cerebral circulation ceases. There can be no doubt that the control of this compensatory mechanism is one of the most important and necessary functions of the group of bulbar centres—a function which must have been evolved to its highest point, as man in his evolution assumed the erect posture. During the course of each day the compensatory mechanism becomes fatigued; especially is this so after severe muscular exertion. By sleep and rest in the horizontal posture the compensatory power is restored. In conditions of neurasthenia, of weakness and exhaustion after bodily strain and disease, of shock after severe injury or hæmorrhage, this power may be greatly lessened.

TABLE I.

Posture.	Pressure in mm. Hg.		Difference in mm. Hg.	Difference calculated from height of column in mm. Hg.	Height of column separating armlets in cm.
	Brachial artery.	Posterior tibial artery.			
Horizontal ..	106	106	0	0	0
Standing	110	165	55	58	75·4
L. posture legs up	115	85	30	33	44
Vertical head down	115	50	65	63	82

A useful clinical guide to the condition of the compensatory mechanism in man is afforded not only by the pressures in the brachial artery, particularly the diastolic pressure, but by the rate of the pulse on change of posture. If the heart greatly accelerates on rising from the horizontal to the vertical position, the mechanism is deficient. From the above the importance of the respiratory movements as regards circulatory efficiency is clearly seen. The downward plunge of the diaphragmatic piston during inspiration, and the inward thrust of the abdominal wall during expiration, are necessary for man's efficiency in the upright posture.

Finally, I would draw attention to the importance of the correct muscular movements of breathing in massaging the abdominal contents. The descent of the diaphragm in inspiration, the contraction of the abdominal wall in expiration provide massage mechanism which plays an important part in the preservation of the tone of the smooth muscle of the abdominal contents.

One of the present-day evils is constipation, which does not occur when a good tone of the abdominal wall is preserved. Equally as important is the fact that the state of semi-constipation is abolished, the state in which the bowels, although acting daily, act only in insufficient fashion without the use of occasional purgatives. By what means good tone of the external abdominal muscles induces good tone of the smooth muscle is not sufficiently known, nor can it yet be adequately explained how conditions affecting directly the tone of the smooth muscle, as, for example, enteritis, bring about a relaxation of tone of the external muscles. The fact remains, however, that good tone of the muscles constituting the natural abdominal belt play an important part in preserving a healthy condition of the abdominal contents.

References.

1. Gavin Milroy: Suggestions for consideration by Council of the Royal College of Physicians, London, in relation to his bequest, 1879.
2. John Brown: Introduction to Horæ Subsecivæ, Rab and his Friends. Everyman Edition.
3. Ministry of National Service, Report No. 1, on Physical Examination of Men of Military Age, 1920, 12.
4. James Galloway: Brit. Med. Jour., 1920, ii., 381.
5. John Hutchinson: Article in Todd's Encyclopædia of Anatomy and Physiology, London, 1852, iv.; also Med. Chir. Trans., London, 1846, 29.
6. Michael Foster: Text-book of Physiology, fourth edition. Macmillan, 1884, 323.
7. Arthur Keith: Mechanism of Respiration in Man (full references to literature). Further Advances in Physiology, Arnold, 1909, 182.
8. Arthur Keith: Lond. Hosp. Gaz. Supp., Oct. 29th, 1903.
9. Leonard Hill: Journal of Physiology, 1892, xviii., 15.
10. Leonard Hill and H. Barnard: Jour. Phys., 1897, xxi., 323.
11. Leonard Hill and Martin Flack: 1909, Proc. Physiological Society, xlviii.; Jour. Physiology, xxxviii.

SPINA BIFIDA.[1]

BY FREDERICK C. PYBUS, M.S. DURH., F.R.C.S. ENG.,
ASSISTANT SURGEON, ROYAL VICTORIA INFIRMARY; LATE SURGEON, HOSPITAL FOR SICK CHILDREN, NEWCASTLE-ON-TYNE.

