Facial paralysis is a most characteristic feature of the malady, and it is probably exceptional for it to be absent, although it may escape observation unless specially looked for.

This arises from the fact that the palsy is so frequently bilateral, and also it is rather a general weakness of all the face muscles than a complete palsy, hence there is frequently no asymmetry of the face. In a series of 20 cases with full records facial palsy is noted in 17 cases; in two no record is made, and in only one is there a definite note that facial palsy was not present at the time of examination. In five cases the facial palsy was unilateral when first observed, and in two of these it became bilateral; in 12 cases it was bilateral when the patient was first seen. Thus in 14 out of 17 cases the facial palsy was bilateral at some period of the illness. The onset of this palsy is often distinctly later than that of the limbs and trunk, and the interval may be as long as four days. The peculiar palsy described above as affecting the limbs, trunk, and face, and sometimes of an ascending type, is the most characteristic feature of the disease, but other palsies may occur. Thus difficulty in swallowing, especially of solids, may occur and in slight degree is not uncommon; palsy of the palate, however, is not common, and the nasal voice and difficulty in the swallowing of liquid such as is seen in diphtheric paralysis is uncommon. The larynx and tongue may be involved, and in one case the symptoms so produced were sufficiently marked for a diagnosis of labio-glosso-laryngeal paralysis to have been made prior to the admission of the patient to hospital. Paralysis affecting the oculomotor nerves must be rare, as the only nerve affected in a series of over 30 cases was the sixth nerve, and this only in one case. No instance of palsy of the third or fourth nerve was seen, and thus ptosis was never observed.

Pain, numbness and tingling, anæsthesia and analgesia are usually present. The sensory loss is usually incomplete, relative rather than absolute, and affecting especially the distal segments of the limbs; its distribution may be of the glove or stocking type. Remissions in the extent of the sensory loss may occur, and the boundary line separating on a limb the normal area from that in which sensation is impaired may vary in position in one and the same case on different days.

Reflexes, Sphincters, and Cerebral Functions.

The tendon reflexes are absent in fully established cases, but in the early stages the knee-jerks may still be present at a time when the weakness of the legs is obvious; and in cases of the ascending type the ankle-jerks may be lost at a period when the knee-jerks are still present, although these also are lost later. The plantar reflex is usually lost, but the abdominal and cremasteric reflexes may be retained where the involvement of the trunk is not very marked. When the trunk is more involved the abdominal reflexes are lost. The pupil reflexes and the palatal reflex are not affected.

Sphincters are not usually affected, and even in the most severe and fatal cases the functions of micturition and defæcation may remain normal to the end. Defæcation may be rendered difficult owing to the weakness of the abdominal muscles, and in the early stages of the palsy there may be slight temporary retention of urine, requiring, perhaps, the use of the catheter once or twice. No case requiring continuous catheterisation was observed.

No case with stupor, delirium, or convulsions was observed, and consciousness was always retained even in fatal cases right up to the moment of death; and it was not uncommon for death to be sudden. In one case the patient was certainly inclined to sleep unduly, but he could always be easily roused, and then answered all questions quickly and intelligently. In one case there was some loss of taste and some slight impairment of vision, and examination revealed the presence of a central scotoma. Tachycardia may be a prominent feature and was sometimes the cause of serious errors of diagnosis, as the case was apt to be regarded as one of D.A.H. with neurasthenia. I know of two cases at least where death occurred suddenly in such cases. The urine may contain a small quantity of albumin and the blood shows the presence of moderate leucocytosis; the cerebro-spinal fluid is clear, limpid, and free from cells.

The mortality of the disease is high—8 deaths in a series of 30 cases personally observed. Half the deaths occurred within a week of the onset of the palsy and only one death after the eleventh day. In half of the fatal cases death was due to pulmonary complications; in the remaining cases death was more sudden and, although possibly dependent upon respiratory failure, it was not accompanied with gross pulmonary lesions.

In the cases where recovery took place the improvement in the palsy was slow and gradual, and a period as long as six months may be necessary for the patient to regain his usual health. The palsy is not followed by muscular wasting.

Remarks.

