# A FOLLOW-UP INVESTIGATION OF 330 CASES TREATED BY PREFRONTAL LEUCOTOMY.*

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BETWEEN 11 October, 1942 and 31 December, 1947, the operation of prefrontal leucotomy was carried out on 345 patients at the Graylingwell Hospital, Chichester. The technique was similar to that of the standard method of Freeman and Watts: in each case the operation was performed by Mr. A. G. Ross. The paper reports the results of a clinical follow-up investigation in 330 of the cases; the remaining 15 could not be traced.

*Method of follow-up investigation.*—The aim was to establish the mental condition of the patients operated on during the above period. The examination consisted of one or two psychiatric interviews, which were as comprehensive as possible. All interviews were conducted by the author. No psychological tests were carried out. In each case at least a year had elapsed between the operation and the follow-up eaxamination. Miss Nancy G. Cook, the Psychiatric Social Worker attached to the Department of Clinical Research, interviewed the patients' relatives, and sometimes their employers, prior to the psychiatric examination. The discharged patients were visited at their own homes. As a rule only one visit was made by the psychiatrist, who, in most cases, also saw the relatives, while it was often necessary for the social worker to make several visits to collect all the information available. The investigators met with most gratifying co-operation from the discharged patients and their relatives. Only in 4 cases was information withheld; in some instances oversolicitous relatives, while anxious to report on the patient's condition, requested the psychiatrist not to see the patient out of fear that his visit might have an untoward effect. The patients who had remained in hospital were re-examined, and, where possible, visiting relatives were interviewed for the purpose of obtaining their impressions on the change that the patients had undergone since the operation.

Only a small number of cases, i.e. those operated on during the last 5 months of 1947, had been known to the author before the operation, but the case notes and the information obtained from his colleagues and the patients' relatives enabled him to form an impression of the pre-operative condition of the rest of the cases. The author was not concerned with the selection of the cases

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for operation. The provisional results of the operation in the first 200 cases were reviewed by J. Frank (1946). The investigations underlying the present report have been carried out independently of Frank's work. The indications for the operation at the Graylingwell Hospital were, as Frank stated, on the whole identical with those laid down by Freeman and Watts.

An investigation such as this, although it has fewer fallacies than follow-ups based on questionnaires, correspondence and social workers' visits alone, is still far from satisfactory. In some discharged cases, repeated interviews spread out over a certain period might have established a more complete picture of the patient's condition than it was possible to obtain by one or two visits. Another fallacy springs from the grouping together of cases operated on 1 to 5 years prior to the re-examination. An attempt has been made, where possible, to assess separately the cases operated on in various periods.

In the course of the present examination it became clear that information obtained from the relatives alone, as well as impressions gained from the interview with the patient only, however thorough, may be very misleading. In most cases the patient's post-operative condition could be assessed only when information from both sources was available. The information obtainable has not, of course, been equally comprehensive in all cases.

Cases where information of progress could be obtained by correspondence only will be grouped separately. The post-operative condition of patients who died from intercurrent illnesses prior to this follow-up, has not been assessed clinically for the purpose of this report. The information concerning their progress after operation was not comparable with that available in the rest of the cases.

Table I gives the numbers of patients discharged, still in hospital, dead and untraced.

TABLE I.—345 *Cases Operated on by Leucotomy.*

| | Schiz. and par. | Affect. | Others. | Totals. |
|---|---|---|---|---|
| Discharged, followed up by interview | 65 | 69 | 13 | 147 |
| Discharged, followed up by correspondence | 9 | 5 | 1 | 15 |
| In hospital at the time of investigation | 115 | 8 | 11 | 134 |
| Dead | 20 | 13 | 1 | 34 |
| Not traced | — | — | — | 15 |
| Totals | 209 | 95 | 26 | 345 |

*Grouping of material.*—The cases have been grouped according to current diagnostic classification. However, as the various clinical reaction-types embrace cases of very different severity and prognosis, an endeavour has been made to subject every case to a structural analysis with a view to establishing which features of the personality or the syndrome present before the operation could be related to changes following the operation. It was also the purpose of this analysis to find out whether or not individual patients had shown

certain peculiarities in their psychotic reactions or personalities, which were in the nature of assets or liabilities as far as short-term prognosis was concerned. It also aimed at establishing the presence of mixed syndromes, such as schizophrenic reactions with depressive features or vice versa. In this way the well-known fallacies of psychiatric classification can be reduced. It is generally accepted that, from the point of view of short-term prognosis, it is not decisive whether a case is diagnosed as a depression with schizophrenic features, as a schizophrenic reaction with depressive features or as a schizo-affective state. A list of about 75 items was drawn up, and the relevant data filled in as fully as possible in every case. The information on many of the items was incomplete and therefore insufficient to be taken into account, e.g. data concerning heredity were too scanty and unreliable to be of value. This report is concerned only with the change in the clinical condition of the patients which had taken place by the time of the re-examination and reference will only be made here to some of the items which could be established in the majority of the cases with a certain degree of reliability. The material will be subjected elsewhere to an analysis from other angles.

In classifying the clinical condition on re-examination the following categories have been distinguished:

*Full Remission*, i.e. disappearance of symptoms and return to the same or almost the same state of mental health and efficiency as before the onset of symptoms.

*Much Improved*, i.e. some slight residual symptoms only are present, without interfering seriously with the patient's conduct, which is similar, or almost similar, to that before the illness.

*Improved*, i.e. symptoms still present, but definitely less severe.

*Unchanged, Conduct Improved.*

*Unchanged.*

*Unchanged, Conduct Worse.*

*Dead*, i.e. (*a*) died within 2 months after the operation;

(*b*) died later than 2 months after the operation.

The term "Full Remission" is preferable to that of "Recovery" or "Cured," especially in a survey which covers a comparatively short period following treatment; it does not have the ring of finality of the latter terms; it refers to the symptoms of the illness only, and makes some allowance for certain defects which careful examination rarely fails to reveal in schizophrenics who have made a full recovery with or without treatment. The term "Social Recovery" has been avoided, as it is liable to be applied too widely.

A classification of the results of leucotomy which takes into account the change of symptoms only would not be entirely satisfactory. The total result should, if possible, be judged by the effect of the operation, not only on the symptoms, but also on the personality. The distinction between effects on the mental condition and on the personality is, of course, an artificial one, because it is in all likelihood the same physiological change which affects the mental symptoms and the personality, and also because, clinically, such a distinction is difficult to make, especially in schizophrenics with only partial improvement. The distinction, however, is possible, up to a point, in cases which have made

a full remission. The changes in the symptoms and in the personality make up the total result, i.e. the patient's total adjustment to reality. This will be assessed here for the highest degree of improvement (full remission) in schizophrenics only.

In assessing results it is necessary to be clear whether one is setting out to judge the changes following the operation against mental health ("absolute" result), or against what could be expected in an individual case (relative result). The result of an operation which has turned a destructive chronic catatonic into a useful or more tolerable member of the chronic hospital population, although he may still be hallucinated and deluded, can be regarded as relatively very satisfactory. Judged against mental health it is, however, poor. The general application of the first standard (absolute result), therefore, does not do justice to the effects of the operation on chronic cases. In those cases the relative results are sufficiently reflected in the change of symptoms. The result will be classified as "very good" in those patients who underwent a full remission, showed only a slight personality change or none at all, fully regained or improved their social status and had no epileptic fits. The result will be classified as "good" where a full remission was associated with a definite loss of social status attributable to the personality change, or with the occurrence of late epileptic manifestations; as "fair" where the patient was unable to make an adjustment notwithstanding the disappearance of psychotic symptoms. No assessment of absolute results has been carried out in the affective psychoses, as in the majority of cases of that group there is a marked tendency to recurrence, and the time which has elapsed since the operation is too short for the results to be assessed in this way.

An assessment of "absolute" results, similar to that proposed here, has been carried out by Garmany (1948).

### 200 Cases of Schizophrenic Reaction Types and Paranoid States.

Two-hundred-and-nine of the 330 cases which could be reviewed were patients in whom the diagnosis of one of the above-named reaction types was made. In 200 of these it was possible to obtain fairly full and uniform information. Nine cases could by followed up by correspondence only, and will be dealt with separately. All the patients had, prior to the operation, failed to respond to insulin or electro-convulsant therapy.

Table II shows the proportions of those discharged, still in hospital, and dead by December, 1947, excluding those followed-up by correspondence only.

