THE RESULTS OF PREFRONTAL LEUCOTOMY IN 68 PATIENTS NOT DISCHARGED FROM HOSPITAL.*

By JOHN M. ROSIE, M.D.

From the Department of Clinical Research, Crichton Royal, Dumfries.

[Received 29 January, 1949.]

THE 68 patients surveyed in this paper form a companion group to the equal number who have been discharged from hospital and of whom a follow-up study has been published by Frankl and Mayer-Gross (1947). The patients' condition was studied during the early months of 1947, when they had remained in hospital from 1 to 4 years after operation or had returned after an unsuccessful attempt at discharge. To what extent they have to be considered as failures will be seen in the paper. They are of special interest not only as a contrast to the more successfully treated patients, but also because a closer observation of the course of their illness was possible than with the discharged group. Being under constant clinical observation since the operation, all significant changes in their condition have been recorded and the important problem of relapse, neglected in the large literature on leucotomy, can be discussed on the basis of these observations. Finally, an answer was sought to the question of why these patients should have reacted less favourably to the operation than their fellows.

The material consists of 36 men and 32 women and includes 2 cases of involutional melancholia, 3 cases of epilepsy and 1 example each of manic-depressive psychosis, post-encephalitic parkinsonism and general paresis. The remaining 60 patients suffer from schizophrenia, 27 being of the paranoid type, 18 of the hebephrenic and 15 of the catatonic. The paramount indication in the selection of these cases for operation was the presence of "mental tension." This well-understood clinical concept was adequately defined by Berliner *et al.* (1945) in a previous communication from this hospital.

The age of the patients at operation varied from 22 to 59, with an average of 37 years. The chronicity of illness is shown by an average duration of 8·4 years. The duration of the present attack ranged from 7 months to 20 years, giving an average figure of 7·8 years. The length of time spent in hospital varied from 6 months to 18 years, with a mean figure of 5·8 years. In Table II more detailed information is given regarding the duration of the present attack. In only 5 cases was this period less than 2 years.

In the majority of cases the well-established but less drastic methods of physical treatment had been tried. Of 60 schizophrenic patients 25 had received pharmacological convulsive treatment with single or, more usually, repeated courses of convulsions, and 20 of these were reported as being improved.

* Adapted from an M.D. thesis accepted by the University of Glasgow.

Of the same group of patients 48 were given electrical convulsive therapy and 36 of them improved. Improvement was reported as amounting to remission in 4 cases, as being considerable in 2, as partial in the remainder, but in all cases it was transient. Generally, repeated courses showed the effect of electroplexy to diminish, although some patients gave a continued response over several years to "maintenance" treatment administered as described by Moore (1943). Of the 60 schizophrenics, 27 received insulin coma treatment, 17 of them with benefit. Here, too, improvement was transient and varied from a good remission to the more common brief partial amelioration. Several patients were given two or more courses. Diminishing effect was not so obvious as with convulsive treatment. Each case treated by Sakel's method also received convulsive therapy. Where insulin was not given the duration of the illness was too long to offer any hope of improvement by this means. Only 5 cases of schizophrenia received no physical treatment, either because of a contraindication in their bodily state or because they had been hospitalized for many years before physical therapies were in common use. Of the 5 schizophrenic patients with a present attack of less than 2 years, 3 had failed to respond to electroplexy and insulin treatment and were deteriorating. One was considered too old for insulin and the other had a history of previous attacks over many years.

The 3 patients with a depressive illness had been given repeated convulsive treatment. The 3 cases of epilepsy had received anticonvulsant drugs for many years and in 2 of them the effect of electrically-induced convulsions had been tried in an attempt to influence the psychic equivalents in which they were aggressive and violent. The post-encephalitic patient was given optimum doses of stramonium for years and in her case pharmacological convulsive treatment had failed to modify her frequent outbursts of violent behaviour. The general paretic had been treated by arsenicals, malaria and inductotherm hyperpyrexia. He retained his grandiose delusions and was tormented by vivid auditory hallucinations.

