consideration in acute closed head injuries, as has been emphasized in a previous publication[1], a consideration of this feature alone would, of course, represent an over-simplification of the problem, for there are other valuable clinical signs that are of aid in evaluatng the condition correctly. It is for this reason that the following summary is presented.

Subjective complaints are of undeniable importance in those cases in which the patient is not too deeply unconscious to proffer reliable information and indeed, the appearance of headache or increasing severity of an already present symptom of headache may be the earliest indication of the occurrence of some space-occupying complication that will demand active treatment. However, in the confused and delirious states that usually accompany these injuries, it is difficult to evaluate correctly the significance of this complaint and one is forced to rely upon signs that can be elicited on objective examination. It is with these signs that we are primarily concerned in this communication.

I. Important Clinical Signs of Organic Cerebral Damage

(i) *Systemic Circulatory Changes*

The centres controlling the cardiac rate, and the degree of constriction of the peripheral arterioles lie in the region of the floor of the fourth ventricle, and are affected, as are all other vital centres, by changes in intracranial pressure. Any space-occupying intracranial lesion occurs at the expense of the volume of the circulating blood within the rigid brain case, as well as that of the cerebro-spinal fluid, thus producing a relative anoxemia of the tissues. The first effect of this oxygen lack upon the cardiac centres is stimulatory in type due to the increase in the hydrogen-ion concentration in the region of the centres. This stimulation of the vaso-constrictor centre causes an increased systolic pressure and concomitant stimulation of the cardio-accelerator centre causes an increased pulse rate so that a fast bounding pulse may be the first sign of raised intracranial pressure and indicates changes in the medullary circulation. As the degree of oxygen lack increases, these centres become less sensitive to normal stimuli and consequently a marked slowing of the pulse rate may occur in unconscious patients as a late stage and usually indicates severe degrees of medullary vascular failure. In this stage of bradycardia the blood pressure tends to be maintained at a hypertensive level, partly as a result of continuing stimulation of an active vaso-constrictor centre and partly as a result of increased filling of the heart during diastole with resultant increase in the contractile power of the physiologically stretched cardiac musculature. The bradycardia itself may in some part be due to stimulation of the cardio-inhibitor centre by this profound degree of oxygen lack, the centre apparenty being less sensitve than the cardio-

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accelerator centre, but when the circulation fails, all these vital centres finally lose their ability to function automatically and a rapid thin pulse results as a terminal event. If this type of circulation persists despite resuscitation, the prognosis is grave.

(ii) *Respiratory Changes*

These changes are often well marked and have definite clinical implications.

Stertorous breathing has long been recognized as a grave prognostic sign, as it indicates involvement of the respiratory centre, provided the airway is clear, and any subsequent deviation from the normal respiratory rhythm indicates failure of this medullary centre due to deficient circulation. The most typical type of respiratory abnormality found in these cases is a Cheyne-Stokes form of respiration, often of Biot's type. This is breathing characterized by a prolonged apnoeic phase during which period an abnormally low pH has to be reached in the circulating blood before the damaged centre is stimulated by these changes. In the Cheyne-Stokes type of respiration the active phase is represented by a gradually increasing depth and frequency of respiration and a gradual diminution of these features prior to the apnoeic stage, whereas in Biot's respiration the active phase appears suddenly and ceases suddenly, the depth of inspiration and expiration being constant throughout the phase in which the respiratory centre is functioning.

Gasping respiration is commonly seen as a terminal event and indicates grave damage to the respiratory centre with complete failure of the anoxaemic portion of the centre to respond to the normal stimuli. In this type both inspiration and expiration begin suddenly and are both followed by a well marked pause, which, in the end stages, may last several seconds.

These are the two types of respiratory changes commonly seen in head injuries and can be easily distinguished, in the great majority of cases, from Kussmaul breathing which is often seen in diabetic or uraemic coma. This form of respiration is due to stimulation of the respiratory centre by changes in the pH of the circulating blood and is characterized by a deep continuous form of respiration, in which the inspiratory and expiratory phases are equal and there are no pauses between the phases.

(iii) *Ocular Signs*

Apart from the changes in the vital functions of respiration and circulation, the changes to be demonstrated in the eyes are probably the most easily recognized of the neurological changes occurring after head injuries. We are particularly interested in the corneal reflexes, the pupillary responses and changes to be observed in the retina.

The *corneal reflexes* are mediated at a brain stem level and sluggish or absent responses indicate a lesion affecting this region of the brain stem and are usually associated with severe degrees of "unconsciousness." On the other hand, active corneal responses indicate that the patient is not deeply unconscious and this is an important finding in those patients who show no evidences of restlessness and tend to lie perfectly still, although they are by no means approaching a state of coma.

Pupillary changes are of two types: 1. the *fixed dilated pupil*, first described by Hutchison, in which the pupil is fully dilated and does not contract in response to direct stimulation by a bright light nor to consensual light.

This sign indicates the presence of a tentorial pressure cone and is due to the compression of the brain stem and the stretching of the third nerve at its point of entrance into the cavernous sinus. It is undoubtedly one of the most reliable signs of increased intracranial pressure. 2. *Small fixed pupils.* This sign is particularly important in patients who are deeply unconscious and when the pupils remain contracted despite changes in the intracranial pressure. In these cases this indicates a pontine haemorrhage and is often associated with pyramidal signs which may be bilateral and a progressive hyperthermia which is so characteristic of pontine lesions.