Such is a short summary of the clinical picture presented by acute infective polyneuritis. It would seem that the disease is a very definite clinical entity, although both on clinical grounds and from the results of the study of the morbid anatomy it is probable that it is not a neuritis but really a diffuse affection of the nervous system affecting both nerve cells and nerve fibres in the spinal cord, spinal ganglia, peripheral nerves, and to a slight degree the cerebral cortex. It probably has affinities both to poliomyelitis and to encephalitic lethargica, and possibly to other varieties of encephalitis; but one of the most remarkable features of the campaign is that although a fair number of cases of this disease was seen, poliomyelitis was very rare, and I saw no case of encephalitic lethargica until the spring of 1919.

DIURNAL VARIATIONS IN THE HÆMOGLOBIN CONTENT OF THE BLOOD.

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THE necessity of paying due attention to daily variations in arriving at figures for the normal hæmoglobin content of the blood, a knowledge absolutely essential for the investigation of the blood under physiological and pathological conditions, has already been emphasised by one of us (G. D., 1919). In the same publication it was also pointed out how important it is to examine the person's blood at the time of the day when the smallest daily variations are exhibited—e.g., late afternoon—in order to arrive at a true estimate of normality (cf. Douglas, J. S. C., 1913).

On searching in the literature one is at once struck by the fact that the normal diurnal variations in the hæmoglobin percentage have hardly received any attention. In the paper by Douglas, Haldane, Henderson, and Schneider (1913) the subject is definitely considered and some actual figures are given. These workers record observations made four or five times during the working day, and they noticed in some cases the existence of definite differences. They seem, however, not to have laid any great stress on these changes in discussing their results, nor did they find these changes with any constancy. Indirectly the subject has been approached in the remarkably careful and long series of observations of Lloyd Jones (1887) on the diurnal changes in the specific gravity of the blood. This author pointed out the existence of definite daily variations of the specific gravity, and found usually the highest specific gravity about 9 to 10 A.M., and the lowest between 6 and 7 P.M. In view of our own experiments there seems no doubt that these changes in specific gravity are to a great extent caused by differences in the hæmoglobin content, and it is interesting to note that the times of the day when he finds his highest and lowest specific gravities coincide closely with those where we find the highest and lowest hæmoglobin content.

While what we call normal daily variations of the hæmoglobin percentage have thus been left unconsidered, as of no consequence, a number of observers have investigated the changes in the hæmoglobin or red-cell content caused by exercise (Tornow, 1895; Willebrand, 1903; Hawk, 1904; and Boothby and Berry,

1915), fluid intake (Haldane and Priestley, 1916), the position of the body (Jørgensen, 1917), and so forth. Changes in position are stated to have no effect on the red-cell content, though a marked one on the number of white corpuscles, but most observers have found that violent exercise results in a concentration of the blood. It seems, however, hardly possible to form an accurate opinion of the actual changes taking place unless the diurnal variations are duly considered. In fact, some findings in the literature regarding changes in the hæmoglobin percentage seem to be most naturally explained as due to these diurnal variations. The subject here dealt with has been under investigation for several years in connexion with various researches by G. D. and his co-workers, though the only hitherto published figures are those contained in the paper by one of us (H. C. B., 1919), in which one curve was given for comparison with pathological cases.

Method Employed.

The technique used has been developed by one of us (G. D.), and has been used in the Department of Pathology at Oxford for all work dealing with the blood and hæmoglobin for the last 10 years. As no accurate description has so far been published we shall give shortly the details of the procedure. Its advantage is accuracy combined with entire absence of knowledge of the results while readings are being taken, thus entirely excluding personal bias.

Measuring pipettes.—The pipettes used are capillary pipettes drawn from glass tubing of about 6 mm. diameter. It is drawn out to form a capillary tube of such proportions that a length of about 15 cm. corresponds to a volume of 0.1 c.cm. The end of the pipette is cut off sharply and squarely, and it is then graduated by means of mercury measured out from an accurately standardised 0.1 c.cm. pipette. The 0.1 c.cm. of mercury is thus used to graduate a large number of pipettes, which are thrown away after the blood has been measured. For taking the quantity of saline required for the dilution of the blood a 20 c.cm. pipette is employed, in which each cubic centimetre is graduated in 1/10ths.