In this series two different operative techniques were used: 16 patients were operated on by the "horizontal cut" and form part of a group of which a follow-up study has been made by Dr. G. P. Egan (1949). In the remaining 52 the cut was made in the plane of the coronal suture as described by Freeman and Watts. Whichever cut was used the procedure was a standard one. Surgical technique was not modified according to the age of the patient or the duration or severity of the psychosis.

General Results.

The criterion of improvement is the standard of the patient's post-operative behaviour and the grading corresponds to that described by Berliner *et al.* (1945). For the sake of clarity that description may be repeated here.

Six patients are regarded as being "much improved." They can now have parole, do useful work under supervision and enjoy the recreational facilities of the hospital. They are potential discharges and some of them would have left hospital had their home environment been more suitable.

Ten patients have improved. They can now take part in occupational and recreational therapy or do useful work in the hospital, on the farm, or in the gardens. Most of them before operation were serious nursing problems.

Twenty-eight patients have improved slightly. They have lost troublesome features of their illness, such as violent or destructive behaviour, while their psychosis remains basically intact.

Twenty patients are regarded as unchanged, some of them after an early but fleeting improvement. Four patients are classified as "worse." The significance of this result will be considered below.

The following table gives the results according to the diagnosis, with subdivisions in schizophrenia. It shows 4 cases of schizophrenia to be much improved, 10 to have improved, and 25 to be "slightly improved"; 39 schizophrenics have benefited to some extent out of a total of 60 undergoing operation; 17 cases of schizophrenia are unchanged and the 4 "worse" cases also came under this diagnostic heading.

TABLE I.—*Results According to Diagnosis.*

	Par.	Heb.	Cat.	Invol.	M.-D.	Ep.	P.P.	G.P.I.	Total.
M.I. . . .	2	—	2	1	1	—	—	—	6
I. . . .	3	4	3	—	—	—	—	—	10
S.I. . . .	14	5	6	—	—	2	—	1	28
U. . . .	7	7	3	1	—	1	1	—	20
W. . . .	1	2	1	—	—	—	—	—	4
Total . .	27	18	15	2	1	3	1	1	68

Key to table: M.I., much improved; I., improved; S.I., slightly improved; U., unchanged; W., worse. Par. = paranoid schizophrenia; Heb. = hebephrenic schizophrenia; Cat. = catatonic schizophrenia; Invol. = involutional melancholia; M-D., = manic-depressive psychosis; Ep. = epilepsy; P.P. = post-encephalitic parkinsonism; G.P.I. = general paresis.

It is also seen that the highest proportion of improved cases occurs in the catatonic patients. The paranoid group follow closely and there is a considerably lower ratio of improvement in the hebephrenic subdivision. No hebephrenic patient of the present series can be classified as "much improved," and 2 of them are among the 4 "worse" patients. Of the 3 patients with an affective psychosis, 2 are "much improved." Two of the 3 epileptics have improved slightly, as has the single example of general paresis.

Table II shows the results according to the duration of the illness. This factor and post-operative improvement appear to be in inverse ratio, but on

TABLE II.—*Results According to Duration of Present Attack*

Duration.	Number treated	Improved.	Unimproved.
Under 2 years . . .	5	4	1
2–4 years . . .	17	13	4
5–9 ,, . . .	26	16	10
10–20 ,, . . .	20	11	9

statistical examination the difference between the two groups is not significant. An investigation of larger numbers would appear to be indicated.

The average age at operation of those patients showing improvement was slightly higher than that of the unimproved patients, 37·8 as opposed to 35·8 years. When the sex-distribution of improvement is reviewed a marked difference between the sexes is apparent. Of the men, 29 are to some extent improved out of a total of 36 undergoing operation. The corresponding figures for women are 15 patients improved out of 32 leucotomized.

Clinical Assessment.

(a) *Schizophrenia.*—If the effect of the operation on the clinical picture is discussed in greater detail, the large group of schizophrenics with their varied symptoms is difficult to present. It is obviously impracticable to describe the progress of each patient, while if considered in general terms much of special clinical interest is necessarily lost. A compromise is here attempted by discussing the effect on certain typical symptoms followed by a few examples of patients' histories given in outline.

Three of these examples of schizophrenic patients in the different categories of improvement also serve to illustrate relapse.