Changes in the Fundi

Rapid increase in intracranial pressure may occur in head injuries but it is uncommon to find an associated sudden appearance of papilloedema, although we have noticed it developing in less than 12 hours. When a true papilloedema does develop rapidly, it is a definite indication of increased intracranial pressure. Gray[2] has observed minute retinal haemorrhages in acute head injuries and is convinced that this is a grave prognostic sign, being associated with severe grades of unconsciousness and often a fatal outcome. In all probability, these haemorrhages indicate the severity of the commotion imparted to the skull and its contents by the force producing the injury and are most likely due to rupture of delicate vessels in the choroidal tissue.

(iv) *Changes in Tone of Peripheral Muscles*

A changing state in the tonicity of peripheral muscles commonly indicates a cortical lesion and the usual picture is one of spasticity developing on the side opposite to a compressive lesion overlying the motor cortex. This compression initially causes a local diminution in the volume of the circulating blood, associated with venous congestion and a resultant diminution in the oxygen tension in the subjacent tissues, which results in a spastic paralysis of the muscles supplied by this region. As the compression increases the cortex becomes ischaemic and the paralysis changes from one of a spastic type to complete flacidity. Interestingly enough, a similar sequence of events takes place as the cortex on the side opposite to the compressive lesion is subjected to the same cycle of events as it is compressed against the overlying skull. A dynamic picture then, of changes in tone, as outlined above, indicates increasing intracranial pressure.

Decerebrate Rigidity

Although the functions of motor and premotor cortex in controlling muscle tone are still one of the favourite fields for neurophysiological disagreement, we find it convenient to accept clinically the old view that the tone of peripheral musculature is governed by several factors, the most important of which are mediated through the red nuclei and the vestibular nuclei at the upper end of the brain stem, and largely under the control of cortico-spinal pathways. The anterior horn cell, according to this conception, is subjected to impulses reaching it by way of the vestibulo-spinal, the rubro-spinal and the cortico-spinal pathways, and normal tone results when these pathways are all intact. If the vestibulo-spinal pathways are released from the inhibitory action of the other two, an accentuation of tone occurs in the anti-gravity muscles and results in the production of a postural state of decere-

brate rigidity somewhat similar to that seen in the experimental animal. When this condition occurs following a head injury, it indicates a release of the vestibulo-spinal tract due to a lesion in the upper part of the brain stem equivalent to a section immediately below the level of the red nuclei. If it develops immediately after injury it usually indicates a contusion of the upper part of the brain stem, but if it appears after an interval, it is due to tentorial herniation causing a pressure cone which compresses this region of the brain stem and indicates a considerable increase in intracranial pressure.

(v) *Temperature Changes*

The absorption of the breakdown products of extravasated blood results in a rise of 1° to 2° in temperature regardless of the location of the haemorrhage. However, if the rise in temperature is considerable, (101 to 103°) it is an indication of profuse subarachnoid bleeding, these products being absorbed readily from the subarachnoid space, or a severe intrinsic brain damage which has affected the heat-regulating centre in the hypothalamus directly or as a result of a developing tentorial pressure cone. As mentioned above, a sudden elevation of temperature which progresses continuously to alarming heights indicates a pontine haemorrhage and is usually associated with grave evidences of brain stem injury.

II. Differential Diagnosis of Patients Who Are Deeply Unconscious

In cases in which there is no definite history of accident, the problem is initially one of the differential diagnosis of any patient who is deeply unconscious, as it is important to realize that "unconsciousness" may have preceded the moment of injury and even in the presence of external evidences of trauma, these may not be the primary cause of the patient's unconscious state. Consequently, it is necessary to rule out the conditions enumerated below:

Diabetic Coma

The characteristic feature of these patients is one of profound dehydration, with an extremely dry tongue and soft eyeballs, as a result of the tremendous polyuria that has been present for some time. These patients do not lose consciousness suddenly and there is usually a satisfactory history of progressive changes in the level of consciousness prior to the onset of coma. The breathing is characteristically Kussmaul in type and often one may distinguish an acetone odour to the breath. The diagnosis is verified by the laboratory findings in the blood and urine.

Hypo-glycaemia

These patients tend to present the picture of shock with cold and clammy extremities and peripheral vascular failure. They are not dehydrated and the condition has a sudden dramatic onset. Diagnosis is made by blood sugar findings and may be suspected in patients with a diabetic history.

Uraemia

Here again the history may be suggestive and characteristically the patient exhibits muscular twitchings, although true convulsions are rare, and shows a definite pallor distinct from the other features of shock, as there is no indication of circulatory collapse other than as a terminal event. The breathing

tends towards a Kussmaul type but is often characterized by a strong deep expiratory phase. Diagnosis is substantiated by the increased level of N.P.N. in the blood and urinary findings of a low specific gravity with albuminuria.

Spontaneous Cerebro-Vascular Accident

A prominent feature of this group of patients is the presence of localizing signs usually suggestive of a capsular lesion, occurring in the older age group. There is commonly no evidence of blood in the cerebro-spinal fluid and if embolic in origin, the source may be apparent. Cerebro-vascular accidents characteristically occur in hypertensive subjects and the extreme degree of systolic elevation associated with a definite elevation in the diastolic level, may often serve to distinguish this from the less marked hypertension that may be seen as a result of increased intracranial pressure after trauma. Interestingly enough, these patients occasionally show sugar in their urine as a result of a hypothalamic lesion and this finding, in our experience, is extremely rare in head injuries.