Table II.—200 *Schizophrenics and Paranoid States.*

M, male; F, female; T, total.

| Discharged. | | | In hospital. | | | Dead. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 30 | 35 | 65 | 54 | 61 | 115 | 9 | 11 | 20 | 93 | 107 | 200 |

Table III shows the number of patients operated on during each year covered by this survey. The fall in the number of operations in 1947 was

TABLE III.—209 *Schizophrenics and Paranoid States. Number of Cases Operated on in Each Year Under Survey. First Operations.*

| | M. | F. | T. |
|---|---|---|---|
| 1942 | 5 | 3 | 8 |
| 1943 | 16 | 15 | 31 |
| 1944 | 27 | 23 | 50 |
| 1945 | 25 | 24 | 49 |
| 1946 | 17 | 30 | 47 |
| 1947 | 4 | 20 | 24 |
| Totals | 94 | 115 | 209 |

mainly due to the fact that the majority of suitable cases among the chronic schizophrenics had already been dealt with, and also to a tightening up of the indications in the light of increasing experience.

Table IV illustrates the social status of the 180 patients still living, according to the classification of Freeman and Watts.

TABLE IV.—180 *Living Patients with Schizophrenic and Paranoid States Followed up by Interview. Their Social Status Assessed According to the Criteria of Freeman and Watts.*

| Employed. | | | Partly employed. | | | Keeping house. | | | At home. | | | In hospital. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 14 | 8 | 22 | 4 | .. | 4 | .. | 19 | 19 | 12 | 8 | 20 | 54 | 61 | 115 |
| | | (12·2%) | | | (2·2%) | | | (10·6%) | | | (11·1%) | | | (63·9%) |

Table V shows the distribution of the various reaction types and the mental state of the patients at the time of their re-examination. The term "paraphrenia" has, according to current usage, been applied to designate paranoid states with delusions and hallucinations, but without thought disorder and signs of personality disintegration. The percentage of male patients classified as full remissions was higher than that of the females.

In Table VI the patients treated in each of the 6 years under review have been grouped separately. It shows that none of the cases operated on in 1947 had undergone a full remission. This appears, at first sight, to be due to the fact that the time which had elapsed since the operation had not been sufficient for the effect to mature. However, the analysis of the individual cases operated on during that year makes it seem unlikely that there will be a material change in the figures for the highest grades of improvement. Of the 20 patients operated on in 1947 who were interviewed, only one had been ill for less than 2 years, and only 3 for less than 4 years before the operation. None of them showed any marked improvement at the time of re-examination. As Table VIII indicates, the great majority of cases classified as "Full Remission" and "Much Improved" come from those with an onset of under 4 years before the operation. Considering also that signs of a favourable outcome are usually

TABLE V.—200 *Schizophrenics and Paranoid States, Grouped According to Reaction Types. Their Mental States on Re-examination.*

| Reaction types. | Full rem. | | | Much impr. | | | Impr. | | | Unchanged, conduct impr. | | | Unchanged. | | | Worse. | | | Dead. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| Catatonia | 5 | 2 | 7 | 2 | 1 | 3 | 3 | 2 | 5 | 10 | 6 | 16 | 3 | 7 | 10 | 2 | 2 | 4 | 2 | 3 | 5 | 27 | 23 | 50 |
| Schiz. simpl.-heb. | .. | .. | .. | 1 | 1 | 2 | 5 | 1 | 6 | 11 | 4 | 15 | 6 | 4 | 10 | .. | .. | .. | 1 | 3 | 4 | 24 | 13 | 37 |
| Par. schiz. | 6 | 3 | 9 | 2 | 5 | 7 | 6 | 4 | 10 | 8 | 7 | 15 | 7 | 8 | 15 | .. | 5 | 5 | 3 | 5 | 8 | 32 | 37 | 69 |
| Paraphrenia | 1 | 5 | 6 | 1 | 1 | 2 | 1 | 8 | 9 | 1 | 15 | 16 | 2 | 4 | 6 | .. | 1 | 1 | 1 | .. | 1 | 7 | 34 | 41 |
| Senile par. state | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 2 | .. | 2 | 3 | .. | 3 |
| Totals | 12 | 10 | 22 | 6 | 8 | 14 | 15 | 15 | 30 | 31 | 32 | 63 | 18 | 23 | 41 | 2 | 8 | 10 | 9 | 11 | 20 | 93 | 107 | 200 |
| Percentage | | | 11 | | | 7 | | | 15 | | | 31·5 | | | 20·5 | | | 5 | | | 10 | | | 100 |

TABLE VI.—200 *Schizophrenics and Paranoid States, Grouped According to the Year of Operation. Their Mental States on Re-examination.*

| Year. | Full rem. | | | Much impr. | | | Impr. | | | Unchanged, conduct impr. | | | Unchanged. | | | Worse. | | | Dead. | | | Totals. | | | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | |
| 1942 | 2 | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 | 1 | 4 | 1 | .. | 1 | .. | .. | .. | 6 | 1 | 7 | 1942 |
| 1943 | 1 | 1 | 2 | .. | 2 | 2 | 4 | 2 | 6 | 9 | 3 | 12 | .. | 3 | 3 | 1 | 1 | 2 | 1 | 3 | 4 | 16 | 15 | 31 | 1943 |
| 1944 | 3 | 2 | 5 | 3 | 1 | 4 | 2 | 2 | 4 | 7 | 7 | 14 | 5 | 5 | 10 | 1 | 2 | 3 | 4 | 4 | 8 | 25 | 23 | 48 | 1944 |
| 1945 | 4 | 3 | 7 | 2 | 2 | 4 | 5 | 4 | 9 | 8 | 4 | 12 | 5 | 6 | 11 | .. | .. | .. | 1 | 2 | 3 | 25 | 21 | 46 | 1945 |
| 1946 | 2 | 4 | 6 | 1 | 2 | 3 | 3 | 4 | 7 | 7 | 9 | 16 | 3 | 6 | 9 | .. | 2 | 2 | 1 | 1 | 2 | 17 | 28 | 45 | 1946 |
| 1947 | .. | .. | .. | .. | 1 | 1 | 1 | 3 | 4 | .. | 9 | 9 | 1 | 3 | 4 | .. | 2 | 2 | 2 | 1 | 3 | 4 | 19 | 23 | 1947 |
| Total | 12 | 10 | 22 | 6 | 8 | 14 | 15 | 15 | 30 | 31 | 32 | 63 | 17 | 24 | 41 | 3 | 7 | 10 | 9 | 11 | 20 | 93 | 107 | 200 | |

marked by the end of the first year after operation, it is unlikely that the number of those with the highest grades of improvement among the 1947 group will increase in the course of time. The one patient assessed as " Much Improved " was a case of paranoid schizophrenia, with an onset 9 years before operation, who showed a number of assets usually found in those who had improved greatly after the operation (see below).

The following tables refer to the 65 discharged patients only. Table VII groups these patients according to reaction types.

TABLE VII.—65 *Discharged Schizophrenics and Paranoid States.*

| Catatonia. | | | Schiz. simplex—hebephr. | | | Par. schiz. | | | Paraphr. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 10 | 4 | 14 | 4 | 2 | 6 | 14 | 9 | 23 | 2 | 20 | 22 | 30 | 35 | 65 |

Table VIII analyses the discharged cases according to the duration of the last attack prior to the operation and demonstrates the degrees of improvement. As the onset of symptoms is often difficult to establish retrospectively, the figures relating to onset have to be treated with reserve.

The average age of the discharged cases was 36 for the males and 44 for the females. This may partly account for the higher proportion of full remissions among the males. This suggestion is supported by the fact that the average age of the male patients with the best outcome was 36, and that of the females 40. If the discharged patients are subdivided into paranoid states and other reaction types, their average age is, for the paranoid states, males 41, females 43 ; for the other reaction types, males 32, females 39, respectively.

*Full remission.*—Twenty-two cases (12 male, 10 female), as shown in Table V, were assessed as full remission. Among these patients there was no case of the schizophrenia simplex—hebephrenia type. Seven belonged to the catatonic type and the rest to the paranoid group. Of the latter reaction types 9 were paranoid schizophrenics, 5 paraphrenics, and 1 (Case Br., male) was probably a case of long-standing paranoia. In the latter case the information available from the relatives was incomplete. Eighteen cases showed manic-depressive features. In 7 cases the attack which had led to their admission, prior to leucotomy, was the first one ; the remainder had had previous attacks from which they had recovered prior to the attack during which they had been operated on.

In none of these cases had the previous attacks followed a regular periodicity. There were 4 cases which had, by the time of their re-examination, remained free from relapse longer than before their last attack. Table IX shows the number of previous attacks in these 4 cases, the length of the intervals between each attack and the period of freedom from symptoms since the operation. In the remainder of the recurrent cases the time that had elapsed since the operation had by then not exceeded the intervals between previous attacks.