Thirty-nine cases of schizophrenia are reported as being to some extent improved. In one half of the patients in whom hallucinations and delusions were prominent before operation these features are still present, but in attenuated form. In a quarter they have disappeared and in a like proportion they remain as marked as before operation. Whether they are modified or intact the patients tend to act on their delusions no longer and to take the view that it does not matter what their "voices" say. Persistent aggression has been lost and violent outbursts no longer appear or do so infrequently and in a modified form. In 3 catatonic patients periodicity has been absent since leucotomy. The effect of the operation on disorders of thought is less apparent. They were not reported as prominent features in all these patients. They cleared up after operation in half the cases in which they had been present, but were little changed in the remainder. The same improvements were also seen for a period in 11 of the 17 schizophrenic patients now classified as "unchanged."

Case 36.—Mr. F. T—, aged 57; retired Army officer.

Premorbid personality.—Little information is available. A Guards officer, he was considered to be effeminate and he did not mix easily with his colleagues. He did well during World War I but was retired after hostilities ceased.

Duration.—(*a*) Of illness, 15 years; (*b*) of present attack, same period; (*c*) of hospitalization, from 28.ix.35.

Diagnosis.—Paranoid schizophrenia.

Previous treatment.—No physical therapy.

Pre-operative state.—He had well-systematized delusions of persecution for many years and was probably hallucinated. He was a most difficult nursing problem, a window-smasher and successful escapist. He made many attacks on the staff and patients. He was unoccupied except for going for long walks, keeping a scrapbook and writing scurrilous letters.

Operation.—11.x.45: Coronal cut.

Complications.—Nil.

Progress.—12.xi.45: He has ideas of victimization and illegal detention, but displays less emotional tension. He is sociable and cheerful, and attends O.T. classes.

11.iv.46: Continued improvement. He writes and talks less about his detention.

10.x.46: He is active and sociable, friendly towards his wife and the staff and has full parole.

Reassessed, April, 1947: He makes good use of his parole. He does not complain spontaneously of detention, but when questioned protests quietly without emotion. The patient accepts advice to remain in hospital until home conditions are more suitable.

Post-operative signs.—Somnolence. Elevation of mood.

Rehabilitation.—Occupational therapy. Social activities. Parole.

Result.—Much improved.

CASE 38.—Mr. J. C—, aged 32; Army officer.

Premorbid personality.—He was a shy, timid and solitary youth. Above average scholastically, he acquired some competence at games, but made few friends. His service record was good.

Duration.—(*a*) Of illness, from 1942; (*b*) of present attack, same period; (*c*) of hospitalization, from 1943.

Diagnosis.—Schizophrenia, hebephrenic.

Previous treatment.—E.C.T., 1943, with improvement. Insulin 50 comas, 1945–46, no change.

Pre-operative state.—Thought disorder was apparent, and hypochondriacal delusions and auditory hallucinations were marked. The patient retained some insight and was willing to co-operate. He occasionally attended classes.

Operation.—28.iii.46: Horizontal cut.

Complications.—Nil.

Progress.—28.iv.46: He is quiet, asocial, irritable at times. He is less restless and his hypochondriasis is less marked.

28.ix.46: Little change. He is doing farm work.

Reassessed, April, 1947: The patient hears both male and female voices, but is not interested in them. He is much less concerned about his "tummy." Still manneristic and withdrawn; he is polite and amenable, attends classes and takes much exercise.

Post-operative signs.—Irritability. Elevation of mood.

Rehabilitation.—Occupational and recreational therapy. Farm work. Parole.

Result.—Improved.

CASE 43.—Mr. R. C—, aged 52; labourer.

Premorbid personality.—An average scholar, he later had many jobs, but persevered with none. He had normal social interests. Was quick tempered, but could exercise control.

Duration.—(*a*) Of illness, 3 years; (*b*) of present attack, 7 months; (*c*) of hospitalization, intermittent since 29.vi.44.

Diagnosis.—Paranoid schizophrenia.

Previous treatment.—E.C.T., 1944, on two occasions with remission; in 1945 without improvement.

Pre-operative state.—He was sullen and unco-operative, often very aggressive, restless and suspicious. Delusions of a persecutory nature were very prominent.