Spontaneous Subarachnoid Haemorrhage

The diagnostic difficulties may be insurmountable in this condition, for a great many patients, subject to spontaneous subarachnoid haemorrhages, fall at the time of the catastrophe and suffer associated head injuries. The diagnosis therefore, in these cases, rests almost entirely upon their history, although it might be pointed out that these patients may show a degree of haemorrhage, seldom seen in head injuries without gross changes in the level of consciousness, and exhibit little else apart from headache, restlessness, irritability and marked rigidity of the neck.

Magee[3] has recently reviewed this subject and has concluded that physical effort was not a factor, in the majority of cases, in precipitating the bleeding. In fact the haemorrhage most frequently occurred during rest and in addition a raised blood pressure did not seem to be a factor in its causation. Premonitory symptoms and signs were occasionally present, most commonly consisting of headache of long duration which had often been labelled as migrainous and was associated with visual disturbances or ocular palsy. A definite history then of the occurrence of the catastrophe at rest often after a period of premonitory symptoms may help to make a correct diagnosis.

Poisoning

The common poisons encountered are largely confined to three groups: the corrosives, the barbiturates, and mercury bichloride. In corrosive poisoning, one commonly finds evidence in the mouth of scarring, discolouration or sloughing of the mucosa. Barbiturate poisoning is demonstrated by depression of the respiration, a lowering of the blood pressure, and widely dilated pupils, often with spontaneous nystagmus, and in addition one can frequently elicit bilateral extensor plantar responses. Patients who have taken an overdose of mercury bichloride may be found in a comatose state and at this time are usually completely anuric, so that the differential diagnosis resolves itself into considering the possible causes of anuria.

Alcoholism

The alcoholic, who is so liable to trauma, is often seen exhibiting drowsiness or extreme difficulty in being roused and in these cases it is difficult

to estimate the importance of the alcoholism, although it is true that most "dead drunks" can be aroused by severe and prolonged painful stimuli, as for example pressure over the supra-orbital notch, and when sufficiently roused their activities are certainly purposeful in type. This reaction is not in keeping with the estimate one would form from their initial flaccid state.

III. Radiological Diagnosis

Although it has been stressed many times, it cannot be too strongly pointed out that a fracture of the skull is but an incident in the occurrence of the associated brain injury. Nevertheless, positive X-ray evidence of a skull fracture is important confirmatory evidence of the nature of the initial trauma, and once the patient has recovered sufficiently that he may be safely moved, a radiological examination should be carried out in every case, even if this is done only for record purposes in those cases who have not been seriously injured.

In patients who have suffered a more severe injury, a fracture across one of the middle meningeal grooves may be an important indication of the possibility of an extradural hematoma, and multiple gross fractures most certainly indicate that the skull has been subjected to considerable force at the time of the accident.

Depressed fractures may be exposed in this manner and offer the explanation for local organic signs or, by their nature, demand elevation to prevent the occurrence of post-traumatic epilepsy. It is not an uncommon occurrence to find X-rays revealing these depressed fractures in cases where a scalp laceration has already been sutured without recognition of the nature of the injury, and this is particularly true in those types of fractures in which the outer table remains intact although there is sometimes gross depression and spiculation of the fragmented inner table. Basal fractures are difficult to demonstrate but are particularly important confirmatory evidence of the nature and probable location of the lesion in cases exhibiting cerebro-spinal fluid rhinorrhoea, or otorrhoea.

The general consensus of opinion then, would indicate that positive evidence of a skull fracture demonstrated by X-rays is important in evaluating the condition of the patient, whereas negative evidence of skull fracture is less important because it is difficult to demonstrate basal fractures, particularly if they involve the ethmoid plates and the mastoid region. It is our routine to take three views of the skull in stereoscopic manner if possible. We would agree with other observers, that all these views are best taken at a 20° angle with a shift of the tube towards the vertex which allows one to look into the base of the skull. This is particularly valuable in the antero-posterior projection which we routinely take in the so-called half-axial projection with a 35° tilt towards the vertex to show the rim of the foramen magnum. The postero-anterior projection and the lateral projection taken with the side of the skull which has been injured, nearest to the plate are also taken with a 20° tilt described above. There are many specialized projections devised to show localized areas of the skull, but the only two we use commonly are a modified optic foraminal view to show the ethmoid plate in cases of rhinorrhoea (and of course the optic foramen itself in cases of traumatic blindness) and a Law or Stenvers mastoid projection in cases of leakage of spinal fluid or bleeding from the ear, in an attempt to show fracture lines entering the mastoid or the auditory air spaces.

We would particularly stress one additional point in radiological diagnosis, namely the frequency with which calcification renders the pineal gland visible, even in young adults, provided one takes the trouble to look for it. Being a mid-line organ having also a relatively constant antero-posterior location, variations in its position, particularly as regards lateral displacement, may represent an easily recognizable means of demonstrating unilateral space-occupying lesions without resorting to more complicated procedures. Certainly when one is dealing with massive post-traumatic haemorrhages no other evidence is necessary if the pineal shows a definite shift.