BY spina bifida we mean a congenital defect of the vertebræ, usually the posterior arch, associated, in most cases, with some protrusion of the spinal contents. The defect may involve a large or small area of the spine, but when a tumour is present this is due to a protrusion of contents due to increase in the intraspinal pressure. This increased pressure may be temporary, as such cases can be cured or may undergo spontaneous cure, while others are progressive in character and are often associated or followed by hydrocephalus. Probably various combinations of these factors account for the production and different varieties of this condition. This defect occurs in about one in 1000 births and is often incompatible with life; at the best many cases succumb during their first year, and others exist for a time with various accompanying deformities.

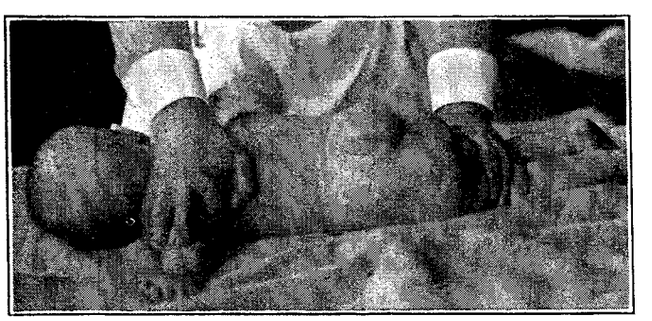
Development of Spine and Spinal Cord.

Fully to understand the anatomy of the condition it is essential to know the method of development of the spine and spinal cord. Briefly it is as follows: in the dorsal middle line a groove appears, the neural groove, which sinks into the underlying mesoblast and subsequently, its edges fusing, it becomes the neural canal. This becomes separated from the surface, the surrounding mesoblast forming the spinal membranes. Round the spinal cord and membranes thus formed the vertebræ are developed. Cartilage being formed round the notochord and being in its turn replaced by bone, centres of ossification appear for the bodies and posterior arches. The process of ossification for the bodies commences in the mid-dorsal region and progresses up and down the spine, while the centres for the neural arches commence in the cervical region, the process extending backwards, so that the lumbar and sacral elements are the last to have a bony roof. Development may be arrested at any one of these stages and accounts for the different types of spina bifida met with clinically.

Spina Bifida as a Family Defect.

Spina bifida is met with almost equally in the two sexes, and we can only suggest that it is due to some somatic defect. Occasionally it is a family defect. One member of such a family is depicted in Fig. 1.

FIG. 1.



Meningo-myelocele in a child aged 4 months, showing large thin-walled translucent sac in the sacral region.

Here all four children had some degree of spinal defect. The eldest died at the age of 18 months with spina bifida, the type of which is unknown, and with hydrocephalus. The second child, now aged 10 years, has a spina bifida occulta, indicated by a scar and depression in the upper dorsal region and by slight scoliosis. A radiograph of this portion of

[1] A post-graduate lecture delivered at the Royal Victoria Infirmary, Newcastle-on-Tyne.

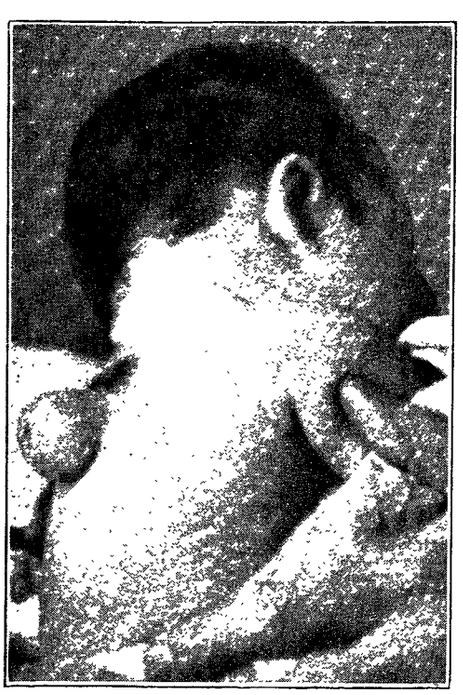
the spine shows a defect of the vertebræ. The third child is the subject of the photograph and had a large meningo-myelocele in the sacral region. This was

FIG. 2.