The blood sample.—If the sample be taken from a finger it is absolutely essential that the capillary circulation should be free and normal, and not restricted as the result of cold or congestion, which produce readings above those obtained from venous samples (cf., Gibson, 1909). No squeezing should be allowed, and the blood should drop freely and have a natural bright colour. Only when this is done is it possible with any degree of certainty to obtain identical results when capillary blood is compared with blood drawn directly from a vein. Five or six drops are now collected into a freshly paraffined watch-glass and the dilution made immediately. While drawing up the blood into the capillary pipette it is necessary to agitate the watch-glass gently and continuously to prevent sedimentation of red cells, which takes place very quickly, and if this point is disregarded very considerable error will be introduced, while otherwise dilutions made from the same drop will give exactly identical readings. In the case of human bloods a dilution of 1 in 200—e.g., 0.1 c.cm. of blood in 19.9 c.cm. of normal saline—is convenient, while in the case of goats and rabbits a dilution of 1 in 150 is preferable owing to their lower hæmoglobin content. Immediately after dilution the blood suspension is carefully mixed, and the tubes with diluted blood are then left in the cold store (or a cool place) and are not hæmolytised until immediately before they are read. As the hæmolytic agent, dry saponin is added (about as much as can be taken up by the terminal millimetre of a penknife). The tubes are then gently rotated and left in a warm room, or preferably in a water-bath at about 30° C., for a few minutes until complete hæmolysis of the red cells has taken place. Before taking readings one should ascertain that the hæmoglobin solution is perfectly clear. The non-hæmolytised diluted red cells can with safety be kept in the cold store at a few degrees centigrade for 24 to 48 hours without showing any change, while the hæmolytised blood kept under the same conditions shows a definite drop in the hæmoglobin content within the same time.

The taking of the hæmoglobin readings.—For all readings a Duboscq colorimeter is used. To secure accuracy and comparable results from day to day it is absolutely necessary to secure an even illumination on the two halves of the fields. To ensure this, and at the same time to secure a greater delicacy of reading, it is to be recommended always to use a yellowish artificial light in a dark room. The light should be so shaded that only the reflecting mirror is exposed to the light rays. It is always necessary on each occasion to determine the actual difference in reading obtained by

filling both cups with the same hæmoglobin solution, and in the calculation of the experiments to allow for these differences. If these details are scrupulously observed it is possible to obtain readings where the mean deviation is not greater than 0.3 per cent., when different hæmoglobin solutions are being read against each other. When a series of hæmoglobins is being compared, one of the samples is poured into the one cup and the other samples are in succession read against it. In the dilution of blood recommended a height of 10 mm. on the vertical measuring scale will give a good colour intensity for allowing accurate comparison. If too weak or too strong a colour is used the accuracy of the readings suffers considerably.

To secure and maintain an unchangeable standard from day to day and year to year, one or more of the bloods are finally read against a standard glass of suitable colour, and in this case it is absolutely necessary to use artificial light rich in yellow rays to obtain a perfect match of colour quality.

The advantage of using a Duboscq colorimeter is that it leaves the observer in absolute ignorance of the numerical reading until he has finally matched the colour, and therefore eliminates the personal equation, a factor of the greatest importance where minute changes have to be ascertained.

Observations.

The observations recorded in this paper have been carried out on goats and men. In the case of goats all blood samples have been taken by introducing a hollow needle into the external jugular vein and collecting the blood in a paraffined watch-glass as described above. In the case of men the samples have been taken in some of the experiments entirely from an arm vein, using a fine needle and a dry syringe, and in others by puncture of the back of a finger near the root of the nail. In a few experiments samples have been taken by both methods as nearly as possible at the same time, and in no case where the circulation has been free and normal, as already stated, has any difference been observed.

To exclude as far as possible the effects of feeding and rest, &c., on the curves, these conditions have been varied in different experiments, with the result that similar curves have been obtained under very diverse conditions. In men the changes found in the course of a long experiment in which no rest was taken for over 30 hours correspond fairly closely with others obtained when the individual was kept entirely at rest in bed, though the exact times for the rise and fall of the curves seem to be somewhat shifted in one direction or the other by the varied conditions. In all cases the times are given in real time, and we do not think that the change from ordinary time to "summer time" has produced any definite shifting of the curve. Even in one surgical patient in bed with marked excursions of temperature the general shape of the curve conformed to the normal type.