Operation.—8.ii.45: Coronal cut.

Complications.—Nil.

Progress.—15.iii.45: No longer suspicious or deluded, he is generally euphoric, friendly towards his wife and with only fleeting irritability. He refuses to occupy himself.

17.v.45: Not irritable now. He has attended classes and is friendly and co-operative. His wife considers him to be his normal self. Discharged.

30.v.46: Seen at O.P.C. He has been relapsing for the past few months into his previous aggressive and deluded state.

12.ix.46: Readmitted; suspicious, sullen with paranoid delusions and auditory hallucinations.

Reassessed May, 1947: He has lost his aggression, shows no signs of hallucinations and denies ideas of reference or persecution. He is idle and unco-operative.

Post-operative signs.—Confusion, restlessness. Transient euphoria. A more lasting elevation of mood. Increased inertia.

Rehabilitation.—Occupational therapy. Parole. Discharge.

Result.—Slightly improved.

CASE 28.—Miss M. T—, aged 28; nurse.

Premorbid personality.—She was a bright and active child, who did well at school. She trained in domestic science and became assistant matron of a college. Later she began nursing and then showed undue anxiety and an over-conscientious attitude. She was reserved, but popular with her fellows.

Duration.—(*a*) Of illness, 7 years; (*b*) present attack, same period; (*c*) of hospitalization, from 1940.

Diagnosis.—Schizophrenia, hebephrenic.

Previous treatment.—Insulin, 27 comas, 1940, with considerable improvement. Cardiazol and E.C.T., 1941, with slight improvement.

Pre-operative state.—At her best she was facile, self-absorbed, lacking in initiative, with emotional blunting and apparent intellectual deterioration. At times she was aggressive and assaultive, and this phase was becoming increasingly frequent and was unaltered by E.C.T.

Operation.—29.vi.44: Coronal cut.

Complications.—Nil.

Progress.—29.vii.44: Hallucinated and preoccupied, but no longer destructive or aggressive. She responds to stimulation.

29.xii.44: No marked change, but she is now attending classes.

29.vi.45: She is again destructive and at times aggressive, but less than before.

29.vi.46: There has been further regression. She requires heavy sedation at times and is otherwise idle.

Reassessed, March, 1947: She is solitary, self-absorbed, and idle; answers questions briefly, smiling incongruously. Frequently noisy, hallucinated and impulsive.

Post-operative signs.—Confusion. Restlessness. Transient elevation of mood.

Rehabilitation.—Occupational and recreational therapy. E.C.T.

Result.—Unchanged.

CASE 26.—Miss B. S—, aged 36; at home.

Premorbid personality.—No information available.

Duration.—(*a*) Of illness, 12 years; (*b*) of present attack, same period; (*c*) of hospitalization, from 1935 with two short breaks.

Diagnosis.—Schizophrenia, hebephrenic.

Previous treatment.—Triazol, 1939, with improvement. Insulin, 1940 and 1942, with improvement. E.C.T., 1942, no change.

Pre-operative state.—She was idle and self-centred, lacking in spontaneity and irrelevant in her answers. Mainly amenable, she had occasional impulsive phases. She required supervision at meals and toilet.

Operation.—7.x.43: Coronal cut.

Complications.—Nil.

Progress.—7.xi.43: Improvement in appearance and in personal habits.

7.iv.44: She lacks spontaneity and has only superficial interests, but is fully occupied and behaves well.

7.x.44: She lives contentedly from day to day and is only infrequently aggressive and then to a less extent than previously.

21.i.45: She left hospital on probation.

22.iii.46: Readmitted, euphoric, lethargic, at times hallucinated.

Reassessed, March, 1947: In August, 1946, she became restless, manneristic and more constantly hallucinated. She improved after E.C.T., but has required maintenance treatment to date.

Rehabilitation.—Occupational and recreational therapy. Social activities. Holidays and probation. E.C.T.

Result.—Worse.

(b) *Other diagnoses.*—In one epileptic, 3½ years after operation, psychic equivalents are still present, but are less severe and less frequent. The second patient in this group is also less aggressive, although irritability is occasionally seen. Grandiose delusions and excessive religious zeal, previously prominent, are now in the background. The third epileptic is unchanged. Her furors continue after a brief period of betterment following operation.

