Professor Küttner, who has had a large operative experience of the method.

The operation aims at breaking through or much weakening the sensory arc of the reflex circle on whose integrity the spasm depends. Unlike most of the other proceedings, it leaves the motor impulses and their paths and the muscles themselves untouched. This is an advantage in itself if the excitability of the cord can be reduced to normal.

The operation may be performed in two stages or in one, and the nerve roots may be identified and located either near their exit from the canal or at their origin from the conus medullaris. In favour of the two-stage operation, the avoidance of bleeding into the dural sac, and of the additional shock of manipulating the cord and nerve roots on the same occasion as the laminectomy, are cited, but if the use of adrenalin by injection before and swabbing during the operation is adopted, as advised by Hey Groves, there is, as it seems to me, no advantage in doing the operation in two stages, but the contrary.

As to the site of the section, I have found that although it is easier to identify the roots near their exit from the canal, it is by no means easy to distinguish the posterior from the anterior roots, although this might be facilitated by electrical tests; on the other hand, if the section be made near the origins of the nerves from the conus, while it is easier to tell posterior from anterior roots, it is less easy to identify the individual roots; but as the mistaking, say, the fifth lumbar for the first sacral is less serious than the mistaking an anterior for a posterior root, and as, moreover, the requisite number of roots can be divided near the conus, with less extensive removal of laminae than lower down (for the whole lumbar enlargement can be exposed by removal of three vertebral arches), there appears to be a considerable balance of advantage in favour of the higher operation, in which, too, the incision is better placed for avoidance of sepsis.

It is not to be denied that the operation is a serious one, but having regard to the hopeless nature of the very severe cases—those for which alone Foerster would advise it—under other treatment, it is quite justifiable. Not only is the operation severe and a good deal of shock to be expected, but for some days after the operation the patients suffer acute pain and hyperaesthesia, which, however, passes off as the central ends of the nerve roots degenerate. Spasm may in some cases return, even when a large number of roots has been divided. Whether the fears expressed by some of secondary degeneration of the cord are justified, time will alone show. So far not much evidence of it is to hand.

As yet very few cases have, as far as I have been able to ascertain, been submitted to rhizotomy for spastic palsy out of Germany. Professor Foerster last summer recorded fifty-nine operations for Little's disease with eight deaths.

In a case operated on by myself in September, 1912, the results are very encouraging, and the child is beginning to walk, but the case is not yet ready for publication.

Foerster and all others are practically agreed that the operation is only justifiable in the worst cases, where the patient is not idiotic, there is not much athetosis or epilepsy, and where other treatment is hopeless.

Finally, but not of least importance, comes as a method of treatment re-education, without which good results are not to be obtained from any operation whatever. This re-education of muscles and will must be constant, patient, persevering, and measured in time more by years than by months.

After all has been done that man can do, there will be cases in which little improvement will be made, but, for all that, there is no need of pessimism, although it must always be remembered and impressed upon the friends that such cases may be improved but cannot be completely cured.

ACCORDING to a statistical report recently issued by the French Minister of the Interior, the total number of medical practitioners in France is 20,809. The departments in which the number of doctors is largest are the following: Seine, 4,393; Nord, 811; Gironde, 614; Rhône, 585; Bouches-du-Rhône, 575. The departments with the fewest doctors are the Hautes-Alpes, 29; Haut Rhin, 32; and La Lozère, 39. There are in France 2,848 dentists, 13,065 midwives, and 11,585 pharmacists.

HEREDITARY TRANSMISSION OF SARCOMA.

BY

J. S. MANSON, M.B., CH.B. EDIN.

LIKE many other diseases which have since been proved to be of environmental origin, malignant disease was long believed in a vague and indefinite manner to be hereditary. The success of modern research in discovering that the essential causes of many diseases hitherto believed to be hereditary were of an environmental nature, gave a gleam of hope that malignant disease would in due course fall into the same category. The present-day belief in the parasitic or at least environmental origin of cancer stimulates research workers to the discovery of its cause, and so to its prevention and cure.