These points are brought out clearly by the five curves reproduced, four on men and one on a goat.

Curves 1, 2, and 3 (Fig. 1) are from different individuals within the same period of 25 hours, all the samples being taken from the arm veins without congestion. Curve 4 (Fig. 2) is from the same individual as curve 3, the samples being capillary blood obtained on another occasion by pricking the fingers. In the case of curves 1, 2, and 3 the persons stayed up the whole of the night without sleep or rest owing to the pressure of work. In the case of curve 4 the subject had a long night in bed, got up late, and did no work during the day. Although woken up at hourly intervals during the night, he slept well between the times when the blood samples were taken.

The most striking feature about curves 1, 2, and 3 is that, though the excursions between the highest and lowest readings show considerable variations, the general configurations of the curves are very similar, and the times of rise and fall are approximately the same. Towards the end of the experiment on subject 2 four control determinations were done by taking also capillary blood samples from the finger, which are represented by the broken line on the curve. The almost perfect correspondence between the two series of samples is evident. As a further control on many occasions two samples of blood have been taken with as short an interval as possible between them, and identical readings have usually been obtained, while a divergence of more than 1 per cent. has been extremely rare. Experimental errors are therefore probably slight.

A comparison of curves 3 and 4 shows a general similarity in character for the same individual on different occasions, though the contour seems to have been somewhat shifted to

one side or the other; and it is also to be remarked that the absolute excursions to be noticed from the highest to the lowest readings are very much greater in curve 4 than in curve 3, reading as much as some 15 per cent. The subject whose changes are given in curve 2 was also examined over part of the time corresponding to the experiment reproduced

FIG. 1.—Curves 1, 2, and 3 are all from venous samples in men. Interrupted line at the end of curve 2 indicates control observations on capillary samples. All three individuals took their meals as indicated in the figure. Subject 2 was lying down from 12.36 to 12.56 A.M. when sample (a) was taken, sample (b) being taken at 12.59 after standing three minutes. The same subject lay down from 6.42 to 6.52 A.M. when sample (c) was taken, sample (d) being taken at 6.58 after standing six minutes.

in curve 4, and again the time relations of the rise and fall were very similar in the two subjects, who lived under the same conditions as regards meals, though considerably different as regards rest. Any shift in the curve was therefore apparently the same in the two individuals.

The curves reproduced in this paper are merely samples taken from a large series of observations made on a number of different individuals. In all of the curves reproduced for man the subjects were males.

From these curves it will be seen that the distance between the various highest and the various lowest points correspond

FIG. 2.—Curve 4. Capillary samples from subject 3 on another occasion.

approximately to some four to six hour intervals, and while usually the lowest readings are found somewhat near midnight the highest readings are obtained in the mornings between 8 and 10, or in evening about the same time. During the working day the lowest values occur in the early evening, and there is therefore a general agreement with the results of Lloyd Jones, who found the lowest specific gravity about that time.

In curve 5 (Fig. 3) is represented one series of observations on a female goat; this curve is only a single illustration of a number of observations made on different goats in connexion with other investigations carried out by two of us (G. D. and H. F. P.), which will be published later. In the goat the

same general configuration of curve is to be found as in the case of man; though the exact hours do not absolutely coincide they fall fairly close together. Again, here we trace four to six intervals between the various highest and the various lowest points. The excursions are very considerable, even showing as much as 30 per cent. increase from the lowest to the highest reading, and that the changes may take place very rapidly is shown by the fact that within two hours an increase of some 23 per cent. is found, followed by a similar decrease within the next two hours.

There is some evidence that the female sex exhibits greater daily variations than the male.

Discussion of Results.