Same patient as Fig. 1, aged 9 years.

operated on with the result shown in Fig. 2. The patient is quite well and without deformity, the only symptom present being that she is perhaps unable to

FIG. 3.



Pedunculated meningocele in the dorsal region. Child aged 2 weeks; a hair field is seen above the tumour.

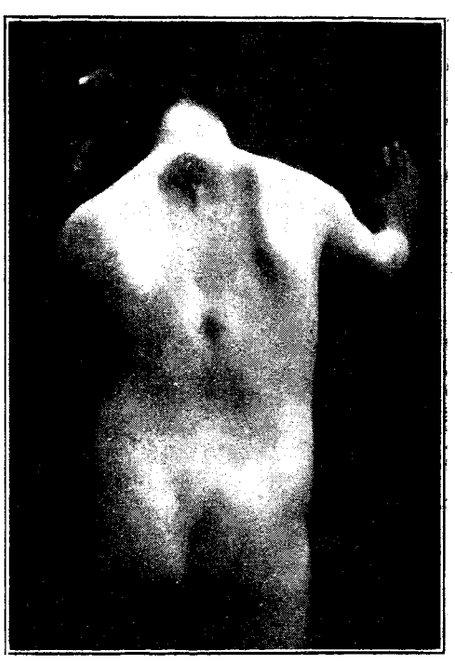
hold her urine as long as usual. The fourth and last member of the family has the least defect, which is an exaggerated post-anal dimple.

Various Forms of Spina Bifida.

As before stated, the course of the case depends mainly on the variety of spina bifida present, and whether it is associated with hypersecretion of the cerebro-spinal fluid. Those in which the central canal of the cord opens on the surface do not survive many days owing to loss of fluid or infection. The other cases may die early from ulceration or rupture of the sac with similar consequences.

Spina Bifida Occulta.—Of the varieties of spina bifida the mildest occurs where there is some defect of the vertebral arches without protrusion of the contents. This form, the spina bifida occulta, is commonest in the lumbar region. The defect is often shown by a scarring and depression of the skin in the middle line. This may be covered or surrounded by a hair field (Figs. 3, 4, and 8). In other cases the defect may be covered by a nævoid condition of the skin or a lipoma which forms a definite swelling. This spinal defect may cause no symptoms or may be associated with other deformities at birth, such as club-feet. Later in life various forms of talipes may become evident, trophic lesions may appear on the feet or legs, and an actual paralysis may result owing to

FIG. 4.



Same patient as Fig. 3, aged 8 years. A hair field partly covers the operation scar. A spina bifida occulta is seen in the lower dorsal region.

pressure or traction on the cord or nerves. In some cases a mild scoliosis or other spinal deformity may develop at the site of the defect.

Meningocele.—The next in order of severity is the meningocele, which is perhaps the least common. Here, in addition to the spinal defect, there is a protrusion of the membranes, the cavity of which is occupied by cerebro-spinal fluid. The tumour may be pedunculated (Fig. 3) and covered by normal skin, having a narrow pedicle which may become closed and a natural cure result. In other cases the sac may be large, sessile, and thin walled (Fig. 5).