One involutional melancholic has lost his depression, hypochondriasis and suicidal ideas. Discharged five months after operation he failed to adapt to his home environment and was readmitted to hospital. Now, two years after leucotomy, with more successful rehabilitation, discharge is again contemplated. The other patient with this diagnosis is classified as unchanged four years after operation. She is still depressed, with alternating apathy and agitation. In this case amelioration after operation lasted eleven months before relapse.

The single case of manic-depressive psychosis showed true cyclothymic swings, sometimes with brief interludes of normality. After operation the periodicity vanished and there was a gradual improvement in adaptation up to two years, when manic phases reappeared. Now, three years after operation, the patient has been at her best level for four months.

The patient suffering from parkinsonism is quite unchanged. Her abusive and violent outbursts remain as before. She is being considered for re-operation.

Three and a half years after leucotomy the general paretic is only occasionally hallucinated and then with much less affect. His grandiose ideas are more in the background.

Post-operative Complications.

Troublesome sequelae immediately after operation were few. Respiratory distress occurred in several cases, but yielded to the administration of oxygen and 5 per cent. carbon dioxide. Post-operative vomiting was more frequent, but seldom persisted after the first twenty-four hours.

Signs of meningeal irritation occurred in two cases; in one on the third post-operative day, in the other not until the sixteenth day. In both instances the condition was rapidly controlled by oral administration of sulphonamide.

Post-operative Signs.

The occurrence of specific mental changes following damage to the frontal lobes of the brain has been discussed by many writers. It is not easy to classify all the changes which occur. Some of them could be interpreted in various ways, some appear to merge into one another. Ten post-operative findings are described here. Of these the first five are early and transient, while the remainder tend to occur a little later and in some instances to be permanent. Temporary symptoms, such as disorientation, somnolence and restlessness are probably due to the effect of the operation on general brain function. There is no evidence to show that these signs are specifically frontal in origin.

Post-operative confusion included disorientation, lack of appreciation of the passage of time, drowsiness. Its duration seldom went beyond several days.

Restlessness occurred in a third of the cases in the immediate post-operative phase. It generally took the form of picking at the bed-clothes or bandages, although in a few cases it went so far as to make difficult the control of the patient in bed. Restlessness lasted longer than confusion.

Lack of facial expression, monotonous voice, disinclination to sustain a conversation with at the same time the exaggerated politeness described by Frank (1946) made a common post-operative picture, which may be termed "over-polite reticence."

In a few cases there was a rapid transition from the state just described to one in which features of disinhibition were prominent. The latter more frequently occurred after one or two weeks had elapsed. Its characteristics were a cheerful familiarity, "Witzelsucht," shouting, singing; occasionally obscene language appearing for the first time, in one case sexual advances also for the first time. These florid features were of short duration.

Incontinence of urine occurred in the great majority of cases for the first few days. In six patients it persisted for several weeks or months. One patient whose toilet habits before operation had been faulty was incontinent occasionally for two years when this tendency faded out.

Irritability appeared in ten patients towards the end of the first post-operative month and reached its maximum in the second or third month. Thereafter, in most instances, it gradually became less noticeable. In two cases its duration was longer than usual and was a factor militating against social adaptation.

Euphoria may be defined as an exaggerated feeling of well-being. Where it occurred post-operatively it did so at an early date and in most cases persisted. In a few patients euphoria faded after several weeks or months, but the sustained mood still remained at a higher level than before operation.

An elevation of mood, varying in degree, not amounting to euphoria but resulting in a freedom from tension, was the commonest post-operative finding. This sign made an early appearance and in the majority of cases it persisted.

Apathy, indolence, lack of initiative and drive are included under the heading "inertia" and appeared in 28 cases. Such findings are common in chronic cases of schizophrenia, and it requires special care to demonstrate them as sequelae of the operation. Only when they made their first appearance after leucotomy, or were then present to a definitely greater degree, are they taken into account here. In this series inertia showed a tendency to persist, in some cases to increase.