All cases classified as full remissions showed certain features which, from the point of view of short-term prognosis, are generally regarded as assets, such as well-preserved personality, intelligence not below average, manic-

TABLE VIII.—65 *Discharged Schizophrenics and Paranoid States Grouped According to Duration of Last Attack Before Operation. Their Mental States on Re-examination.*

| Duration of last attack before operation. | Number of patients. | | | Full rem. | | | Much impr. | | | Impr. | | | Unchanged, conduct impr. | | | Unchanged. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| Under 2 years | 12 | 16 | 28 | 11 | 7 | 18 | 1 | 4 | 5 | .. | 4 | 4 | .. | .. | .. | .. | .. | .. |
| 2 to 4 years | 9 | 8 | 17 | .. | 3 | 3 | 5 | 2 | 7 | 3 | 1 | 4 | 1 | 1 | 2 | .. | 1 | 1 |
| 5 to 9 ,, | 4 | 6 | 10 | .. | .. | .. | .. | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 6 | .. | .. | .. |
| 10 to 19 ,, | 4 | 4 | 8 | 1 | .. | 1 | .. | .. | .. | 2 | 2 | 4 | 1 | 1 | 2 | .. | .. | .. |
| 20 years and over | 1 | 1 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 | 2 | .. | 1 | 1 |
| Totals | 30 | 35 | 65 | 12 | 10 | 22 | 6 | 8 | 14 | 6 | 9 | 15 | 6 | 6 | 12 | .. | 2 | 2 |

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TABLE IX.—4 *Cases (Full Remissions) who had, following Leucotomy, been Free from Attacks longer than before the Last Attack.*

| Case. | Year of operation | Number of previous attacks. | Previous intervals (in years). | Number of years free from attack since operation. |
|---|---|---|---|---|
| Bu—. | 1942 | 2 | 9; 1 | 6 |
| Ri—. | 1943 | 1 | 2 | 5 |
| Ch—. | 1944 | 3 | 12; 2 | 4 |
| Hu—. | 1944 | 1 | 3 | 4 |

depressive features, tendency to remission in the past, good work record prior to the last attack. In 81·8 per cent. of the cases who made a full remission the duration of the last attack had been less than 2 years, and in 13·7 per cent. between 2 and 4 years. In this respect these cases differ significantly from those who were still in hospital. Of the 115 still in hospital the duration of the last attack, prior to the operation, could be approximately assessed in 110 cases: in only 10 per cent. had it been less than 2 years, and in about 21 per cent. 2 to 4 years.

Of the total results in the cases which underwent a full remission, 8 (6 female, 2 male) were assessed as very good, 3 as fair, and the rest as good. Of the 12 male patients assessed as full remissions, 5 were working at the same professional level as before their last attacks, 4 at a lower level, 3 were doing no work, one of them having reached retiring age. Of the 5 who had maintained their professional standard, 2 were clerks, one a compositor, one a salesman and one a butcher. Of the 4 working at a lower level, 2 had been small business people who were now working as unskilled workers, one was a language teacher who could now work only half-time, and one who had been a skilled worker before was now working in an unskilled capacity. Of the 3 who were doing no work, one had owned a butcher's shop, one had been a radio operator, and the third, who was 67 at the time of the re-examination, had previously been an unskilled worker. Among the 10 female patients assessed as full remissions, there was a district nurse who had resumed her work and was doing it well. The others were employed in domestic duties, working in their own or their parents' households, and the quality of their work had not suffered noticeably. Two of the cases with full remission, both male, have had epileptic attacks, the first occurring in one case 7 months, in the other 5 years after leucotomy.

The age of the patients classified as full remission ranged from 21 to 63 at the time of operation. The average age of the male patients was 36, of the females 40.

Among the 6 male patients classified as "much improved," one was a retired officer who was doing no work, 3 who had been unskilled labourers before their last attack were working and earning minimum wages, one who had been doing clerical work before, was doing nothing, and one who was deaf and dumb and had previously been a student in an art school, was still at home without work 4½ years after the operation. Of the 12 "much improved" female patients, 10 were doing housework more or less satisfactorily, one earned her keep by dressmaking, which she had done before her illness, and one, the

daughter of a wealthy stockbroker, was working as a kitchen hand away from home, earning minimum wages but supported by her parents.

*Personality changes.*—In 3 of the 22 cases classified as full remissions, no personality changes could be established from the information available. The relatives and the patients themselves had in each case been interviewed, but not the employers and workmates. One of the cases was the nurse mentioned above. In 4 cases no marked personality changes were elicited, but there were indications that such changes were present to a slight degree. In the remaining 15 the well-known features of the frontal lobe syndrome were quite obvious. Apathy and increased irritability were the most constant. In all the other discharged patients personality changes were present, and they could also be established in most of the patients who had remained in hospital. It is not intended to enter into a description of the various features of those well-known changes which, in the majority of cases, contributed to the improvement in conduct. The composite picture of the personality of the improved patient was identical with that drawn by Frankl and Mayer-Gross (1947). While, in this material, apathy of various degrees was one of the most common features of the personality change following leucotomy, there was a group of patients, comprising 18 in all, who showed marked restlessness and inability to relax. In one of the discharged schizophrenic patients this symptom led to the urge to make unnecessary journeys almost daily. This peculiarity could not be correlated to any other feature of either the psychosis or the pre-psychotic personality. It was also observed in 4 cases belonging to the affective reaction types (see below).

*Discharge.*—All patients had, following the operation, been subjected to a routine of rehabilitation, which varied according to their individual needs and the degree of improvement. They received intensive occupational therapy and took part in planned social activities. Supportive psychotherapy was also given wherever possible. Some patients who had shown marked improvement, and whose home environment promised to contribute to their rehabilitation more than hospital treatment, were allowed home on trial as early as two months after the operation, provided the relatives could be relied on to follow the hospital's instructions. This applied particularly to patients who worked on the land.

Two of the male patients assessed here as full remissions had had short relapses necessitating their readmission before they were finally discharged. One was a male paranoid schizophrenic who was readmitted 5 months after his first discharge, having left hospital on trial 10 weeks after operation. He was finally discharged a month later. The second, who had left hospital on trial 6 weeks after the operation, was readmitted 6 weeks later and discharged again after 2 weeks. None of the female cases of this grade of improvement was readmitted.

*Other readmissions.*—Of the 54 male patients in hospital at the time of the re-examination, 11 had been at home for a period following the operation. Seven of them were readmitted after having been at home 3 to 11 months, 3 had been at home for 2 years and 3 months, 2 years and 9 months and 5 years respectively. One patient, a case of paranoid schizophrenia who was discharged

much improved, was readmitted with a complete relapse after 2 years. The others were on their discharge either improved or unchanged with conduct improved.

Of the 61 female patients in hospital, 9 had been readmitted after varying periods at home, 5 having been at home for less than a year, and the rest for 13 months, 14 months, 20 months, and 3 years respectively. In no case had the operation been followed by more than a slight degree of improvement.

*Patients classified as "worse."*—These were the cases whose psychotic condition had not changed following the operation, but whose conduct had deteriorated. They were either more aggressive or more apathetic, or their habits were worse than before. Two of them had had a short period of slight improvement following the operation. All were deteriorated schizophrenics with a poor prognosis. No definite statement can be made as to the difference between these cases and other deteriorated cases who remained unchanged or even showed an improvement in conduct after the operation.

*Hallucinations and delusions.*—Of the 180 cases interviewed, 154 had suffered from hallucinations and 160 from delusions prior to the operation. Table X shows the number of patients in whom these symptoms had disappeared or had been reduced following leucotomy.

TABLE X.—180 *Cases of Schizophrenic and Paranoid States.*

| Number of cases with halluc. | Halluc. reduced. | Gone. | Unchanged. |
|---|---|---|---|
| 154 | 8 | 29 | 117 |

| Number of cases with delusions. | Delusions reduced. | Gone. | Unchanged. |
|---|---|---|---|
| 160 | 22 | 22 | 116 |

*Nine cases followed up by correspondence only.*—In the majority of these cases the written information received was incomplete and the assessment of their condition is based on scanty information only. All but one of the patients were female. Of the 9 cases 2 were catatonics and 7 paranoid psychotics. The information received suggested that 5 might have undergone a full remission, 3 might be much improved and one improved. For reasons mentioned above, these cases have been kept separate from those which it was possible to investigate more closely.

*Deaths.*—Twenty patients in this group had died, 6 of them within 2 months of the operation. In only 3 of these 6 cases was death directly due to the operation, the cause being cerebral haemorrhage; in the other 3 cases the causes of death were bronchopneumonia, uraemia (the patient had had one kidney removed because of tuberculosis), and polycystic disease of the lungs.