IV. Suggested Routine Plan for Recording Diagnosis

It has long been the custom to apply the generic term "cranio-cerebral injury" to all types of head injuries, and this is a useful term because it implies the presence of associated lesions affecting the cranium and the brain occurring as the result of a single trauma applied to the head. However, we must again emphasize the fact that the skull injury is but an incident in association with the brain injury, which is the important factor in the patient's condition. Consequently it is essential that in the recording of a diagnosis one should first describe the brain injury and as it is best assessed by the level of consciousness, it is our opinion that a descriptive term, such as we have described before[1], defining the level of consciousness should be added to the original designation as a cranio-cerebral injury. It is not possible clinically to define exactly the primary pathological change that has occurred in the brain as the result of the injury, but from certain observations it is possible to estimate whether the patient has suffered a simple concussion or whether the lesion has progressed to a contusion or laceration of the cerebral tissue. Concussion is a transient state, showing dynamic features, with rapid changes in the level of consciousness, and if unaccompanied by contusion, laceration or damage to lower centres, the patient will make a rapid recovery. As we know, the patient is not deeply unconscious as the result of any primary lesion involving cortical or subcortical tissue above the level of the tentorium, and if he shows minor changes in the level of consciousness persisting after the period of concussion has passed, and no gross evidence of blood within the subarachnoid space, one may postulate that his cerebral damage consists of areas of contusion.

Although patients who are deeply unconscious have a primary lesion affecting the hypothalamic region, the brain stem or possibly the corpus striatum, it is true that the acceleration necessary to produce these lesions has commonly caused cortical laceration, and this diagnosis is particularly suggested when the patient demonstrates in addition to the profound changes in the level of consciousness subarachnoid bleeding of considerable degree. It is however, also true that that amount of subarachnoid blood, when it is not great, bears no constant relationship to the level of consciousness, but Russell[4] has stated that when the red blood count exceeds 100,000 per cu. mm. the patient is always deeply unconscious, the profuse haemorrhage indicating severe cortical trauma, or rather free bleeding from the rupture of delicate vessels crossing the subarachnoid space.

From the point of view of the active treatment of these patients, the most important feature is the presence or absence of secondary developments causing increased intracranial pressure, as, apart from localized cortical

laceration, the primary pathological change is not amenable to treatment other than maintaining the optimum condition for its recovery, and therefore it is important that the presence or absence of these complications should be noted at this point in the recorded diagnosis.

Fractures of the skull, if demonstrated radiologically to be present, are important confirmatory evidences as to the nature of the initial trauma and should also be recorded in the diagnosis with a note as to their type and location, the latter being particularly important in the event that the fracture line crosses one of the middle meningeal grooves. If a depressed fracture is present, one should mention whether the fragments are greatly depressed and liable to cause organic signs or whether there are evidences of spiculation, for these two features are the major indications for surgical interference in this type of lesion. Finally, it is essential that one should record in the diagnosis the presence of cerebro-spinal fluid rhinorrhoea, or otorrhoea, as in these cases one must be on guard for the onset of meningeal infection, and if recorded in the diagnosis, the presence of these signs which might otherwise be missed, is immediately brought to the attention of any subsequent observer. Signs of organic cerebral damage such as aphasia, spastic paralysis, discriminative sensory loss, or hemianopsia, indicate laceration or contusion of cortical tissue, or compression by a depressed fracture, and are important confirmatory signs as to the location of the lesion, but they have no definite relation to the level of consciousness nor the treatment to be employed and are best recorded in the physical examination, there being no need to mention them in the diagnosis.

Following this plan a typical diagnosis might be recorded as follows:

1. Craniocerebral injury with stupor.
2. Cerebral laceration.
3. Secondary space-occupying haemorrhage—Possible extradural haemorrhage—right.
4. Linear fracture of skull—right fronto-temporal.
5. Rhinorrhoea—right.

This plan proves of inestimable value when the patient's condition is changing or when subsequent observers desire a base line on which to form an opinion as to the progress that the patient is making towards recovery, or the progress that is taking place in an intracranial pathological state secondary to the initial injury and possibly of space-occupying proportions. This assessment of the clinical state assures a reasoned approach to the problem that will result in the correct active treatment being employed if necessary, at the earliest possible moment. The plan is simple and capable of general application in all types of head injuries.

Summary

1. As a supplement to a previous report, a resume is presented of the more important diagnostic considerations in acute closed head injuries. These are used in conjunction with the clinical appraisal of the level of consciousness, and offer corroborative evidence as to the nature of the lesion that is affecting the patient's conscious state. Changes in consciousness, however, remain the single most important sign of intracranial pathology.

2. The main conditions to be considered in the differential diagnosis of patients who are deeply unconscious are briefly outlined with emphasis on the salient features of importance in making the differentiation.

3. Radiological methods commonly used in the diagnosis of the skull injury are discussed, but it is again emphasized that the skull injury is but an incident accompanying the associated injury to the enclosed brain.

4. A suggested plan is described for recording the clinical diagnosis in a consecutive manner with proper emphasis upon the important features of the patient's condition so that subsequent observers may at once obtain a clear-cut picture of the clinical state and be in a position to evaluate the significance of any recent change.

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The Protruded Lumbar Intervertebral Disc

Toward Its More Exact Localization

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THE protruded lumbar intervertebral disc has attained clinical maturity. It is the most complete major surgical entity to evolve since the epoch making work of Fitz and his surgical cohorts on appendicitis, half a century ago. Every case of right sided abdominal pain and tenderness, preceded by nausea and epigastric pain, is not appendicitis. Every case of sciatic pain and tenderness, preceded by a sore back, spasm of the erector spinae muscles, with flattening of the lumbar curve and elevation of the pelvis on the affected side, is not due to a protruded disc. But the surgeon who fails to consider the latter in his diagnosis must soon be looked upon as a transgressor almost as grave as he who disregards the former.