Changes in the higher differentiated feelings concerned with ethical and social conduct have frequently been described. They are of the nature of a slight but definite blunting. A few such changes could be detected in those patients who had improved since operation. Tactlessness was a failing in two patients. In two there was a lack of emotional appreciation of the future. Diminished self-consciousness was present in two patients, both of whom showed a tendency to flirtation with the opposite sex. This trait was quite foreign to their pre-operative state and also to their schizoid prepsychotic personality. A decrease of the self-critical factor was evident in six patients, who manifested moral changes which included lying, petty pilfering (2), extra-

vagance of money (2) and homosexual behaviour. The majority of these features appeared in phases, although a few seem to be permanent personality changes.

The most important frontal lobe symptoms are those concerned with affect and volition. In the emotional sphere two findings fall to be considered, euphoria and elevation of mood to a lesser degree. Inertia is the volitional change which merits attention. These three main findings are extracted and their persistence and distribution in all categories of improvement is set out in the following table.

TABLE III.—*Main Post-operative Signs in* 68 *Cases.*

Result.	Number.	Euphoria.		Lesser elevation of mood.		Inertia.	
		Transient.	Persistent.	Transient.	Persistent.	Transient.	Persistent.
M.I.	6	1	3	—	3	1	2
I.	10	—	3	—	7	1	4
S.I.	28	1	4	—	24	2	14
U.	20	—	—	13	—	1	—
W.	4	1	—	—	2	—	3
Total	68	3	10	13	36	5	23

Where a patient has improved, tension has been lost and the mood is raised, in some instances to euphoria. In the improved cases the mood has remained elevated. In the majority of the " unchanged " cases it has risen transiently, although in some patients under this heading no such change could be detected. The other main post-operative sign, inertia, serves in some cases as a counterbalancing factor. Where permanent, inertia may, even in the presence of raised mood, cause a case to fall into the category of only " slightly improved." Where it is marked and persistent the patient may even be deemed " worse." The result in any one case depends on the proportions of three factors, raised mood, inertia and the residue of the psychosis.

After-treatment.

The importance of after-care of patients is stressed by most writers on leucotomy. Opinions differ as to whether the burden of rehabilitation should be borne by the family or by the hospital. The policy of this hospital is to prolong the period of convalescence in the institution, the average period for successful cases being about six months. The regime of re-education with its emphasis on individual care has been described by Berliner *et al.* (1945).

It goes without saying that the best results of after-care will not be seen in the patients of this series. In a few cases the clinical state after leucotomy had altered so little that no re-educative measures were possible. For the majority a programme which included individual attention in the occupational,

recreational and social spheres was initiated and continued until it was clearly seen that further improvement by this means was not to be expected. A few patients followed the routine successfully up to discharge only to return to hospital at a later date. It is obvious that no amount of rehabilitation will do much to help a patient whose psychosis has not lost its emotional charge or one in whom tension has been relieved, but who has developed a persistent lack of initiative.

Electroconvulsive treatment was given post-operatively to 46 of the 68 patients. Its effect was to cut short isolated impulsive outbursts and in 12 cases to alter favourably the clinical picture in a relapse. Electroplexy had little effect in initiating improvement or in increasing it. In the majority of cases its effect was no more permanent after operation than before, although by maintenance treatment a few patients could be kept at a higher standard of mentation and behaviour than before leucotomy.

No case among the 68 was thought to be suitable for insulin coma therapy after operation. Two were submitted to re-operation and in both cases a degree of improvement followed it. In both cases the coronal cut was employed at the first operation. In one, at re-operation, the lower half of the same line of section was followed. At the point of entry the leucotome was turned horizontally and the incision was continued anteriorly to complete the "horizontal cut." In the other a second coronal cut was made from a point of entry 1 cm. below and in front of the original one.

Relapse.

This question involves more than consideration of the "unchanged" patients who have failed to maintain a temporary improvement. Minor fluctuations of behaviour were common and are not considered here. Relapse is taken to mean a close approximation to the pre-operative state and as such it occurred in 30 patients of the series after an average period of nine months had elapsed. In 14 of these regression was permanent. In the remainder, after an interval of a few months, improvement again took place. Figures in the different categories are as follows:

Much improved: 3 of the 6 patients now in this group relapsed after gradual improvement over one to two years. One of them had been discharged.