Thirteen patients died from intercurrent conditions. Three of these died in the course of coma treatment which they received some time after the operation —one under electronarcosis 2 years after the operation, one as the result of irreversible coma during insulin treatment 2½ years following leucotomy, and one in a status epilepticus, also during insulin therapy, a year and 3 months

after the operation. Three patients died of cancer of the pancreas, the oesophagus and the lungs respectively. Four patients, all female, died of tuberculosis of the lungs, respectively 7 months, 19 months, 22 months and 3 years after the operation. One patient died of septicaemia and nephritis 13 months after operation, one of heart failure 16 months after operation, and one of pneumonia 3 years after operation.

In one case, where death occurred 2 years following leucotomy, no information was available regarding the cause.

In none of the patients who died from intercurrent conditions had the psychiatric improvement been more than slight.

### Affective Reaction Types.

Ninety-five cases belonging to the affective reaction types were followed up, 5 of them by correspondence only; the following observations refer to the remaining 90 patients.

Table XI demonstrates the numbers discharged, in hospital and dead at the time of the re-examination.

Table XI.—95 *Cases with Affective Reaction Types.*

| | M. | F. | T. |
|---|---|---|---|
| Followed up by interview | 32 | 45 | 77 |
| Followed up by correspondence | .. | 5 | 5 |
| Dead | 3 | 10 | 13 |
| Totals | 35 | 60 | 95 |

The 77 cases re-examined clinically have been grouped according to reaction types, namely: (1) recurrent depressions; (2) recurrent mania; (3) manic-depressive illness, (*a*) predominantly manic, and (*b*) predominantly depressive; this subdivision recommended itself in the light of the observations on the effect of leucotomy; (4) involutional depression; (5) senile affective states. Table XII shows the number of cases and the average age of the patients belonging to each group. The study of the histories of these patients brought home the intrinsic difficulty of separating involutional depression from other affective reaction types, especially if one is dealing mainly with depressive states in middle age. If one restricts the term "involutional depression" to depressive states occurring for the first time in the involutional period of life, then a considerable number of cases have to be classed under some other subdivision because they have had periods of affective illness earlier in life, although in every other respect the depression which formed the indication for leucotomy was similar to that of the involutional cases in the narrow sense. But, as Table XII demonstrates, in the material under survey even the cases belonging to the other subdivisions were middle-aged at the time of operation. Practically all cases, therefore, had at the time of operation already reached or were near to the involutional period of life, apart from the few senile patients. The younger age groups were not represented among the affective reaction

TABLE XII.—*77 Cases with Affective Reaction Types.*

| Reaction types. | Rec. depressions. | | | Rec. mania. | | | Man.-depr. | | | Invol. depr. | | | Senile depr. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| Number of cases | 8 | 8 | 16 | 1 | .. | 1 | 11 | 13 | 24 | 10 | 23 | 33 | 2 | 1 | 3 | 32 | 45 | 77 |
| Average age | 45·2 | 41 | .. | 60 | .. | .. | 54·6 | 45·7 | .. | 59·2 | 53·7 | .. | 71 | 68 | .. | .. | .. | .. |

TABLE XIII.—*Recurrent Depressions.*

| Number of cases. | | | Full remission. | | | Mitig. chron. depr. | | | No change. | | | Level of work of disch. patients. | | | | | | | | | In hospital. | | | Marked undesirable personality change. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Same. | | | Lower. | | | None. | | | | | | | | |
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 8 | 8 | 16 | 6 | 7 | 13 | 2 | .. | 2 | .. | 1 | 1 | 2 | 2· | 4 | 4 | 5 | 9 | 2 | .. | 2 | .. | 1 | 1 | 2 | 1 | 3 |

types as, naturally, leucotomy was considered to be indicated only in those cases of recurrent psychosis in which the likelihood of recovery without operation was held to be very small. No attempt has been made to differentiate in this material between mainly reactive and mainly endogenous reaction-types.

*Outcomes.*—In attempting to judge the outcome in cases of affective psychoses, the following aspects have to be considered: (*a*) the effect on the condition which had been present at the time of the operation; (*b*) the effect on the tendency to recurrence and the periodicity, and, in case of relapse after the operation, the possible modification of the recurrent psychosis; (*c*) the personality change. In cases which had previously shown a tendency to remission with or without shock treatment, the value of leucotomy can be assessed only after a much longer period of time than that covered by this survey. However, it will be of importance to note whether a patient has, following the operation, so far remained free from recurrence longer than before. Cases with regular periodicity are very rare. Besides, there is reason to believe that they have become even rarer since the introduction of shock treatments which, though not preventing recurrence, often seem to change the rhythm of periodic psychoses and to break up chronic psychotic states into irregular periods of illness. Of the recurrent cases surveyed, only two had, prior to the operation, shown a regular periodicity. All the cases under review had had shock treatment at some time prior to the operation.

The following changes have been found after the operation in cases of the affective reaction types:

(1) *Full remission*, which in a considerable number of cases ensued immediately after the operation. In a proportion of the cases a period of mild elation preceded the return of full normality as far as the symptoms of the psychosis were concerned. In others the symptoms receded gradually within a few weeks or months. The clinical observations at the writer's disposal were not sufficient to allow a statement as to the proportion of cases in which remission set in gradually or suddenly.

(2) Full remission followed by *relapse* after some interval. The recurring psychosis was usually less severe than the previous attack, as far as depth of mood disorder was concerned.

(3) No remission, but *mitigation* of the existing mental condition. This was observed in depressions only. The depressive symptoms had decreased in depth. The patients would continue to express their old complaints, but the accompanying affect would be either much shallower or one of facile apathy. In a few cases the combination of mild depression with euphoria or apathy had produced a permanent condition reminiscent of a mixed affective state.

(4) *Fragmentation* of the depression. In a small number of patients the depression had subsided, but on closer inquiry they were found to be suffering from short and mitigated periods of their previous condition, lasting for a few days only.

(5) No material change.

(6) Mental condition *unchanged, conduct worse.* There were 3 cases with manic symptoms which, after the operation, showed even greater irresponsibility and lack of inhibition than before.

Tables XIII, XIV and XV illustrate the changes found on re-examination of the cases with recurrent depression, manic-depressive reaction types and involutional depression. The cases listed in Tables XIV and XV, under "Relapse Mitigation" and "Relapse Fragmentation," had had periods of mood disorder since the operation, but were found free from symptoms of affective disorder at the time of re-examination. They were therefore included among the fully remitted cases. On the other hand, among the cases classified as unchanged, some had had periods of remission between operation and re-examination, but these remissions had not been of longer duration than previous intervals between attacks.

Table XIII demonstrates the changes found in the patients who had been suffering from recurrent depressions, the level of work they had attained following discharge from hospital, and the emergence, in 3 cases, of marked antisocial personality features. Each of these three patients had, in the course of the depressions, shown thought contents of an aggressive nature and hostility against the environment.

In Table XIV the cases of manic-depressive reaction types are grouped according to the mood disorder which had been most marked in the course of their illness. In this group, as a whole, the number of patients who had developed marked anti-social personality features following leucotomy was comparatively higher than among the recurrent depressions. Of the 7 cases in which the operation had been carried out in a manic period, 4 were unchanged, 2 showed a full remission, and 1 was much improved with considerable mitigation of his manic symptoms. Among the group of 7 patients, therefore, who had had both manic and depressive attacks, all the cases in which the operation failed to bring about a change in the clinical condition had been operated on in a manic state.

Table XV analyses the group of involutional depressions. Three of the cases which, on re-examination, were found free from symptoms had since the operation had periods of comparatively mild depression lasting for a few months only, while one male patient had had several times a year since the operation brief periods of mild depression without known cause, lasting for about a week ("fragmentation"). The number of patients, therefore, who had kept well without relapse of any kind by the time of the re-examination was 21 (63·6 per cent.).

Among the cases operated on there was one with recurrent mania. He was 60 at the time of operation, which took place in March, 1944. He had developed marked antisocial personality changes (irresponsibility, aggressive behaviour complete lack of consideration for his relatives). Prior to the operation he had, in the intervals between his attacks, been an excellent worker, husband and father. Since leucotomy he had worked only occasionally, and had not held a job for longer than a week. His condition could be regarded as one of chronic mania with marked antisocial tendencies. Compared with his previous attacks, which had lasted not longer than 15 months, his chronic condition could be regarded as mitigated. While during each of his three previous attacks he had to be in hospital, he has so far been able to live at home since 1944, though causing almost constant irritation and annoyance to his relatives.