From the curves published it must become evident that in any kind of research dealing with observations where blood changes caused by extraneous influences are studied, it is absolutely essential to give the greatest possible consideration to diurnal variations in the concentration of the blood as shown by changes in the hæmoglobin percentage. If this is not done it is hardly possible to draw true and correct conclusions as to the real nature of any variations found. It is not unlikely that in view of the marked diurnal changes normally taking place we may have to reconsider results already obtained in a number of observations dealing with the blood and circulation, and it is also probable that some of the phenomena that have hitherto been veiled in obscurity may be more readily understood.

At the present moment we are unable to offer any rational explanation of these diurnal variations, though

FIG. 3.—Curve 5. Jugular vein samples from a goat. Animal fed each day at 3.45 P.M. and allowed access to food and water the whole time of the experiment.

there is strong evidence that they are closely connected with variations in pulse-rate, blood pressure, rate and volume of respiration, and possibly with fluid absorption or kidney secretion, though it would be premature to attempt to express an opinion as to which is the primary factor in bringing about these changes. We do not consider that the suggestions put forward by one of us (H. C. B.) in the preliminary communication already quoted afford an adequate explanation of the facts in the light of this extensive series of observations.

In connexion with what we have put forward it is worth mentioning that changes produced by cold in the capillary circulation greatly resemble those found during shock by Cannon (1917), though his views regarding changes in colour index must be taken with some reservation until they have been confirmed by experiments with improved methods. It is also worthy of notice that some of the data for diurnal variations in the rate of kidney secretion given by Leathes (1919) show some similarities with the times when changes in the concentration of the blood occur, though any interdependence of the two remains unproved.

Conclusions.

1. The diurnal variations in hæmoglobin percentage met with in man and animals are very considerable and may even reach as much as 30 per cent., while 10 per cent. changes are of more or less common occurrence.

On an average the excursions seem to be more marked in individuals or animals with a low hæmoglobin content of the blood.

2. In attempting to establish the normal hæmoglobin content in a series of individuals it is essential to take the observations at a time of the day when the daily variations are found to be the smallest—i.e., late afternoon between 5 and 7 P.M.

3. In the study of any phenomena where alterations in the concentration of blood are concerned it is necessary to view them in the light of the marked normal diurnal variations that may occur.

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RUPTURE OF CÆSAREAN SECTION SCAR IN SUBSEQUENT PREGNANCY OR LABOUR.*

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AN obstetric surgeon has seldom to face an accident of pregnancy or labour more disturbing to his peace of mind than rupture of the scar of a former Cæsarean section. My interest in the subject has been excited by the following series of events in the obstetrical department of the London Hospital. In November last I operated on a patient almost moribund from the effects of rupture of the scar of a Cæsarean section performed in 1915; in February of this year I saw in the post mortem room a patient dead from abdominal sepsis consequent on rupture of the scar of a Cæsarean section I had myself performed in 1916, and in the years 1915 and 1916 three other of our Cæsarean section patients got rupture of their scars. The occurrence of five of these treacherous accidents in five years has made a very great impression on the minds of myself and my colleagues.

On inquiring into the subject I was impressed with the fact that we possessed very little information about rupture of the scar, either as to its causes, or, far more important, as to the frequency with which it occurred. At the outset I was struck by the wide divergence of opinion amongst the few with whom I talked or corresponded. On the one hand, I was told that rupture of the scar was more or less of a myth; on the other hand, I learned that certain outstanding surgeons—the Camerons of Glasgow, for example—were so afraid of ruptured scars that their invariable custom was to sterilise their patients

at the first operation. Further inquiry proved that rupture of the scar was no myth, but was a real menace; I heard of recent cases in London and elsewhere; about a hundred cases had already been reported in the obstetrical literature of Europe and America. Obviously the subject required investigation. It seemed, above all, imperative to find out what was the actual frequency, the real risk, of rupture. Quite apart from the importance of this information to obstetric surgeons, patients themselves might wish to know what sort of obstetric future they were likely to have after submitting themselves to Cæsarean section. It seemed all the more important to get exact information in view of the increasing frequency with which the operation is being performed; its modern indications form an ever-growing list. There is another point: many patients who nowadays have had Cæsarean section have nothing to prevent them, in the event of a future pregnancy, from delivering themselves by the natural passages—a very different thing from the days when pelvic contraction was almost the only indication, when a repeated operation was the only way of future delivery, and when scars were seldom strained by labour.