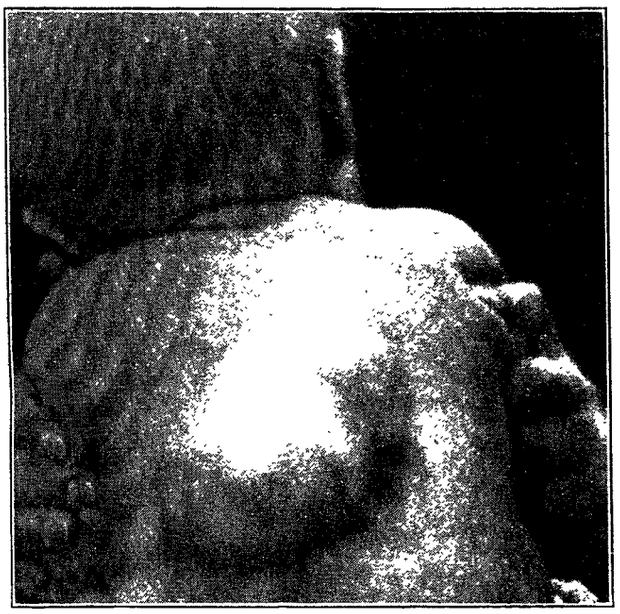
Meningo-myelocele.—This, the commonest type seen in hospital, is associated with a protrusion of the membranes and some part of the spinal cord. It is, as a rule, larger than the former, having a broad base and larger defect in the spine. The coverings may be thin, scarred, and translucent; when the tumour is situated in the lumbar or sacral region the tip of the cord is attached to the summit of the tumour, the cord itself crossing the sac to reach this position. The spinal nerves also cross the sac on either side to reach the intervertebral foramina. In other region

the cord is attached by its dorsal aspect to the top of the sac, leaving the spinal canal to reach this attachment and passing down to the lower extremity of the sac to regain its normal position. In some cases the cord, at this area of attachment, may open on the surface or present a reddened and apparently ulcerated surface as is shown in Fig. 6. When the cord opens on the summit of the protrusion the condition is really a myelocele.

Syringomyelocele.—The fourth type or syringomyelocele resembles the above in many particulars, but the central canal of the cord is dilated, the distended cord occupying a portion of the sac. One such example was found at operation, and the finger could be passed readily into the dilated central canal.

Myelocele.—The myelocele is the gravest defect of the series. Here the posterior part of the spinal canal and cord is undeveloped and the central canal opens directly on to the surface at its termination or for a considerable part of its length. Indeed, the condition resembles the earliest stage of its development. The defect is seen as a red and vascular area at the bottom of which the central canal can be found. Naturally these cases do not survive long.

FIG. 5.

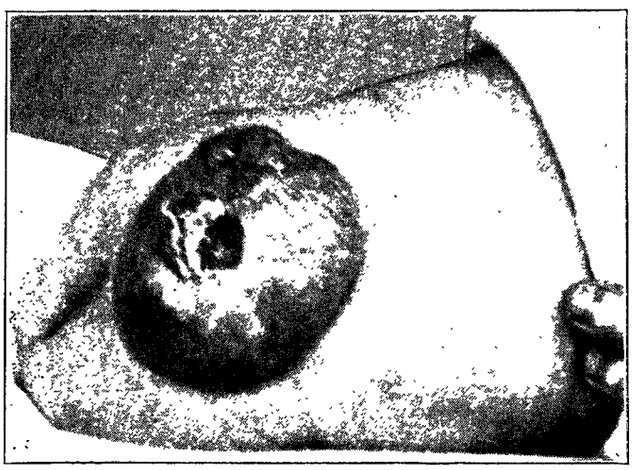


Large meningocele in the dorsal region.

Diagnosis.

The diagnosis is made on the history and appearances of the swelling. The condition is congenital, it is situated in the middle line over the spine, the surface is scarred or vascular, while in most cases a swelling is present. The covering may be natural skin, and the consistence of the swelling shows it to contain fluid. It has an impulse on coughing or straining, and if necessary fluctuation can be obtained between the tumour and the anterior fontanelle. To determine the variety present may be more difficult. Pedunculated tumours are usually simple meningoceles and are covered by normal skin. If the tumour is large, has a broad base, with scarring on the surface and transculent walls, a meningo-myelocele is probably present. In some of these three definite zones can be recognised, the apex a red vascular zone, surrounded by a thin translucent area, while at the base this merges into the skin of the back. (Fig. 6.) It is impossible to determine the syringomyelocele from external examination. The character and extent of the spinal defect can, in some cases, be determined by palpation, for the defect can be felt at the margins of the tumour. In other cases the protrusion overlaps the defect to such an extent that its edges cannot be detected. A radiograph will, however, reveal the defect if it is thought necessary to have this information. There are two conditions which may be mistaken for spina bifida. The first is a nævus in the middle line of the back, an unusual position. It can be lifted off the deeper structures and is not associated with any spinal defect. The second condition is that of sacro-coccygeal tumour. Here the tumour may be solid

FIG. 6.