TABLE XIV.—*Manic-*

(A. predominantly *manic*;

| Number of cases. | | | Full. rem. | | | Relapse mitigation. | | | Relapse fragmentation. | | | Mitig. chronic. | | | No change. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| A. | | | | | | | | | | | | | | | | | |
| 6 | 4 | 10 | 2 | 3 | 5 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 3 | 1 | 4 |
| B. | | | | | | | | | | | | | | | | | |
| 9 | 5 | 14 | 4 | 9 | 13 | .. | 1 | 1 | 1 | 1 | 2 | 1 | .. | 1 | .. | .. | .. |

TABLE XV.—*Involu-*

| Number of cases. | | | Full remission. | | | Relapse mitigation. | | | Relapse fragmentation. | | | Chronic mitigation. | | | No change. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 10 | 23 | 33 | 8 | 17 | 25 | .. | 3 | 3 | 1 | .. | 1 | 2 | 2 | 4 | .. | 4 | 4 |

Two cases with senile depression were operated on. One of them recovered from his depression, but showed progressive dementia with marked personality changes as seen after leucotomy and also in senile dementia. The other case made a very good remission and has kept well for 4 years, apart from a short period of mild depression of 2 months' duration a year after leucotomy.

A case of senile mania, operated on in 1944, relapsed 2 years after the operation, but her manic symptom had been less severe than before leucotomy and did not call for readmission to hospital. She has recently shown early signs of dementia.

The assessment of various grades of "absolute" results in cases of the affective reaction types would be unprofitable at this stage, for reasons outlined above. However, it may be worth noting that if the criteria proposed for the assessment of absolute results were applied to this group of 77 patients, 5 male cases (3 involutional and 2 recurrent depressions) and 9 female cases (3 involutional, 3 recurrent depressions and 3 manic-depressive) would qualify for a "very good" absolute result.

Eight patients, i.e. about 10 per cent. of the living patients with affective reaction types, followed up by interview, were in hospital at the time of the re-examination. The 5 involutional cases still in hospital had been operated on at the age of 69, 63, 55, 52, and 47 respectively; only in one of these cases had the duration of the illness before leucotomy exceeded 4 years. Of the remaining 3 cases in hospital, 2 (aged 39 and 61 on operation) were manic-depressives, predominantly manic, who had been ill almost without remission for 15 and 18 years respectively; the third was a case of recurrent depression, operated on at the age of 47 in her fourth attack which had set in 2 years previously.

From the data available no consistent features common to most of the failures emerged. Marked hypochondriacal symptoms had been noted in only

*Depressive Reactions.*

B. predominantly *depressive*.)

| Level of work of disch. patients. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Same. | | | Lower. | | | None. | | | In hospital. | | | Dementing. | | | Antisocial personality change. | | |
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| A. | | | | | | | | | | | | | | | | | |
| .. | 2 | 2 | 1 | 1 | 2 | 4 | .. | 4 | 1 | 1 | 2 | 1 | .. | 1 | 3 | 1 | 4 |
| B. | | | | | | | | | | | | | | | | | |
| 2 | 5 | 7 | 4 | .. | 4 | 3 | .. | 3 | .. | .. | .. | .. | .. | .. | 2 | 1 | 3 |

*tional Depression.*

| Level of work of disch. patients. | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Same. | | | Lower. | | | None. | | | In hospital. | | | Dementing. | | | Marked antisocial personality changes. | | |
| M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 1 | 11 | 12 | 1 | 6 | 7 | 7 | 2 | 9 | 1 | 4 | 5 | 2 | .. | 2 | 5 | 4 | 9 |

3 of the cases still in hospital. Delusions had been observed also in 3 of the 8 cases in which the operation did not alter the clinical picture. Hypochondriasis and delusions had been present in a considerable number of patients who had made a full remission or had improved. The average age on operation of the patients still in hospital was about the same as in the group of affective reaction types as a whole.

*Personality changes.*—In only 5 cases did the follow-up examination fail to reveal features of the well-known personality changes following frontal lobe lesions. However, this number has to be reduced by 2 if those patients are excluded whose relatives stated that since the operation they had been better than ever before. This statement invariably reflected the disappearance of such habitual personality features as oversensitiveness, moodiness and obsessionalism, which are so often found in those suffering from attacks of depressive illness. In these cases the personality change resulting from leucotomy had led to a modification of premorbid traits, which was regarded by the relatives as a permanent gain. Similar statements were recorded in 8 other cases where definite, though mild, personality changes could be established. Only 3 cases remain, therefore, in which no personality changes were found. Changes were present to a varying degree in all the others, and were no doubt responsible for the frequent decline in working capacity (see below). In a number of cases undesirable personality features of an antisocial nature made their appearance, such as complete lack of consideration for others, increased irritability and aggressiveness, and a decline of moral standards. However, only one patient committed a criminal offence. The patient was a man of 37, with manic-depressive periods, predominantly manic; he had a history of psychopathic personality features. His illness started at the age of 31. He left, against advice, a month following the operation and was, 2 months later, jailed, having been convicted for fraud to the amount of £60. This was

alleged to have been his first conviction. Antisocial features were not observed to any marked degree in cases where the illness had been one of pure depression. They were observed in patients who, in the course of their depression, had shown marked aggressive tendencies directed against the outside world, and in patients who, in addition to their depressions, had had manic attacks, and in the case of recurrent mania mentioned above. Tables XIII, XIV and XV demonstrate the correlation between these clinical features and this type of personality change.

In 4 cases an interesting new behaviour pattern had emerged after the operation. These patients showed marked instability and restlessness, which expressed itself in an urge to make unnecessary journeys every day. A male patient travelled almost daily to a town 20 miles away to have lunch and attend the cinema there; these journeys ate up his small capital. A female patient was continually changing her domicile and travelling abroad, which she had not done before. Two other patients travelled unnecessarily several miles to another town to do their shopping. Among the discharged schizophrenic patients this feature was found in one case only. Each of the patients in question admitted that the journeys were quite unnecessary, and that in making them they were giving way to an urge to move about.

Of the 8 patients in hospital at the time of the follow-up, 3 had been operated on in 1947, 3 in 1945, and 2 in 1943. Two of the patients operated on in 1945 (both cases of involutional depression) had been at home for a period: the one whose conduct had not changed materially was readmitted after 11 months at home, while the other had relapsed 2 years after the operation.

*Work.*—The number of patients in this group who, following the operation, took up work at the same level as before the illness or the last attack was very small (see Tables XIII to XV). Of the 5 male patients whose standard of work was not lower than before, 4 were unskilled workers and one a business man who, after his recovery, even increased his status and income. A considerable number of patients worked on a lower level than before their illness. The female patients were almost invariably housewives, of whom the majority were able to carry on as before. The comparatively large proportion of unoccupied men was at least partly due to age, some having retired before the operation, while others, being elderly, did not succeed in finding work. In the majority of these cases the personality change following the operation was no doubt responsible for their inability to find work and to re-establish themselves as useful members of the community.

*Periodicity.*—In only 2 cases had there been a regular periodicity prior to the attack during which the operation was carried out. One was a male patient, aged 57 at the time of the operation, the second a female patient aged 44. Both of them, prior to their last attack, had had over many years periods of depression lasting for several months annually. In neither case have these attacks recurred since the operation. The first case, however, has, since the operation, had short periods of depression lasting for about a week, at more or less monthly intervals ("fragmentation"); in this case the last attack, which had led to the operation, had been much longer and more severe than the previous ones. The second patient has been entirely free from relapses so far. In all the

other cases of recurrent illness the interval had varied in duration, and no conclusions could be drawn as to the effect of the operation on the tendency to recurrence.

*Dementia.*—Four cases (aged 61, 63, 67 and 70 respectively at the time of operation) showed marked signs of dementia similar to those observed in senile dementia. These cases had not been stated to be demented prior to the operation. One was a case of chronic depressive illness of many years' standing, 2 were involutional, and 1 a case of senile depression. In 3 of the cases the depression had subsided following the operation.

*Cases followed up by correspondence.*—Five cases (1 senile and 4 involutional, depressions) could be followed up by correspondence only. The senile patient was improved, but apparently dementing. Of the 4 others, 3 appeared to have undergone a full remission, while one was said to be slightly improved.

*Deaths.*—Thirteen patients (3 male, 10 female) died following the operation ; 8 were cases of involutional depression, 3 of recurrent depression, 2 of manic-depressive illness ; their average age was 53.

Five died within 2 months, and 3 within one month of the operation (one following a second leucotomy). Five of these 8 cases were involutional depressives ; their average age on operation was 54. In 6 of these cases cerebral haemorrhage was the cause of death (in 4 the blood pressure had been high) ; one had been suffering from diabetes mellitus and one had shown signs of general arteriosclerosis. One patient died of purulent meningitis. In one case, where death occurred a month after the operation, an abscess of the lung, a subdural haematoma in the middle cranial fossa and a softening in the medulla were found.

In 5 cases there was no indication of any direct relation between the operation and death. One patient, having recovered from a severe depression following operation, died 9 months later of tuberculosis of the lungs, which had probably precipitated her depression. One died of coronary thrombosis 6 months after the operation ; he had shown signs of generalized arterio-sclerosis. One patient died of cancer of the bowel 2 years after the operation, and one from cancer of the uterus 3 years later. One patient died 14 months after leucotomy, probably from a late cerebral haemorrhage ; in this case the blood pressure had been normal.