Twelve years ago the diagnosis of protrusion of the intervertebral disc was based principally on myelograms made after the injection of lipiodol. This heavy medium sometimes failed to fill the normal contours of the dural canal; it sometimes failed to show filling defects when they existed. Once injected, removal of the lipiodol was most difficult. More than once we were distressed to have a postoperative case return, relieved of his disc syndrome, but suffering from sacral nerve pain, and with lipiodol causing herniations of the dura through the sacral foramina. The use of air as a contrast medium was successful only in the hands of a few.

Gradually the clinical picture grew, through the contributions of many workers, and diagnosis swung from an x-ray to a clinical extreme. It was held that the protruded disc could be discovered and localized with complete satisfaction by clinical methods alone.

The surgeon operated and still, on occasion, found nothing. The hypertrophied ligamentum flavum, regular accompaniment to the protruded disc, was no longer considered as a primary pathological condition, although its removal did sometimes give relief from symptoms. Further appreciation of the anatomy of the lower lumbar spine, that the position of the articular facets of L3 to L5 makes for a structural weakness sometimes requiring a fusion operation for its relief, and the recognition of the clinical fact that protruded discs are often multiple, tended to reduce operative failures. The work of Dandy on the "concealed disc protrusion" brought the whole problem to etiological maturity. That a disc could rupture the annulus fibrosa and produce nerve pressure without breaking the posterior longitudinal ligament, and that it could be discovered at operation by puncture of the ligament —with this, operative failures dropped sharply.

Clinical Errors

Still we believe that diagnostic errors will be many if based upon clinical findings alone. The reasons:

1. The variations in segmental distribution of the lumbar and sacral nerves.
2. The different points at which the intervertebral disc can protrude.

1. Eisler showed, many years ago, that variations form the normal segmental distribution of the nerves making up the cauda equina are present in 20% of cases. It is generally appreciated that while the tendo Achillis reflex usually travels via the first sacral nerve, it may indicate the state of the fifth lumbar, in fact of any nerve from L3 to S2. Similarly, while the first sacral nerve usually supplies the lateral border of the foot, it may take over the more medial area of the fifth lumbar, leaving the lateral border to the second sacral nerve. It follows that localization of the disc protrusion to either of the two common sites, the lumbo-sacral or the L4-L5 space, by these two most important signs, is not reliable.

2. While the usual protrusion of the intervertebral disc is lateral and at such a position as to exert pressure on the nerve of the lower cord segment (i. e. the disc between L4-L5 pressing on the fifth lumbar nerve,) it is possible for a more central protrusion to produce its symptoms by pressure on the nerve of the second lower cord segment (i. e. the L4-L5 disc on the first sacral nerve.) A large central protrusion can, of course, press upon the whole cauda equina, producing widespread neurological changes in the legs. Moving out, again, the protrusion may appear, rarely, in an extreme lateral position, to impinge on the nerve of its own cord segment. Clinical signs may be further invalidated by these variations.

Errors In Myelography

Myelography, using pantopaque, has few of the disadvantages met with when lipiodol was the medium. Almost always removable after the examination, the newer oil is not irritating and slowly absorbs, if circumstances prevent its withdrawal. Because it is less viscous, and makes more intimate contact with the intradural structures, it gives a more accurate myelogram than lipiodol. Even the concealed disc protrusion can usually be localized by it, the swelling of the traumatized nerve and the hyperplasia about it being sufficient to produce a filling defect.

But to depend on myelography alone for diagnosis is a mistake. Not only may it fail to show the concealed disc protrusion, but the smooth, symmetrical filling defect opposite an intervertebral space may be diagnosed a disc protrusion only when clinical signs are reconcilable with it. Particularly if the defect be bilateral, its pathogenicity should be looked on with suspicion. It is our belief that this defect, in the patient with a sore back, but lacking defintie signs of terminal nerve involvement, is due most often to a mild duro-arachnitis with adhesions to the posterior longitudinal ligament where it most closely approximates the dura, that is ,at the level of the intervertebral disc. It follows that only through the studied correlation of clinical and roentgenological observations can the most accurate diagnosis be made.

A Localizing Sign

A localizing sign I have found to be of value in differentiating between disc protrusions at L4-L5 and the lumbo-sacral space has to do with the posterior primary division of the first sacral nerve. Emerging through the first posterior sacral foramen, it sends motor branches to the erector spinae muscles and supplies sensory fibres to a small area of skin over the posterior superior iliac spine. It leaves the larger anterior division only a few milli-

meters above its foramen. Hence it shares the same fate from protruded disc pressure above. It becomes tender.

The patient will frequently put his finger directly on the nerve as it perforates the multifidus muscle—the most tender spot on his back. Palpation here elicits tenderness, or sometimes, sharp pain. The area of skin supplied by this nerve is usually hyposthetic. Less commonly, it is hyperesthetic.

The posterior primary division of the fifth lumbar nerve does not supply the skin of the back. It has no sensory fibres. Superficial tenderness in this area can be first sacral nerve tenderness only. Taken with the protruded disc syndrome it points almost always to the lumbo-sacral disc. (Adjoining the sacro-iliac joint, this tenderness has probably led to many faulty diagnoses of sacro-iliac arthritis.)