Meningo-myelocele in the sacral region showing a "raw area" in the centre of the swelling.

or possess translucent cysts, but is situated at the termination of the spine, and involves the perineum and coccyx. No impulse is present on coughing or straining, and no fluctuation can be obtained with the anterior fontanelle. It should be mentioned that very rarely there may be a defect in the anterior part of the vertebræ, and that a protrusion may take place forwards into the pelvis or abdomen.

Congenital Malformations Accompanying Tumours.—In addition to a local tumour certain other congenital malformations may be present. Scoliosis may accompany the spinal defect, while it is not

FIG. 7.

Child with sub-occipital meningocele.

uncommon to find talipes equino-varus or calcaneus. Hydrocephalus may be present at birth or may supervene shortly afterwards and is the complication most to be feared. It has been mentioned that later certain nervous phenomena may appear such as paralysis due to involvement of the

motor nerves, anæsthesia, or trophic lesions such as perforating ulcer.

Selection of Cases for Operation.

Even of the cases submitted for one's opinion at hospital only a comparatively small number admit of surgical treatment, which should be limited to the most favourable types, and those who, after operation, are likely and capable of becoming useful members of society. It will, perhaps, be best to discuss each variety separately.

In spina bifida occulta operation is rarely required for the spinal defect. Surgical intervention may be required for the relief of symptoms due to pressure or traction on the spinal cord. In larger defects where static deformity shows itself some form of spinal brace may be necessary or a plastic operation to control this.

In all other cases certain general rules for the care of the patient may be given. It is important to keep the affected part clean, especially when situated in the sacral region, where it is too apt to become dirtied with fæces much to the detriment of its coverings. The surface or tumour should be protected from

FIG. 8.

Spina bifida occulta.

pressure and abrasion by a careful arrangement of wool round it, and its surface covered by an antiseptic dressing if thin. The lower margin of such dressing may be sealed down by strapping or collodion and so protected from the napkin area.

The most difficult question now is the selection of suitable cases for operation. Most meningoceles require operation, but as a rule there is no urgency, especially when the tumour is small and has a narrow pedicle. Operation may be carried out at leisure . any time during the first year, but parents are usually anxious for the children to be put right as the tumour is a source of anxiety to them and may prevent the child being nursed on its back.

In certain cases operation is contra-indicated. The presence of hydrocephalus should be considered a bar as after operation the head continues to distend —the cerebro-spinal fluid being robbed of a second outlet for the relief of tension. Other cases presenting gross bodily deformity or deformity of limbs not easily rectified should be included in this group. Certain technical difficulties may present themselves in dealing with some of these cases. Owing to the large size of the tumour, and especially if a considerable part is composed of thin translucent membrane, much difficulty may be experienced in covering over the raw surface after removal. In other cases, where a raw spinal area or ulceration is present, sterilisation of this surface may prove difficult, and if not effected leads to wound sepsis and often death.

Cases in which operation is of doubtful use are those of myeloceles and meningo-myeloceles where there is a large raw area. Even if operation is successfully accomplished, deformity is likely to become manifest as the patient grows older, and one such case has complete incontinence of urine and fæces and is a nuisance to himself and his parents. No operation should be undertaken if hydrocephalus is present, but if doubt is felt about this point the head may be measured at regular intervals and its rate of growth noted.

Method of Operation.