## Other Conditions.

The number of patients operated on who did not belong to either the schizophrenic paranoid or affective reaction types was small, and does not permit any conclusions to be drawn as to the indications for the operation or its effect on the conditions treated.

*Obsessional illness.*—Five patients (2 male and 3 female) were operated on for obsessional neurosis. In 2 of them anxiety symptoms were very marked. Both these cases were assessed as full remissions ; in one of them, however, the degree of improvement could not be established beyond doubt because the patient refused to see the psychiatrist. The remaining 3 cases, which belonged to the classical type of obsessional neurosis, responded less satisfactorily ; 2

could be classified as improved, while the third was unchanged, according to his relatives, and worse in his own judgment.

The two patients classified as full remissions were housewives who maintained a good standard of work following the operation. Of the remaining three, the one who had not improved, a skilled workman, continued at the same level of work as before the operation, the second was working on a lower level than before, but not continuously, while the third case, a female patient, aged 35, who had been working in her mother's household before the operation, is now training on a poultry farm.

There were 2 other cases with severe obsessional symptoms of long standing, but both had shown definite schizophrenic features. They have been listed among the schizophrenics. In neither case did the operation effect a change; one died in the course of electronarcosis treatment 2 years after the operation.

Except for one of the 2 cases showing a full remission, all patients of this group showed personality changes of various degrees.

*Anxiety states.*—Only one patient, aged 35, was operated on. He had been suffering from a long-standing chronic anxiety neurosis with hypochondriacal symptoms. The operation effected a full remission with only slight personality changes. The patient has not so far succeeded in re-establishing himself professionally. Prior to the operation he had done clerical and insurance work; having failed in both, he has now, 3 years after the operation, decided to take up agricultural training.

*Psychopathic personalities.*—The operation was carried out in 6 cases of psychopathic personality with hysterical and hypochondriacal features. In 1 case a full remission ensued, 1 is much improved, 2 are improved, and 2 unchanged. One of the 2 unimproved patients was still in hospital; 3 of the others were working at their previous level and 2 at a lower level. Four of these 5 are working in unskilled occupations, while one is a business man who has maintained his standard of work and even improved his standing in his firm.

In addition, 2 patients who had been alcoholics and had developed a hallucinatory psychosis were operated on. They recovered from their psychotic state following the operation, and have refrained from excessive drinking so far, i.e. over a period of 2 and 4 years respectively. Both are unskilled workmen whose work records following the operation have been satisfactory.

*Mental defectives.*—Four cases of high-grade mental deficiency with aggressive and antisocial behaviour were operated on. One of them was an active homosexual. He was drowned in his bath in an epileptic fit 2 years after the operation. The other 3 are still in hospital. They had failed to improve, and one of them was even more difficult to manage than before the operation.

*Mental deficiency with epilepsy.*—Two imbeciles and one low-grade mental defective with frequent epileptic fits since childhood had been operated on. They had shown aggressive-destructive behaviour over many years. In one of the imbeciles there was some improvement of conduct and he had had fewer fits since the operation, the other had become even more aggressive

than before the operation ; the idiot has remained fundamentally unchanged, though he is somewhat easier to manage.

*Post-encephalitic personality disorder.*—Two male patients, both aged 35, had been operated on. They were both high-grade defectives. The one, who had an encephalitis lethargica at the age of 10, and was free from neurological symptoms but suffering from impulsive outbursts, did not improve. The other patient, who had marked Parkinsonian symptoms, had been less aggressive following the operation, but otherwise his physical and mental condition remained unchanged.

An early case of *Huntington's chorea*, accompanied by a schizophrenic-like psychosis with delusions and catatonic features, improved greatly from the psychiatric point of view, following leucotomy, while the neurological symptoms have progressed rapidly.

The operation had practically no effect in a youth of 18 who had developed a profound organic dementia with extreme restlessness following an llness diagnosed as *Schilder's disease* at the age of 12.

## Second Operations.

Five of the cases under review were subjected to a second operation before the end of 1947. Three of them were deteriorated schizophrenics, one was a case of chronic depression, and the fifth was the case diagnosed as Schilder's disease. The case of depression died from cerebral haemorrhage 7 weeks following the re-operation. The case of Schilder's disease remained unchanged. Two of the schizophrenics showed improvement of conduct, while the third schizophrenic remained unchanged.

## Post-Leucotomy Epilepsy.

Thirty-six (11·0 per cent.) of the 327 non-epileptic patients operated on have had at least one epileptic fit at some time following the operation. Table XVI shows the number of patients with epileptic manifestations, relative to

Table XVI.—*Post-leucotomy Epileptic Attacks Among 327 Patients.*

| Year of first oper. | Numbers of first oper. | Second oper. | Cases with ep. attacks. | | | Percentage of cases. |
|---|---|---|---|---|---|---|
| | | | M. | F. | T. | |
| 1942 | 7 | .. | 1 | .. | 1 | 14 |
| 1943 | 41 | 1 | 3 | 4 | 7 | 17 |
| 1944 | 84 | .. | 7 | 1 | 8 | 9·5 |
| 1945 | 92 | .. | 8 | 5 | 13 | 14·1 |
| 1946 | 62 | 2 | 2 | 5 | 7 | 11 |
| 1947 | 41 | 2 | .. | .. | .. | .. |
| Totals | 327 | 5 | 21 | 15 | 36 | 11 |

the number of operations carried out during each year under survey. If those cases are excluded whose fits can be regarded as caused solely by traumatic

irritation due to the operation, the number of patients with post-leucotomy epilepsy is reduced by at least 5, which would give a percentage of about 9·4.

The average age of the patients with post-leucotomy epileptic fits was 43 for the female and 39 for the male cases.

None of the patients operated on in 1947 has so far had an epileptic fit.

Table XVII analyses the material according to sex and illness. It demonstrates the following facts: (*a*) A considerably higher proportion of male

TABLE XVII.—36 *Cases of Post-leucotomy Epilepsy.*

| Year of operation. | Schiz. and par. | | | Affective reaction types. | | | Others. | | |
|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | T. | M. | F. | T. | M. | F. | T. |
| 1942 | 1 | .. | 1 | .. | .. | .. | .. | .. | .. |
| 1943 | 2 | 3 | 5 | 1 | 1 | 2 | .. | .. | .. |
| 1944 | 5 | .. | 5 | .. | 1 | 1 | 2 | .. | 2 |
| 1945 | 5 | 3 | 8 | 3 | 2 | 5 | .. | .. | .. |
| 1946 | 2 | 5 | 7 | .. | .. | .. | .. | .. | .. |
| 1947 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Totals | 15 | 11 | 26 | 4 | 4 | 8 | 2 | .. | 2 |
| Number of previously non-epileptic cases followed up | 94 | 115 | 209 | 35 | 60 | 95 | 12 | 11 | 23 |
| Percentage of cases with post-leucotomy epilepsy | 16·0 | 9·6 | 12·4 | 11·4 | 6·7 | 8·4 | 16·7 | .. | 8·7 |

cases had epileptic fits. (*b*) The percentage of schizophrenic and paranoid patients who, some time after the operation, had epileptic fits was markedly greater than that of patients with affective reaction types. The lowest proportion of epileptic fits was found among female affective psychoses. (*c*) All the patients who had epileptic fits more than 3 years after the operation belonged to the schizophrenic reaction types and paranoid states. This means that the proneness to late post-leucotomy epileptic fits was, in this material, greater in schizophrenics and paranoids than in cases with affective psychoses. There was no correlation between different schizophrenic and paranoid reaction types on the one hand and the occurrence of epileptic fits on the other hand: 7 of the 26 cases of that group belonged to the catatonic, 8 to the hebephrenic reaction types, 4 had been diagnosed as paranoid schizophrenia, 6 as paraphrenia, and 1 as senile paranoid state. Two of the hebephrenics and 2 of the paranoid schizophrenics had at times shown catatonic features.

Table XVIII analyses the cases according to the period which had elapsed between the operation and the first fit, and according to the number of fits. It shows that half of the cases had had only one fit so far by the time of the re-examination, and a quarter of the cases not more than 5 fits altogether. It also shows that only in a minority of cases had the first fit occurred within 6 months of the operation, while in some it occurred 3, 4 or 5 years later. None

of the patients whose fits occurred more than 3 years after the operation belonged to the affective reaction types. They were all schizophrenic and paranoid reaction types, except for one with minor fits who was a case of obsessional neurosis.