The most recent addition to modern research has been the analytical study of heredity, and it is interesting to note that the question of heredity in malignant disease is again coming into prominence. Bashford¹ has discussed the relation of heredity to the frequency of cancer in man, and comes to the conclusion that the difficulties of the problem are too great to admit of a satisfactory result. He was hopeful, however, that numerous experiments with short-lived animals like mice would lead to some definite conclusion. His colleague Murray² states that it has been part of the original plan of the work of the Imperial Cancer Research Fund to study the hereditary factor in the problem of cancer, and he has already made an important contribution to the subject. He has shown that the incidence of spontaneous mammary cancer in mice of recent cancerous ancestry is nearly double that in mice of remote cancerous ancestry. The conclusion from this is that an acquired susceptibility to cancer has been transmitted, but no light is thrown on the origin of the disease itself.

As a small contribution to the study of malignant disease in man, I give the following account of the illness and deaths of a mother and two sons from sarcoma, which I venture to think justifies the title of this article.

CASE I.

The Mother.

S. P., the mother, was born in 1869, a native of Cheshire, the youngest of a family of one brother and four sisters. At the age of 22 she married E. P., who is still alive and well. Three sons were born: W. in March, 1892; T. in July, 1894; and C. in August, 1897. There was thus an interval of two years and four months between W. and T. and three years and one month between T. and C.

S. P. had always been a healthy woman. At the beginning of 1896 she noticed a small lump about the size of a bean on the left side of the neck. This grew slowly, until it reached the size of a marble. She consulted her doctor, who advised her to have several teeth extracted, and this was done. The swelling, however, continued to increase, and in August, 1897 (eighteen months after it was noticed), it had attained the size of a walnut.

On August 3rd, 1897, C. was born, and after this the tumour grew very rapidly.

On November 9th she was admitted to the Manchester Royal Infirmary. The following extract from the register of Manchester Royal Infirmary was kindly supplied by Mr. E. E. Hughes, the surgical registrar:

"S. P., admitted November 9th, 1897; discharged November 18th, 1897. Diagnosis: Lympho-sarcoma neck, left side. Result: Home *in statu quo*."

The growth continued to enlarge, and she died from exhaustion on February 21st, 1893, about two years after the growth was first observed.

CASE II.

The Sons.

C., the youngest son of the family, had always been a healthy lad. He consulted me in September, 1912, about a small growth on the left side of the neck. The growth was about the size of a walnut, movable and painless, the skin moving freely over it. I referred him to Mr. Roberts at the out-patient department of the Manchester Royal Infirmary, and he was admitted in November. A small piece of the growth, which had increased in size, was excised for microscopical examination. The report from the clinical laboratory stated that the section showed the structure of a round-celled sarcoma.

He was sent home, and the growth continued to enlarge, until it formed a fungating bleeding mass as large as a cauliflower on the left side of the neck. On February 17th, 1913, he died from exhaustion and haematemesis.

CASE III.

T., the second son in the family, consulted me in March, 1912, about some swellings on the right side of the neck. He had an enlarged right tonsil with some exudation on its inner surface. The swellings were evidently enlarged glands secondary to the

diseased tonsil. Local antiseptic treatment was applied to the tonsils and fomentations to the glands. The tonsil looked healthy after a month's treatment, but the glands remained enlarged. In April I sent him to see Mr. J. W. Smith, who thought the glands tuberculous, and on May 1st removed them at the Manchester Royal Infirmary. The patient then went to the country for a month and returned looking well, but there was some recurrence of the glandular enlargement on the right side.

On October 4th he was readmitted to the Manchester Royal Infirmary, and on October 7th the glands were excised. The pathological report on the glands removed in May and October stated that they showed only inflammatory enlargement, and in the subsequent history of this patient there was no recurrence after the second operation.

In January, 1913, the patient consulted me about bleeding from the right tonsil, which was considerably enlarged; on the left side of the neck, about the junction of the upper and middle thirds of the sterno-mastoid muscle, there was a small tumour about the size of a Barcelona nut. This was freely movable and painless. I referred him to Mr. Smith, who admitted him to his wards in February. The growth on the left side was excised and a portion of the tonsil removed and both submitted to microscopical examination. The report of this examination stated: "Section of tonsil shows changes of an inflammatory nature; there is no evidence of malignant disease. Section of lymph gland shows structure of a lympho-sarcoma."

After a stay at the Cheshire Convalescent Home he returned home, but the tonsil had so increased in size that there was difficulty in swallowing and obstruction to breathing.