If, on inquiry, the risk of scar-rupture was revealed to be a negligible one, then we could, with clear consciences, go on advising and performing the operation according to its extended indications; but if the risk turned out to be an appreciable one, then we should be forced to seek safety either by limiting the indications or by contriving an operative technique which would give a more dependable scar.

I have divided my paper into three sections: (1) An account of five new cases. (2) A general discussion on the ætiology and anatomy of ruptured scars and an analysis of the literature. (3) The results of a follow-up inquiry into the subsequent obstetric history of a large number of Cæsarean section patients operated on between 1912 and 1918.

1. AN ACCOUNT OF FIVE NEW CASES.

The details of the five new cases, from the London Hospital, are as follows:—

CASE 1.—Cæsarean section, 17/4/14, by Dr. Russell Andrews. Primigravida, aged 22, with extreme contraction of the pelvic outlet. Entered hospital early in labour at term. Uterus opened by anterior median incision; sutured with two layers of chromic catgut, a deep buried one including whole thickness of the muscle and missing endometrium, and a continuous peritoneal suture. Living child, weight 6½ lb. Recovery good, temperature not above 99.4° F. during first four days, and afterwards not above normal.

Readmitted 13/8/15, with rupture of scar. No intervening pregnancy. Last menstrual period 11/11/14. Pain began suddenly on 13/8/15 at 2.30 A.M.; a continuous cramping pain which doubled her up made her vomit and faint. Admitted at 8 A.M., anæmic, pulse 120; was in continuous abdominal pain, uterus very tender and hard, abdominal muscles rigid, fetal heart not heard; no labour pains, no external hæmorrhage. Concealed accidental hæmorrhage diagnosed. Laparotomy by the late Dr. Drummond Maxwell. An ovoid rupture, 1½ inches long, was seen in upper part of uterine scar. Placental tissue protruded through the rupture, and blood was oozing from it; about 2 pints of blood in peritoneal cavity. The uterus, with the ovum in situ, was removed by subtotal hysterectomy, and patient made a good recovery.

CASE 2.—Primigravida, age 19, admitted 26/7/14 with eclampsia, in thirty-eighth week of pregnancy. Before admission had already had five convulsions; between 5 A.M. and 11.30 A.M. had convulsions every half hour; treated with morphia, venesection, and intravenous saline. After temporary improvement convulsions increased in severity and frequency. At 2.30 P.M. Cæsarean section by Mr. Gordon Luker; labour had already started. Uterus opened by anterior median incision. Recently dead 7½ lb. fetus delivered. Incision sutured with two layers of chromic catgut, deep and superficial. Convalescence febrile; temperature rose daily to 102° F. for first four days, for next seven it ranged between 100° and 103°. Patient was discharged well on 16/8/14; abdominal wound healed by primary union.

Readmitted 19/11/15 in state of collapse in eighth month of second pregnancy. Laparotomy by Dr. Drummond Maxwell; dead fetus and much blood in peritoneal cavity; rupture through scar of former Cæsarean section; placenta lay almost completely outside uterus, being still attached to one side of rent. Uterus removed by subtotal hysterectomy, but patient died shortly afterwards.

Description of the uterus: A uterus with a long, widely gaping rupture through anterior wall. Outside measurements of uterus: Length, 14.5 cm.; greatest width, 14 cm. Measurements of rupture: Length, 10.5 cm.; width at upper end, 7 cm.; at lower end, 5 cm. Thickness of uterine wall at edges of rupture, 2 cm. near the upper end, decreasing to 1.5 cm. near lower end. Continuous with the lower angle of the rupture is a linear thinned area in the uterine wall 2.5 cm. long; this is the unruptured part of the scar and is only 0.5 cm. thick. The edges of the uterine wall at the site of rupture are for the most part rounded and smooth. At first sight the impression is got that the whole thickness of the

* A paper read before the Obstetrical Section of the Royal Society of Medicine, May, 1920. Full table of cases of Cæsarean Section used in the collective investigation, as well as short abstracts of all reported cases of rupture of the scar, will be published in the Proceedings of the Royal Society of Medicine.