TABLE XVIII.—36 *Cases of Post-leucotomy Epilepsy Analysed according to Number of Fits and to Periods within which the First Fit Occurred.*

| Number of fits. | 2 weeks. | 6 months. | 1 year. | 2 years. | 3 years. | 4 years. | 5 years. | Totals. |
|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 9 | 1 | 3 | 1 | .. | 18 |
| 2 to 5 | 1 | .. | 3 | 2 | 1 | .. | 2 | 9 |
| over 5 | 1 | 3 | 2 | 3 | .. | .. | .. | 9 |
| Totals | 5 | 4 | 14 | 6 | 4 | 1 | 2 | 36 |

The fact that the first epileptic fit often occurs more than a year after the operation may at least partly explain the absence of fits among the patients operated on in 1947. Possibly some will have fits later. There are probably other factors which also contributed to the absence of fits in this group. Among those operated on in 1947 the proportion of schizophrenics was considerably smaller than in the previous years and a greater proportion of them were females. Among the affective psychoses, too, the females far outnumber the males operated on during that year. As post-leucotomy epileptic fits appear to be most frequent in male schizophrenics and paranoids, and least frequent in female affectives, a low incidence of such fits was to be expected in the 1947 group. Also, the majority of patients operated on in 1947 are still in hospital, where they are given phenobarbitone as a routine. Many discharged patients tend to ignore the advice to take the drug, or fail to take it regularly.

Table XIX demonstrates the occurrence of fits in individual cases, the relation of the fits to the operation, their numbers and spacing. The dots signify the dates of the operations. The figures refer to the number of fits which had occurred during each quarter year. In 5 cases (Nos. 4, 6, 22, 24, 25) the closeness of the figure to the dot indicates that the fit occurred within 2 weeks following the operation.

The following particulars concerning the fits are of interest:

Case 8 had all the fits within a week preceding her death from septicaemia and nephritis. There was no status epilepticus.

Case 15 was drowned in his bath in a major attack.

In Cases 16 and 34 the fits were *petit mal* attacks.

In Case 18 a series of 9 spontaneous fits occurred in the course of cardiazol treatment; 3 fits occurred 3 months later.

Case 23 died from cerebral haemorrhage a month following the first and only fit.

Case 24 had an isolated fit 6 days after the first leucotomy, but no fit followed the second operation.

## TABLE XIX.—*Post-leucotomy Epilepsy in* 36 *Cases.*

The chart demonstrates the number of fits and their relationship to the operation in each case. Each square represents a quarter of a year. The numbers indicate the number of fits within a quarter. The dots indicate the dates of operations. The second dots, in Cases 24 and 34, represent second operations. (In cases 4, 6, 24 and 25, the figures indicating fits had, for technical reasons to be put before instead of closely after the dots.)

| Case No. | 1942 | 1943 | | | | 1944 | | | | 1945 | | | | 1946 | | | | 1947 | | | | 1948 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | • | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 2 | | • | | | | | | | | | | | | | | | 1 | | | | | | | | |
| 3 | | • | | | 1 | | | | | | | | | | · | | | | | | | | | | |
| 4 | | | 12. | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | • | | | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 3 | | 1 | | |
| 6 | | | 2. | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | • | | 1 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | • | | | | | 21 | | | | | | | | | | | | | | | |
| 9 | | | | | | | • | | | | | | | | | | | | | 1 | | | | | |
| 10 | | | | | | | • | | | | | | | | | | | | | | | | | 2 | |
| 11 | | | | | | | • | 5 | | 3 | | 2 | 3 | 4 | | 4 | | | 3 | 4 | | | | 2 | 4 |
| 12 | | | | | | | • | | | | | | | | 5 | | | | | | | | | | |
| 13 | | | | | | | • | | | 1 | | | | | | | | | | | | | | | |
| 14 | | | | | | | | • | | 3 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | • | | | | 3 | 4 | 2 | | | | | | | | | | |
| 16 | | | | | | | | | • | | | | | | | | | | | | | 3 | | | |
| 17 | | | | | | | | | | • | | | | | | | | | | | 1 | | | | |
| 18 | | | | | | | | | | • | | | | 9 | 3 | | | | | | | | | | |
| 19 | | | | | | | | | | • | | | 1 | | | | | | | | | | | | |
| 20 | | | | | | | | | | • | | | | 1 | | | | | | | | | | | |
| 21 | | | | | | | | | | | • | | | 1 | | | | | | | | | | | |
| 22 | | | | | | | | | | | •1 | | | | | | | | | | | | | | |
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| 24 | | | | | | | | | | | 1. | | | | • | | | | | | | | | | |
| 25 | | | | | | | | | | | 1. | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | · | • | | | | | 6 | | | | | 16 | | | 8 | |
| 27 | | | | | | | | | | | | • | | | 1 | | | | | | | | | | |
| 28 | | | | | | | | | | | | • | | | | | 5 | | | | | | | | |
| 29 | • | | | | | | | | | | | | | • | | | 1 | | | | | 1 | | | |
| 30 | | | | | | | | | | | | | | • | | | | | | | 1 | | | | |
| 31 | | | | | | | | | | | | | | | • | 2 | | | | | | | | | |
| 32 | | | | | | | | | | | | | | | • | | | | | | | | 1 | | |
| 33 | | | | | | | | | | | | | | | • | | | | | | 1 | | | | |
| 34 | | | | | | | | | | | | | | | | • | | 1 | | | | | • | | |
| 35 | | | | | | | | | | | | | | | | | • | | | | | 1 | | | |
| 36 | | | | | | | | | | | | | | | | | • | | 1 | | | | | | |

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Case 25 had a Jacksonian fit on the day of the operation.

Case 28 had a series of 5 fits in the course of insulin coma treatment, but not in the hypoglycaemic state.

Case 29 had her first fit in October, 1946, and the second in January, 1948. She had a course of intensive electro-convulsant therapy in December, 1946; she had been without spontaneous fits for 13 months following that treatment.

Case 27 was the father of Case 21. The latter, a hebephrenic, had a major fit 11 days, the former, diagnosed as involutional depression, 7 months after operation.

The number of cases is too small to allow any conclusions to be drawn as to a possible correlation between the incidence of epileptic fits and the degree of improvement, but the following figures may be of interest. Of those with epileptic fits 16 had left hospital, 17 were still in hospital, and 3 were dead; they represented 11 per cent., 12·5 per cent. and 8·8 per cent. of the totals discharged, in hospital and dead respectively. Of the 16 discharged, 6 were classified as full remissions, 2 as much improved, 5 as improved, and 3 as unchanged. Of the 17 in hospital, 15 were unchanged, 1 improved, and 1 worse.

Eleven patients, including the 2 who had died, had had more than 2 attacks. One of these, who was much improved, had 12 attacks within 2 weeks of the operation and 1, classified as a full remission, had only a short series consisting of 3 fits. The remaining 9 cases showed no material change in their clinical condition. In this material, therefore, there was an inverse correlation between the degrees of improvement and the number of fits. Of the 11 cases with more than 2 fits, 7 belonged to the schizophrenic and paranoid groups. Three (Cases 5, 8, 11) were catatonics.

It is noteworthy that none of the patients who had epileptic fits within 2 weeks after the operation (Cases 4, 6, 22, 24, 25) had further fits later. This suggests that in these cases the fits were solely due to traumatic irritation caused by the operation. The same probably applies to fits occurring within a few months of the operation. In the rest of the cases the fits were obviously due to scar formation. One is, therefore, justified in distinguishing two groups of epileptic attacks following leucotomy: (*a*) those due to the acute operational trauma, and (*b*) those due to scar formation. It is difficult to draw the line between the two groups within the first few months following the operation.

Agencies which tend to increase the state of cerebral irritation were apt to lead to fits or to increase their frequency, but this does not apply generally. While in some cases spontaneous fits occurred for the first time and only during the course of insulin or convulsant therapy, in the intervals between treatments, many leucotomized patients had shock treatment which did not give rise to fits. This is illustrated by Case 29: the patient had an isolated fit following the operation, but intensive E.C.T., 2 months later, failed to elicit spontaneous fits; she had one more isolated fit more than a year after this treatment.

Among the 5 cases which had a second leucotomy during the period under review, no epileptic fits were observed following the operation, not even in a patient (No. 24) who had had an isolated fit 6 weeks after the first operation.

The second leucotomy was, in this case, carried out almost exactly a year after the first.

It may sometimes be impossible to decide whether or not epileptic attacks occurring after leucotomy are related to the operation. Therefore a schizophrenic patient who died in a status epilepticus in insulin coma, 13 months after operation, but who had had no epileptic fits previously, has not been included among those with post-leucotomy epilepsy. However, it is not unlikely that the leucotomy scar acted as a predisposing factor in this case.

All patients operated on, with only a few exceptions, had at some time before operation had convulsant therapy. It was therefore not possible to correlate the occurrence of post-leucotomy epilepsy with previous shock treatments.