Improved: 3 patients under this heading returned to their pre-operative state after periods of from three to ten months. Two of them relapsed while at home.

Slightly improved: 10 patients in this category relapsed two to sixteen months after operation, two of them while at home.

Unchanged: 13 patients relapsed after intervals varying from two to twelve months., One of these patients had been able to go home.

Worse: one patient relapsed while at home two years after leucoctomy.

It will be seen that 7 unsuccessful discharges are included in the relapsed cases. In addition, 2 discharged patients could not be considered to have

relapsed in the strict sense of the term, but in part owed their return to hospital to the acquisition of symptoms such as irritability, inertia, tactlessness and lack of consideration for others. The 9 patients remained at home for periods varying from two and a half to twenty months. When re-admitted they had been regressing for several weeks, in one or two cases for several months. In 3 cases the home environment was clearly a major factor in precipitating a relapse, in the others it may have played some part.

Where true relapse occurred the returning psychosis largely blotted out the new personality features which the patient had acquired since operation. The elevated mood was lost although inertia showed a tendency to remain in some cases and so to modify the clinical picture. Of the 16 patients who overcame a temporary setback, 12 received E.C.T. In half of this number a single course of treatment was followed by improvement. The other 6 required repeated courses or maintenance treatment before the beneficial effect of leucotomy was given permanence. The remaining 4 cases of the 16 subsequently regaining a better level, and the 2 showing marked frontal lobe symptoms required no more active treatment than continued rehabilitation in the sheltered hospital environment.

Post-operative Epilepsy.

Epileptiform fits occurred for the first time in six leucotomized patients. All of them had received electroconvulsive treatment before leucotomy. In three cases there were single major convulsions taking place, 9, 10 and 16 months respectively after operation. Only the second case had been given electroplexy post-operatively, and this treatment had consisted of several short courses which were terminated six months before the appearance of the spontaneous convulsion. Two patients had two major fits, in one instance on the same day, in the other with an eleven-day interval. These appeared nine months and two years and ten months respectively after operation. In both cases convulsive therapy had been given on a maintenance basis following leucotomy, but had not been administered for several months before the spontaneous seizures occurred. In the only case where epilepsy showed a tendency to persist it first developed two years and six months after leucotomy. Post-operative E.C.T. had been given, but seventeen months separated its termination and the onset of epilepsy. In all, six major convulsions have occurred to date, at approximately monthly intervals for the first four fits, latterly with intervals of several months. This last patient received a bromide and chloral mixture, two of the others were given phenobarbitone and the remaining three patients received no anti-convulsive treatment. Rizatti has stated that leucotomized patients later developing epilepsy continue to improve mentally. Of these six patients one is classified as "improved," two as "slightly improved," two as "unchanged" and one as "worse."

Four cases of epilepsy, one of them also a schizophrenic, are among the 68 patients of the series. In one of them fits have been less frequent since operation, the others have shown no significant change in the rhythm or frequency of their seizures.

Changes in Personality.

The material of the series does not permit of much contribution to the extensive literature on this question. Frankl and Mayer-Gross have suggested that leucotomy acts by superimposing a modified frontal lobe deficiency syndrome on the existing psychosis and therefore the prepsychotic personality should not have a decisive influence on the final result. Study of the present series lends some support to this view. Symptoms of frontal lobe deficiency and of the original psychosis are found side by side in the great majority of patients. No relationship was found between the nature of the pre-psychotic personality and the patient's response to the operation, and no post-operative trait could be traced back to the character of the patient before his illness.

As the cases under consideration were generally unsuitable for intensive psychological testing, both before and after operation, nothing can be said regarding changes in intellectual functions except that clinically there was no deterioration after leucotomy.

Changes in Body-weight.

Increase in weight may be counted as the most striking vegetative manifestation of frontal lobe deficiency. It is associated with a voracious appetite. The latter has been accounted for by the lack of visceral distress which these patients show; they fail to recognize the fullness of the stomach after an adequate meal. Decreased self-consciousness and self-criticism with no fear of fatness, may play a part. Freeman and Watts (1942) have stated that post-operative increase in weight is more marked in women than in men. Lyerly is reported by these authors as finding a high correlation between gain in weight and improvement in the mental state.