In performing the operation the child should be supported on a pillow and lie on its face with the head at a lower level than the trunk, to prevent the undue escape of cerebro-spinal fluid. The first step in the operation consists in exposing the neck of the sac by an encircling incision—designed to leave as much skin as possible for covering over the defect. The neck of the sac should now be isolated—this consists of the dura mater and needs to be cleared of fascia and other coverings obtained from the spinal muscles. In meningoceles, when the neck is narrow, it may be ligatured and the stump returned to the spinal canal; or it may be opened, the redundant sac being then removed and the opening in the neck closed by suture.

In meningo-myeloceles, after the neck is isolated, the sac is opened at one side and the contents inspected. The spinal cord is then separated from its attachment to the apex of the sac and returned with its nerves to the spinal canal. The redundant portion of the membranes is then removed, and the dura and arachnoid closed. In some cases it is impossible to pack the cord back into the spinal canal. In these cases it must be left projecting as far as necessary in the hope that with growth in length of the spine it will gradually be drawn into its proper place.

The third stage in the operation consists in repairing as far as possible the spinal defect. Where a small opening only is present it may, by small incisions undercutting the margins, be possible to draw these together and give sufficient protection to the cord and prevent further displacement of the contents of the canal. In cases where a larger defect is present incisions are made along the outer margins of the erector spinæ muscles through the lumbar fascia. This is dissected up on either side towards the middle line, and the flaps so formed turned over the gap and sutured together. In order to further supplement this covering similar portions of the erector spinæ itself may be used in like fashion. Following this the skin is brought together—a procedure which may require considerable undercutting or even flap formation.

In some cases an osteoplastic repair may be necessary. It has not been so in my cases, but in order to form a bony covering for the defect the spinous processes above and below the gap may be cut across at their bases and turned to meet one another and sutured over the defect. A further possible method is to expose and divide the laminæ of the affected vertebræ on each side and bring them together in the middle line. Where a considerable defect requires filling, and especially if some deformity has arisen or is likely to arise, bone grafting, after the method of Albee, would be suitable.

STUDIES FROM THE ST. ANDREWS INSTITUTE OF CLINICAL RESEARCH.

II. CASE-TAKING METHODS.

BY J. H. P. PATON, M.B., CH.B. EDIN.

Introduction.

IN 1918 Sir James Mackenzie was appointed consulting physician to the St. Andrews Cottage Hospital. In that capacity he at once instituted weekly out-patient clinics, at which he saw patients brought to him by medical practitioners in the town. These clinics took the form of meetings which attracted not only local practitioners but a number of doctors from the surrounding district; discussions took place on the special problems which confront the general practitioner, and on the need for systematic investigation of these problems. It became obvious that a vast amount of material for their solution was lost, or could not be utilised, under the present conditions of general practice. As a direct result of these discussions Sir James Mackenzie enlisted the support of all the local practitioners, and plans were drawn up for the creation of an Institute for Clinical Research. The idea of founding such an institution had long been present in Sir James Mackenzie's mind, and he had made an attempt in that direction at the London Hospital, but it was found to be impossible to keep in touch with patients where the population was of so migratory a character, and he realised that the plan was only possible in a small town such as St. Andrews with a comparatively stationary population.

As a result of his influence several personal friends of his own, who realised the possibilities of the scheme, offered to provide the necessary financial support for its initiation. A council was formed, and a building was acquired on lease and suitably fitted up, containing consulting rooms and examination rooms and laboratories for radiology, chemistry, and bacteriology. The Carnegie Trustees made a grant for five years to provide the services of a fully-qualified chemist and also those of a bacteriologist. The general basis of the work of the Institute was set forth in the minute of the first general meeting of staff, held on Sept. 5th, 1919, as follows:—

"The main objects of research would be the early stages of disease, and the work would primarily consist of detailed observation of symptoms and the keeping of careful records. Prolonged observation of cases would be carried out in order to discover the significance of early symptoms, and researches would be undertaken with a view of ascertaining the mechanism of their production."

This minute makes clear the two essential needs which justified the establishment of the Institute—namely, (1) The need of obtaining accurate records of the earliest symptoms of disease, at a stage prior to the occurrence of structural damage; (2) the need of following up each individual case from its onset to its termination.