The Exploratory Operation

In stressing the points which make for an exact preoperative localization of a lumbar disc protrusion, we realize that there must be certain cases where exploration of more than one intervertebral space is necessary. Careful diagnostic study will reduce them to a minimum. The exploratory operation on the spine is much more to be decried than the exploratory operation on the abdomen. Every surgeon who has cared for compression fractures of the lumbar spine knows what lasting discomfort may be found with the slightest bony deformities. In the early days of disc surgery there was many a patient relieved of his sciatica only to suffer out his remaining days from the effects of a widespread laminectomy. The conservative exploratory operation of today is not being compared with an extensive laminectomy. But it does require dissection that perhaps need not have been done, expose areas of the dura that need not have been exposed.

An operation that confines itself to the area of the lesion, carried out through the interlaminar space, in which the nerve is well protected, bleeding avoided rather than controlled, in which the cortices of the approximating vertebral bodies are roughened to promote postoperative fusion, in which the ligamentum flavum is preserved to prevent the formation of scar tissue in the interlaminar space, is a safe procedure and is followed, in almost every case, by a good end result.

In our experience, the conservative operation is simplified by the use of pentothal anaesthesia with curare. Small doses of curare produce sufficient relaxation of the erector spinae muscles to permit retraction, yet do not abolish the nerve impulses to the muscles. Thus, any more than the most gentle pressure on the first sacral nerve will produce twitching of the gluteus medius. With this very real danger signal to guide him the surgeon can depend, for a great part of the operation, on the sense of touch which here, as in the abdomen, is often a wiser counsellor than sight. The slight lowering of blood pressure produced by the two drugs does, with operative care, result in a practically bloodless field.

Summary

The development of the protruded intervertebral disc syndrome is reviewed and some of the weak points in clinical and roentgenological diagnosis are considered. The importance of using all aids in determining the exact site of the disc protrusion, and the significance of tenderness over the posterior

primary division of the first sacral nerve, in lumbo-sacral disc protrusion, are stressed. Complete study of each case makes for good results with a most conservative operative procedure done under pentothal anaesthesia with curare and lessens the need for the exploratory operation.

I am indebted to Dr. Richard Saunders, of the Department of Anatomy, Dalhousie University, for his dissections on the lumbar and sacral nerves; and to Dr. Carl Stoddard, of the Department of Anaesthesia, Victoria General Hospital, for his work on anaesthesia in intervertebral disc surgery.

The Old Lady Steps Back

H. L. Scammell

WITHIN a few weeks the new Victoria General Hospital at Halifax will be formally opened. It will be one of the finest hospitals in Canada. For months its massive walls have o'ershadowed the old hospital building behind it which for many years has been bravely meeting the great demands for accommodation made upon it. It is comforting to learn that despite the erection of a new structure the old hospital will continue its career of usefulness as an integral part of the institution. So at the age of ninety the Old Lady steps back but still remains in the family.

There are many living who can recall incidents in the life of the old hospital during the past fifty years or even longer. To them this will appear a jejune effort. On the other hand there are many of a younger generation who may read of the doings of an earlier day with interest, and to the few who participated these recollections may awaken pleasant memories.

My first visit to the Victoria General Hospital was a quarter of a century ago. One of the members of our class in medicine, growing thinner and weaker daily before our eyes was examined and found to be suffering from diabetes, then a disease which held for young adults an outlook for life of about three years under the closest dietary management. But a supply of the new miracle working extract, Insulin, had been sent by Banting, its discoverer, to a number of centres in Canada for trial. A quantity come to Halifax, and one of the first to enjoy its benefits was W. A. Tuttle. He lived for many years afterwards. At the time I went to see him he was in one of the small wards on the second floor, along with the members of the group receiving the new treatment under the direction of Dr. K. A. MacKenzie.

A year or so later our class was thronging the wards to write case histories and examine patients under supervision. The wards were not so crowded as they were in later years, but the cases were often rare and interesting. The aura of fear of a hospital had not then been wholly dispelled from the minds of the sick, and many would not consent to go to hospital unless they were seriously ill or could be persuaded that the nature of their illness required the combined resources of a large institution to diagnose and treat. From the standpoint of the student who must learn the common diseases well, this was not a good thing, but it did introduce us to a wide variety of clinical entities, and as time went on we saw a goodly number of ordinary things as well. Tuberculous cervical adenitis in children and young adults, almost unknown to-day was then very common. Chorea, now uncommon, was frequent. The multitudinous forms of tertiary syphilis were encountered so often that the famous dictum, "know syphilis and all things clinical will be added unto you" became very real to us. Usually there was at least one Charcot's joint in the wards. In fact luetic bone lesions were seen every day.

Following the 1925 Provincial Election all Government institutions were under close scrutiny by auditors appointed by the new Conservative Government to investigate their financial operations. As a student I remember their presence at the Victoria General where they examined the accounts of the preceding twenty-five years. The accountant, Mr. E. P. Webber who had been responsible for this work during the entire period had performed his task faithfully and well. Not a single cent was found missing—not a single transaction was left unexplained in a satisfactory manner.

In the spring of 1926 twelve members of our class entered as internes. At that time there was no rotation system so we remained there the entire year. We did rotate within the hospital, however, at the end of the first six months period. There were four surgical services each headed by a Chief and there was one assistant common to all four. In the same way there were two medical services and one assistant. The gynaecologist and urologist worked entirely alone. There were three staff members on the eye, ear, nose and throat service. The anaesthetic service had two visiting men and two residents gave part of their time to this work. Besides this they kept an eye on the neophytes and directed our paths. The arrangement meant that from the very first the interne shouldered heavy responsibilities. He assisted his chief or the assistant surgeon at all operations, wrote the histories, did routine laboratory work, all routine dressings which he could not persuade the nurses to undertake, carried out his chief's orders day and night for public and private cases, filled prescriptions which were needed during the night, and in general made himself useful in the good conduct of the hospital as well. When he was on the medical service or on any service where his duties did not involve his attention at the operating rooms he took his turn at riding the ambulance.