Mr. Smith admitted him again in April and performed an extensive operation by resecting the lower jaw on the right side, removing the soft palate and enucleating the growth from the right pharyngeal wall. This was only a palliative procedure to prevent death by suffocation, as the growth was manifestly malignant and a radical removal impossible. The pathological report of April 25th states, "Section of tonsil is that of round-celled sarcoma." The patient made a good recovery from the operation and went to the convalescent home for a few weeks, returning home in June. On June 27th I made a differential leucocyte count, which gave: Polymorphs, 40 per cent.; small mononuclears, 33 per cent.; large mononuclears and transitionals, 25 per cent.; eosinophiles, 2 per cent.; an average of three counts gave 7,500 per c.cm.

The growth from the pharynx continued to grow rapidly and formed a large mass in the parotid region and below and behind the angle of the jaw on the right side. The growth on the left side recurred and increased to the size of a Tangerine orange before death, which took place on August 17th, 1913, from exhaustion.

Portions of both growths were removed *post mortem* and submitted to microscopical examination by Dr. J. P. McGowan, of Edinburgh, who reported them to be lympho-sarcomata.

In neither Case II nor Case III was there any sign of generalized enlargement of the lymph glands.

That there are some striking facts recorded in these three histories will be generally admitted. The main outstanding facts are the death of the mother from sarcoma, originating in the left side of the neck, and the deaths of her two sons from the same disease arising in the same region. This sequence and similarity, although not conclusive of an hereditary origin, strongly favours it in the absence of other known cause. Granting a strong element of heredity, the question arises, "What has been transmitted?"

The following are the pedigrees of the father and mother (Case I) of the two sons C. (Case II) and T. (Case III), founded on information obtained from the father, who is an intelligent man, and is anxious to be as accurate as possible.

FATHER'S (E. P.) SIDE.

- W. P. Father of E. P., living, aged 66.
K. P. Mother of E. P., died, aged 60, of heart failure; she had two sisters, who died of cancer of the breast, one aged 45, and the other 67.

CHILDREN OF W. P. AND K. P.

- W. P. Son, aged 4, died; diphtheria.
E. P. Son, living, aged 42; father of C. and T.
A. Daughter, living, aged 39; married, three healthy children.
A. Son, died, aged 2; scalds.
E. Son, living, aged 36.
M. Daughter, living, aged 34; married, 2 healthy children.

MOTHER'S (S. P.) SIDE.

- T. W. Father of S. P., living, aged 89.
M. W. Mother of S. P., died, aged 54; consumption.

CHILDREN OF T. W. AND M. W.

- J. W. Son, living, aged 52.
F. W. Daughter, died, aged 28; consumption.
M. W. Daughter, living, aged 50, with three healthy children.
A. W. Daughter, died, aged 25; consumption.
B. P. Case I, daughter, died, aged 29; sarcoma.

CHILDREN OF E. P. AND S. P.

- W. Living, aged 21.
T. Died, aged 19; sarcoma.
C. Died, aged 15; sarcoma.

It will be observed that T. W., the maternal grandfather of T. and C., is alive, aged 89, and he has no knowledge of any one dying of malignant disease either on his side or on that of his wife, M. W.

The paternal grandfather, W. P., is also alive and well, and he has likewise no knowledge of malignant disease on his side.

In this pedigree there is no evidence of malignant disease, except in the two paternal grand-aunts of C. and T., and in them it was cancer of the breast at an advanced age.

The sarcoma in Case I apparently arose *de novo*, and the following questions arise: Was this sarcoma an acquired character arising in response to some environmental stimulus, or was it a true germinal variation having its origin further back in the ancestry of the patient than can now be accounted for? Of course, neither of these questions can be answered with any definiteness, but such evidence as there is seems to point to its being a germinal variation.

In problems of heredity there is often doubt as to the similarity of supposedly transmitted characters, but in these cases the evidence is complete, clinically and microscopically, that the fatal growth in all three was of the same nature—namely, round-celled sarcoma arising in a lymph gland or lympho-sarcoma. Again, the anatomical site of the original growth in all three was practically the same—namely, the lymph glands at the junction of the upper and middle thirds of the left sterno-mastoid muscle.

If the mother, S. P., had had an extra thumb on the left hand, and the same characteristic had appeared in C. and T., the influence of heredity would have remained unquestioned, but then there are many instances of transmitted polydactylism, and but few of sarcoma. This comparison is further complicated by the fact that polydactylism appears at birth, is non-fatal, and does not hinder reproduction, while sarcoma appears later, is fatal, and may prove so before the reproductive age has been reached.