Upon these essentials depends any advance in the early diagnosis of disease and in its accurate prognosis. It is true that the hospital records throughout the country are full of information regarding the symptoms of disease, but a little consideration will show that they cannot be records of those facts with which the staff of the Institute are attempting to deal. Advanced cases and cases of acute illness alone are admitted to hospital wards. The symptoms recorded are those of fully established disease; the physician does not see in the hospital ward those early stages of disease which it is our purpose to investigate. As soon as his patient has sufficiently recovered to resume work he returns to the care of his general practitioner, and all record of his case ceases. Hospital records do not provide first-hand information of the patient's earlier symptoms, habits, and environment in the stages when the necessary information may be acquired.

In the rush of a busy practice the making of accurate records is extremely difficult, and leisure for classification and analysis cannot easily be obtained. The St. Andrews Institute affords facilities to the general practitioner for making such records, and supplies means whereby when taken they are made permanent and systematically kept, so that information can be drawn from them and incorporated into the general sum of medical knowledge.

The first staff meetings were devoted to the consideration of a general scheme of case-taking applicable to early cases of disease. The following scheme was ultimately adopted, and a year's experience has convinced the staff of its suitability for the purpose.

I.—*General Scheme of Case-Taking.*

Duties of the Doctor.—(1) Elicit clearly the sensation which led the patient to the belief that he was ill; (2) elicit other sensations associated; (3) have a clear idea in mind as to the information to be elicited by questions; (4) never leave a particular symptom until fully investigated; (5) use questions suitable to the patient's understanding.

The Patient.—(1) Details of main complaint; (2) associated sensations; (3) origin and history of present complaint; (4) general survey of each system or organ by questions, to elicit other associated sensations; (5) previous health; (6) family surroundings, home surroundings, habits, &c.; (7) physical examination: (*a*) general appearance (physiology, peculiarities of manner, &c.); (*b*) physical signs (under systems); (*c*) urine, &c.; (8) opinion; (9) treatment; (10) after-history.

Duties of Doctor.

It will be observed that the scheme is prefaced by certain directions of such simplicity that they are especially liable to be forgotten, but essential for detailed accuracy in recording the phenomena present before gross physical changes are perceptible. They differentiate clearly the leading symptom from associated symptoms, and discourage aimless and haphazard investigation. In the fourth the complete investigation of every symptom is insisted upon. It was soon recognised by everyone that the doctor's conception of symptoms were in general so hazy that steps must be taken to obtain a clearer insight. Consequently, although the earlier notes were unsatisfactory, continued investigation into the nature of symptoms is rendering these notes daily of more value.

The Patient.

It was early realised that for successful inquiry into the patient's sensations the element of possible suggestion by the examiner must be eliminated. Simple inquiries make clear to the patient that his own sensations of ill-health are what we desire. It is the examiner's duty tactfully but firmly to suppress the numerous suggestions emanating from relatives and friends that appear in the patient's story at this stage. Many pertinent symptoms may have been omitted by the patient as being of no importance; these should be elicited by careful inquiry. In order that the examiner may carry this out in an orderly and logical manner, it is essential that he should have previously obtained some general idea of the origin and history of the complaint. This, then, is taken before proceeding to the systematic inquiry into symptoms present (No. 4). The remainder of the scheme proceeds upon conventional lines, but special care is taken to note all details in regard to family history, environment, diet, occupation, &c., factors which there is every reason to believe are frequently germane to the development and perpetuation of ill-health.

Perhaps the most essential part of the scheme is that dealing with after-history. Arrangements are made to ensure that each patient will be again seen from time to time, and the records of his condition and any subsequent illnesses are added to the case. In this way in the course of years the elements of a scientific system of prognosis will be built up—prognosis, that is to say, based upon the outcome of actual cases, and not upon the vague fears engendered by abnormal phenomena of whose significance we are ignorant.