I cannot say the date at which the hospital had its first ambulance. It was I think, about 1899. Certainly about that period the Annual Reports rather boastfully stated that such a vehicle was available and added: "The ambulance is a covered vehicle especially designed to convey patients to and from hospital who must travel in the recumbent position." Apart from new coats of paint and sundry repairs the same "vehicle" or a "reasonable facsimile" did duty in my day. It was of one horsepower. Two drivers and two horses were kept, the latter in part sustained by the hay mown from the grounds in front of the institution. Do not imagine, you sybarites who roll in luxury in the modern ambulance that our ambulance duty was any "bed of roses." In the late autumn of 1926 I was persuaded, nay commanded, to "face the music" in the front office and see if a warm overcoat and gloves could not be secured at the expense of the province for the ambulance surgeon. Mr. W. W. Kenny, then superintendent did not at first take kindly to the idea, but when dire prognostications of colds, even pneumonia, with consequent loss of time on duty, were foretold if the coat and gloves were not forthcoming, he yielded and I was empowered to make the purchases. The coat had to be big enough to fit the largest interne, consequently the smaller members were amply if not elegantly clad. It did yeoman service until the covered vehicle was replaced by motored luxury.

An ambulance call comes, night or day. The bell rang on the barn, and Alice Cox on the switchboard rang feverishly for you. As a rule you were at the front door with the message in your hand in three minutes to meet the vehicle as it swayed around the corner. If by day, and Mr. Kenney had received the call, he stood at his door in the hall with his watch in his hand to see that all were "on their toes". You hopped up on the high seat with the driver and with a clang of the gong you were away. If it was an urgent call, you really could feel like Paul Revere, in spirit at least. The horse was driven at his topmost speed, which was considerable, accompanied by the constant clanging of the bell, operated by the driver, who supplemented its effect by a shrill stream of invective at all and sundry who delayed our passage. A trip in this manner along Upper Water Street, its undulating surface rock-

ing the springy wagon like a ship in a heavy sea was an experience never forgotten. When our destination was reached, the task began. Sometimes first aid had to be rendered or the patient or his relatives persuaded at the last moment that the hospital was the place for him. In any case words and ministrations were as brief as possible for we knew the Old Man was sitting at his desk with his watch in front of him. The cot was removed, the patient enveloped in red blankets, and the cot with its human burden hoisted into the ambulance. For the interne the scene then changed. He accompanied the patient sitting on a seat about twelve inches square near the head. The rear of the wagon was closed by a draw curtain and off we rattled at as great or if possible at a greater speed than that at which we came. On the wall was a tin basin which rattled hideously. In the darkness there was the firefly glow of a five watt lamp operated by a storage battery. Pervading the interior was the horsy odor ever present. You had a bag filled with all necessary drugs in which stimulants figured largely. The bottle of brandy needed constant replenishment. Come what might we must get our patient to the hospital **alive.** Failure meant loss of honor and money as well, if our associates learned of it. Despite its primitive arrangements this service was as good as the times or necessity demanded. On one occasion from the time of leaving to get a man at the Queen Hotel who had fallen downstairs with dire results, to our arrival back was twenty minutes, not too bad even for to-day.

As internes we were most comfortably lodged and very well fed. Mrs. Hattie Hanson was the housekeeper. Long experienced in the pranks of us boys she watched over us with a tolerant and kindly eye. Only on one occasion do I recall her being disturbed. While a confrere took a bath, an interne standing on a chair squirted a dressing syringe filled with methylene blue over the cubicle into the bath water. For some days the recipient was as one of the ancient Britons, but it was long before Miss Hanson was able to get the tub white again. She also presided at the head of the dining table and poured tea from a huge brown earthenware teapot for all the staff. The pharmacist, the accountant and the dietitians ate with us, and many were the horrible tales manufactured to shock their sensibilities. An argument initiated by one genius, as to whether the brine rose in a barrel of sauerkraut at the full moon, and if so why, lasted for days. With her gentle smile Miss Hanson sat unperturbed through it all.

After being away a year I returned in 1928 as a resident physician. A few months later, Dr. G. A. MacIntosh who was senior to me was transferred to become for the time chief health officer of the province. In consequence Mr. Kenney and I were left alone as administrative officers. The tide had turned meanwhile and the hospital was filled to capacity. In fact one morning with a total capacity of two hundred and fifty-two we had two hundred and fifty-three patients. At times we had so many cots between the beds that it was scarcely an overstatement to say that one could lie and roll from one end of the long wards to the other. In addition we had a waiting list that day by day grew more hopeless in its length. In times such as those all departures from normal presented major difficulties. There were, however, assistants on the services and the nursing service was never better. We worked desperately hard but there was a definite sense of achievement.