It will be noted that S. P. was pregnant with C. while actually showing marked signs of the disease.

If the growth in S. P. had been of environmental origin, say due to the *Spirochaeta pallida*, the disease might have been expected to show signs of the disease at birth or soon after, or to be immune to the disease (Profeta's law) certainly later than the age of 15, when he died of it. If the environmental agency had been, say, the tubercle bacillus, then although C. would not have expected to show signs of the disease at birth, yet it would have been very unlikely in the case of a later infection for the disease to have appeared in exactly the same anatomical site as in his mother and brother.

When the clinical history of T. is considered the evidence for germinal variation becomes strengthened. This patient underwent two operations for cervical adenitis on the right side. The glands on microscopical examination showed inflammatory reaction only, and there was no recurrence in these glands after the second operation. In January there appeared on the left side of the neck (the same side as in his brother and mother) a small tumour which proved on microscopical examination to be lympho-sarcoma, while a section of the enlarged tonsil only showed inflammatory reaction. In April the tonsil had become sarcomatous, and also the lymphoid tissue of the pharynx. Here again one lays stress on the side on which the disease commenced; if the sarcoma had commenced in the tonsil, and had appeared later on the left side of the neck, then the similarity between this and the other two cases would have been less, and the argument for genetic continuity correspondingly lessened.

It might be said by some, in arguing against heredity, that T. was infected from C., but against that we have the facts that T. was less in touch with C. than any other member of the household, and very much less than his brother W. Infectivity cannot explain the onset of the disease in T. and at the same time explain the immunity of the other members of the family, who were in constant and close contact with C. during the whole course of his illness.

It is interesting to observe that the law of anticipation enunciated by Dr. Mott with regard to the heredity of mental disease seems also to be at work here. C. died at the age of 15, and T. at 19—that is, 14 and 10 years younger than their mother respectively; thus the chance of propagating the disease, supposing males to transmit, was very small indeed.

It is generally stated that the heredity of malignant growths is best expressed as a susceptibility or tendency (Mansell Moullin³), and that such growths only occur in susceptible individuals when exposed to some influence such as chronic irritation. It is, however, interesting to note that the sarcoma in T. did not commence in the chronically irritated glands on the right side of the neck, which were removed by operation and did not recur, but commenced on the left side, as in his mother and brother.

Thus the evidence, so far as it goes, points to the conclusion that the sarcoma which arose in the mother was a germinal variation or sport which she transmitted as a dominant character to her two sons, T. and C.

While this provisional conclusion from data so slight may seem hazardous, yet with regard to the ultimate pathology of the disease it is worthy of consideration.

In any consideration of malignant disease much turns on the view as to whether it be local or constitutional in origin. If heredity be as strong a factor in the origin of sarcoma as the foregoing cases suggest, then the view that it is of local origin would place sarcoma among the local hereditary tissue changes, such as produce hereditary cataracts or moles, and would give some support to the theory of embryonic cell rests propounded by Cohnheim and others. If the alternative view be taken, then sarcoma—or at least lympho-sarcoma—might be added to the other blood diseases having a marked hereditary character, such as haemophilia, and perhaps pernicious anaemia (Gulland and Goodall⁴).

In the foregoing cases the evidence for a local origin is strong. In all the initial lesion was a small growth on the left side of the neck, which increased in size, and only affected the lymphoid tissue in proximity to it. There was no glandular enlargement in the axillae or groins, nor was there any sign of pressure on the bronchi from mediastinal growth. As no *post-mortem* examination was made in any of the cases, it is impossible to say whether the lymphoid tissue in the body cavities was affected or not. Again, in cases C. and T. it was interesting to note that there was little constitutional disturbance in spite of the rapid advance of the disease. Their appetites were good, minds clear, and both patients were out walking five or six weeks before death occurred. Such marked constitutional disturbances as occurred towards the end were due to pain and difficulty in swallowing and breathing from mechanical pressure.

The only evidence for a constitutional origin was the condition of the blood in Case III as revealed by the differential leucocyte count made on June 27th. This showed in a normal total count a diminution of polymorphs and an increase of lymphocytes and large mononuclears. This count is evidence of a general disease, and it bears some resemblance to that in the case of nodular leukaemia reported by Reid, Calwell, and Thomson.⁵

It is to be regretted that no blood examinations were made in Cases I and II, for they might have afforded additional evidence for comparing the disease in these cases with leukaemia. The latter disease is now practically regarded as a tumour in the blood, and it may also be strongly hereditary, although from that point of view it would be a very difficult disease to study.