No conclusions can be drawn from this case material as to why epileptic fits occur in some cases and not in others. The problem appears to be the same as in other types of brain injury. No electroencephalographic studies were carried out in the case material presented here, and nothing can be said about the role of predisposition to epilepsy in the origin of these fits. However, the occurrence of isolated fits in father and son mentioned above is noteworthy.

The question has been investigated whether certain personality features, such as increased aggressiveness and irritability, were more frequent among patients with post-leucotomy fits than in others. No such correlation has been found in this case material.

## Comments.

This follow-up investigation has been confined to the clinical re-examination of patients operated on during a period of more than 5 years. The majority of the cases had been operated on during the war and the early post-war period, when psychiatrists working in mental hospitals had to be satisfied with establishing the salient clinical facts only. A survey such as this, though necessarily lacking in depth, is nevertheless useful for the study of the broad clinical aspects of a therapy. In many respects this follow-up investigation has corroborated observations made by other workers, especially concerning the schizophrenic and paranoid reaction types. It is not intended to compare the results of this study with those reported by others or to discuss the literature. Some of the observations presented here, such as those pertaining to the modifications of affective reaction types after leucotomy, to the correlation between certain clinical features and the post-leucotomy personality changes, and to the epileptic manifestations following the operation, have not been reported before, and require confirmation by other investigators.

The limitations of leucotomy in the treatment of schizophrenic reaction types and paranoid states have again been demonstrated. Full remissions have been observed mainly in cases which showed features in their personalities and in their mental conditions which are generally regarded as assets from the point of view of prognosis. There is still no general consensus of opinion whether or not such cases should be operated on. The final decision on this point should depend on whether leucotomy can prevent or delay progress of the illness and relapses. So far no proof has been forthcoming that it can, and

therefore the indication for leucotomy in these cases is questionable. However, when it comes to assessing the chances of remission in an individual case, opinions, even of experienced psychiatrists, differ. None of the patients of this series would have been operated on if the likelihood of a good remission had been deemed to exist. Retrospectively, it is impossible to judge what would have been the fate of the patients who made a full remission following leucotomy if they had not had the operation. That the remission was in these cases related to the operation was clear from the fact that leucotomy was followed by immediate or almost immediate improvement. Leucotomy, therefore, set in motion a process which might or might not have taken place without it. Whether the remissions obtained by leucotomy are of a better quality and durability than spontaneous remissions or those following other methods of treatment, it is impossible to judge at present. The relative results of the operation in the rest of the schizophrenias and the paranoid states were satisfactory in a considerable proportion of cases, though material improvement was, in this series, observed less frequently than by some other workers.

The modification of affective states by leucotomy, whether by mitigation or fragmentation, is worthy of interest. The mitigating effect on recurrent attacks is in keeping with what is known about the lowering of the level of emotional tension resulting from this treatment. The phenomenon of fragmentation may be attributable to the same mechanism which reduces the ability of the individual to remain on a stable level of emotional tension for prolonged periods.

Among the various affective reaction types the results have been relatively most satisfactory in the involutional group, while the effect of the treatment on cases with manic periods has been less favourable. The outcomes in patients with purely depressive symptoms, i.e. in the recurrent and the involutional depressions, were more favourable than in those with manic periods. Partridge (1949) has arrived at a similar conclusion. On the whole, this survey does not suggest that a drastic revision of the indications for leucotomy in affective states, which has so far been restricted to the involutional group and to cases of recurrent depressions without or with only very brief remissions, is called for.

No reference to the exact location of the cuts in individual cases has been made in this paper. Mr. A. G. Ross has, like Freeman and Watts, attempted to vary the planes of the cuts according to the suggestions of the psychiatrists. In certain cases an " anterior " cut was aimed at, in others a " middle " or " posterior " cut, the latter especially in those cases where general behaviour was gravely disturbed, as in chronic catatonics. However, in view of the anatomical findings in the brains of patients who died some time after leucotomy, an attempt at correlating clinical changes with the location of the cuts aimed at by the surgeon seems futile. The brains of those among this material who died from intercurrent illnesses have been examined by Meyer and his co-workers. They formed part of his material which demonstrated a bewildering variety of final anatomical results of leucotomy, and the absence of a consistent correlation between the actual location of the damage and that intended by the surgeon. Meyer and McLardy (1948) have found that per-

sonality changes, especially apathy and restlessness, tend to be severest in cases with widespread lesions of the posterior parts of the prefrontal areas. In discussing personality changes attributable to the operation, some authors expressed the opinion that they depended mainly on the location of the damage, while others stressed the relationship to previous personality features. A final solution of this problem can only be expected from a study of a series of cases in which full clinical and personality studies, as well as anatomical investigations, are available. So far no such series has been reported.

Certain personality changes, especially those related to psychomotor behaviour, seem to be related to location and extent of the lesion. But clinical observation strongly suggests that other traits, especially those affecting social behaviour, are intimately related to the premorbid personality. In a number of cases of this material marked antisocial tendencies, which emerged after the operation, appeared to be related to traits which had been present to a smaller degree before the illness, and in several instances the patients' relatives spontaneously remarked on that relationship. This investigation also confirmed the impression of other workers that personality changes concerning social behaviour are less marked in previously well-adjusted subjects, provided the personality has not suffered disintegration as the result of the illness.

The post-operative personality changes in the affective reaction types also suggested a correlation between certain features in the mental disorder and certain post-operative personality changes. Antisocial behaviour following leucotomy was much more frequent in those cases where manic symptoms had been present before the operation, and where aggressive thought contents and behaviour directed against the environment had coloured the depression, even where no such antisocial features had been present before. Such personality changes may therefore be related either to premorbid antisocial traits, or to manic and aggressive features which formed part of an affective mental disorder. Possibly this is the case because these features themselves are the expression of a constitutional tendency to disinhibition which leucotomy in many cases seems to accentuate. One may speculate whether the personality structure which allows of manic disinhibition is not inferior to one in which this does not happen, and whether there does not exist some fundamental constitutional difference, as far as personality structure is concerned, between affective reaction types with, and those without, manic symptoms and externalized aggressive tendencies.

Among the patients who died from intercurrent illnesses 2 groups are of special interest. The first comprises the 3 patients who died as the result of shock treatments administered a considerable time after the operation. This may have been purely accidental, but the possibility cannot be excluded that these deaths were due to impairment through frontal lobe lesion of certain autonomic mechanisms. This would apply especially to the two cases who failed to recover consciousness from therapeutically induced coma. The second group are the 5 cases who died from tuberculosis. In only one had the illness been known to be active at the time of the operation. In this case it was hoped that leucotomy would, by removing the symptoms of an agitated

depression, help to arrest the tuberculous process. Although in these 5 cases the periods which had elapsed since the operation had been considerably longer than in cases of "delayed post-operative death," described by Meyer and McLardy (1948), it is not unlikely that in these patients leucotomy had resulted in a reduced resistance of the organism. These observations make a large-scale systematic study of morbidity and mortality rates among leucotomized patients appear highly desirable.

Further studies on a large series of cases will also be required to assess the significance of post-leucotomy epileptic manifestations in general, and their correlation with sex and type of mental illness in particular. Post-leucotomy epilepsy has, in this survey, been found much more frequently in patients with schizophrenic and paranoid reaction types than in those with affective states. This is of interest in view of findings of abnormal electro-encephalograms typical or suggestive of epilepsy in schizophrenics. Denis Hill (1949) has recently reported observations on this subject and reviewed the literature. Owing to the absence of electroencephalographic investigations in this series it is not possible to say whether such abnormalities had been present in the cases with post-leucotomy epilepsy. The incidence of epileptic manifestations among the whole material was about similar to that reported by Greenblatt *et al.* (1947). The occurrence, in some cases, of the first epileptic fit as late as 5 years following operation has also been observed by Freeman (1949).

## Summary.

The results of a follow-up investigation of 330 cases treated with pre-frontal leucotomy are reported.

The types of cases in which the mental disorder took a favourable course following the operation are discussed.

Modifications of affective reaction types following leucotomy are described. The effect of the operation on recurrence and periodicity is discussed.

The emergence and aggravation of antisocial personality features following leucotomy in patients with affective reaction types has been found to depend not only on the previous personality, but also on certain features of the mental disorder. Such changes have been observed especially in those patients who had, in the course of their depressions, shown aggressive tendencies directed against the environment and who had had manic periods.

The occurrence and frequency of post-leucotomy epileptic manifestations has been studied. In the material surveyed, epileptic fits had occurred in a higher percentage of male than of female patients. A considerably higher percentage of schizophrenic and paranoid patients had epileptic fits than of patients with affective reaction types. The possible significance of this discrepancy is discussed.

Among the causes of death from intercurrent conditions, coma treatment and tuberculosis have been specially commented on.

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