When I returned after another longer absence, in 1931, Mr. Kenney had died after thirty-three years of service, and Dr. G. A. MacIntosh was superintendent. There was by this time no doubt that a new hospital was needed. The overcrowding still continued. A consultant studied the situation and reported. Preliminary sketches were made. Then the Government changed and for the next few years the matter rested. Meanwhile it became and remained a point of honor that if we could not have a new building, we could give the best service possible. A new clinical record system was introduced, laboratory services were improved, the best equipment possible to procure was installed in the X-ray department, the Cancer Clinic was organized, staff meetings were brought to a high standard. The dietary department was developed and it became our boast that our patients were the best fed anywhere whether in the general wards or private rooms. All the time we were aware of the increasing appreciation of the medical profession and the public of the service rendered. It became obvious that the destiny of the Victoria General Hospital was one of specialized services not only to the city but to the province at large. To maintain this it must ever remain a teaching hospital.

The passing years have made these facts more and more evident. A new building will soon be opened which will embody all services in the most ideal fashion. Nobody should forget that constant effort is necessary to keep them at an acceptable standard and further improve them. This hospital is the fulfilment of our dreams. May its future satisfy our fondest hopes.

The Oxford Vaporiser No. 1 as applied to Anesthesia in General Practice.

C. H. Smith

THE Oxford Vaporiser No. 1 was produced by the Nuffield Department of Anesthetics, University of Oxford in 1941.

The apparatus was designed to give a constant supply of ether vapor, in desired concentrations up to 25 vols. %. The apparatus was to be compact, simple to operate, and rugged in construction without being too bulky and economical in use.

The principle of this apparatus is that hot water is used to melt a crystalline reservoir substance—in this case hydrated calcium chloride which melts at 29° C. This substance yields up its latent heat of crystallization to provide as required, the latent heat of vaporation of a liquid anesthetic, ether.

Thus the ether in the ether chamber is kept just below its boiling point at a constant temperature. This provides a steady source of ether vapor, the concentration of which is controlled by a calibrated mixing valve.

The machine is so constructed that ether vapor is delivered to the patient on inspiration only or by use of the hand bellows by the anesthetist. Rebreathing is provided for by use of a bag, which may be cut into the circuit, as desired.

The apparatus is compact and well constructed. The vaporiser with accessories, i.e., mask, airways, (nasal and oral), tubing and bag fits into a case of approximately 1 cu. foot and weighs 35 lbs. The only moving parts are two small non-return valves, one spring loaded expiratory valve and the mixing valve. No trouble should be experienced with these due to simplicity and ruggedness of construction.

Ether vapor is delivered to the patient at slightly below room temperature, and at constant concentration provided the anesthetist keeps the vaporiser temperature at operating room temperature.

For induction one may use the conventional drugs, e.g. pentothal, ethyl chloride or chloroform if desired, but it is perfectly practicable to use ether from the beginning. Ether vapor at room temperature is less irritating by far than ether vaporised on a mask. This combined with the smooth increase of concentration made possible by judicious use of the mixing valve enables the patient to tolerate moderately high concentrations more quickly than by other methods. Even young children if handled with tact and consideration may be anesthetised with little trouble using ether only.

This vaporiser is comparatively unknown as far as can be ascertained. It was known to the writer in 1941, but through "The Lancet" only. War Assets Corporation had one for disposal, which found its way to this area.

The problem of satisfactory analgesia in obstetrics has been a source of much research in late years. However, the majority of methods are too complicated for rural obstetrics or nursing homes where specially trained help is not available. It was decided that this apparatus would prove to be as near the answer to this problem as possible in the late stages of delivery, either spontaneous or operative.

While not ideal it has been found to have given excellent analgesia, and anesthesia as well, if required. It obviates the use of open ether, always a danger especially in country homes, and the inevitable inefficiency of untrained help.

It has been found that a trained nurse can operate this machine under supervision with little instruction, and do a good job. Our V.O.N. nurses in this area have proven this. In normal cases, in late Stage 1 and early Stage 2, the machine is set up and the ether concentration set at 4-5 vol. %/ether and mixture.

The patient is given the mask and told to take two or three deep breaths. This gives fair analgesia rapidly and helps the patient to cooperate.

It is to be noted that the patient is instructed to use the mask only when the contraction begins. In this way there is little interference with uterine contractions and the patient remains calm, but rather drunk at times. She is unable to take an overdose, as unconsciousness would cause her to drop the mask. Likewise if she persists, one can always lower the vapor contraction without trouble.

As strength and frequency of contractions increase, one may have to increase concentration. This varies in individual cases, and each must be considered on its own merits. It has been used successfully in both operative and non-operative cases. Using up to 8 Vol./% will be satisfactory for delivery and suturing if required. Full anesthesia is required in longer and more severe procedures.

From the patient's view point, the procedure has been given favorable comment. Analgesia has been satisfactory and the psychological value to the patient's co-operation has been marked.

Patients stated that they knew they were given more than ordinary help and appreciated this.

From the obstetrician's view point the patient is given something to do while she is in pain, and while the doctor's attention is otherwise occupied. The grandmother or so-called nurse is free to do something useful and is not a source of danger or annoyance. So often they have been told to put six drops of chloroform on the mask. As often does the patient get anywhere from 12 to 20 drops.

Seldom is enough ether given to slow down labor to any great extent but it must be remembered that patients tolerate higher ether concentration by the vaporizer than by the open mask, so one's judgment must be adjusted accordingly.

Summary

In the Oxford Vaporiser No. 1 the concentration of ether vapor is indicated by the position of the control lever on the calibrated scale.

The use of this machine in obstetrics has been indicated, emphasizing the simplicity of control and the advantage of this method over, the conventional and more complicated methods of analgesia.

It is regretted that time and space do not permit technical details of this apparatus. The reader is referred to "The Lancet," July 19, 1941, for details.