In reflecting on heredity and tumours one cannot help thinking that the origin and growth of tumours are in some way related to a form of sex activity of either tissue or blood cells. Sex characters or analogous properties are present in the lowest protozoa, and are necessary for

the rejuvenescence of the race, because organisms reproducing themselves normally by fission eventually degenerate and decay unless conjugation occurs.

While in differentiated multicellular bodies there are specialized germ cells and somatic cells, yet each may have latent some property of the other. Wilson⁶ states:

It must, however, be borne in mind that the distinction between germ cells and somatic cells is not absolute, as some naturalists have maintained, but only relative. The cells of both groups have a common origin in the parent germ cell . . . both have essentially the same structure, and both may have the same power of development.

From this it may be inferred that the tissue cells of the body have latent sex characters potentially present. If this be so, then, if these sex characters become active, the stimulus to reproduction is given, and a cell mass or tumour results.

The late Sir Henry Butlin,⁷ in commenting on Professor Calkin's statement "that the cancer cell, so far as we know, undergoes no processes analogous to fertilization," wrote: "One can only say that if in the future no process analogous to fertilization is discovered in the life-history of cancer cells, it is evident that the import of the process of fertilization will have to be reconsidered."

The process of fertilization is essentially the fusion of complementary sex characters, and is too well established to need reconsideration. The difficulty is to associate the process with tumour growth. If any and every cell of the body has latent sex characters, it might be suspected that if these became active at all then such activity would be displayed more in the less than in the more highly specialized cells, and it is a broad fact that tumour growths are most common in connective tissue and epithelial cells, while the highly specialized parenchymatous cells escape.

In this speculation the origin of tumours is referred to the primordial sex characters of the cell which become latent in the specialization involved in the formation of multicellular bodies. These characters are likely to become active when the specialized function of the cell is decaying with the advance of age, or has been lowered by injury or irritation. The cells themselves, being a product of the parent germ cell, a heightened sex activity in certain tissue or blood cells may be present as an hereditary character, as seems evident in the cases here quoted. Further, the now well-known influence which radio-active rays have in producing sterility may, on this hypothesis, explain the action of these rays in arresting and reducing tumour growth.

I have to thank my friends, Mr. J. W. Smith of Manchester and Dr. J. B. Naden of Warrington, for their valuable help.

REFERENCES.

- ¹ Bashford, Introduction Third Scientific Report Imperial Cancer Research Fund, pp. xi and xii.
- ² Murray, Fourth Scientific Report Imperial Cancer Research Fund, pp. 114 et seq.
- ³ Mansell Moullin, Bradshaw Lecture, Biology of Tumours, BRITISH MEDICAL JOURNAL, 1912, vol. ii, p. 1598.
- ⁴ Gulland and Goodall, *The Blood*, p. 101.
- ⁵ Reid, Calwell, and Thomson, BRITISH MEDICAL JOURNAL, 1913, vol. i, p. 1318.
- ⁶ Wilson, *The Cell in Development and Inheritance*, p. 122.
- ⁷ Butlin, *Uncellula Canceri*, BRITISH MEDICAL JOURNAL, 1911, vol. ii, p. 1396.

THE first Italian Congress of Medical Radiology was held at Milan on October 12th, 13th, and 14th. On the initiation of the Society of Radiology, it was organized by a local committee of which the chairman was Dr. Parola. The Congress opened with an address by Professor Augusto Righi on the nature of the x rays, delivered to a large audience composed of specialists from every part of Italy, with a few from France and Germany. Four reports were presented—one by Professor Maragliano on intensive apparatus in radiological technique; another by Dr. Busi on the radiographic image of the skull; a third by Dr. Tandoja on the radiology of the intestine, and the last by Professor Bertolotti on x -ray and radium treatment in gynaecology. Each of these gave rise to animated discussions. Afterwards, communications to the number of ninety-four were presented. In connexion with the Congress there was an exhibition of apparatus. The second congress will be held next year at Genoa under the presidency of Professor Maragliano. It was decided that a monthly review, to be called *La Radiologia Medica*, should be founded. The editor will be Dr. Perussia, of Milan, who acted as General Secretary of the Congress. Dr. Busi, of Bologna, was elected President of the Society for the coming year.