In this series satisfactory weight-records were available for 62 patients, half of whom were male. Twenty-four patients of each sex gained weight post-operatively and the average initial gain was approximately the same, 20 lb. for men and 19 lb. for women. In some cases there was a gradual increase over many months, but the commonest finding was an initial increase reaching its peak in the fifth to eighth month. Thereafter, in most cases, the weight decreased, but still remained above the pre-operative level. The maximum gain reported was 47 lb. This occurred in a "much improved" patient after eight months, but an equal increase was made over twenty-one months in a patient classified as "worse." No relationship could be traced between improvement and increased body-weight. The different categories of improvement are distributed among those who gained weight, permanently or transiently, and the 14 whose weight either decreased or showed no significant change after operation. Of the latter group, eight are classified as being in some degree improved. Weight records over four years are available for a few cases. One patient (slightly improved) with a gain of 7 lb. in the first three months had increased by an additional 10 lb. after four years. Another

(improved) who had gained 19 lb. in the first five months had returned to his pre-operative weight at the end of four years.

Factors Influencing Prognosis.

In the view of Freeman and Watts (1946) certain general factors influence prognosis with leucotomy regardless of the psychiatric classification. Among these are the pre-operative degree of mental tension and of break with reality. With behaviour as a guide, different degrees of tension and break with, or withdrawal from, reality can be made out. In making individual assessments of the two factors, maximal tension or reality-break was equated with unity, minimal with $\frac{1}{8}$ and an intermediate degree was recorded as $\frac{2}{8}$. A percentage of the total possible score for each factor was obtained in two groups of patients, the 44 who improved and the 24 who failed to do so. The degree of tension in the improved group gave a percentage figure greater than that in the unimproved group and statistical examination showed the difference between the two figures to be significant. The percentage figure for the degree of break with reality was greater in the unimproved group, but the difference between the figures for the two groups was not statistically significant.

Comment.

Various authors have reported successive stages in the recovery of patients following operation. It is perhaps more accurate to say that some post-operative signs appear early and some later, but once the immediate post-operative phase is over there is no hard and fast sequence. Improvement, especially in schizophrenia, is certainly gradual and it should be stressed that the results in this series cannot be considered as final at the time of reporting.

As presentation of the results of the hospitalized patients alone gives an incomplete picture of the effects of the operation it is proposed to combine them with the results of Frankl and Mayer-Gross. Of 68 patients discharged these authors found 7 whom they considered to require readmission to hospital. These have been added to the " unchanged " group, which means putting their post-operative status at probably its lowest level. For the total of 136 patients the results are therefore 61 socially recovered, 6 much improved, 10 improved, 28 slightly improved, 27 unchanged and 4 worse. Percentage figures for the combined group are 45 per cent. recovered, 32 per cent. improved, 20 per cent. unchanged and 3 per cent. worse. These results compare favourably with those for 1,000 cases published by the Board of Control (1947). This larger series is similar to the present one in that cases of schizophrenia were in a majority, although to a less extent than among the 136 patients. Freeman and Watts (1946) for 331 cases report results to be good in 52 per cent., fair in 32 per cent. and poor in 13 per cent, but almost two-thirds of their patients suffered from involutional psychoses, obsessive states or psychoneuroses. The same authors also in 1946, from a study of 65 cases of schizophrenia predict results to be good in 31 per cent., fair in 27 per cent. and poor in 41 per cent., where the duration of the illness is over two years.

It is felt that more should be said of those patients considered to be worse after operation. Four may seem to be a high proportion of a small series. The term itself may be to some extent misleading. As slight improvements in behaviour have been noted, so also have all deteriorations. In the case of one patient, no more is meant by "worse" than that a man previously able to work at occupational therapy is now unable to do so. Another is similar, but with the addition of post-operative epilepsy. In a third male brief periods of relative remission present before operation have disappeared. The presence of frontal deficiency signs suggests that the operation has left its mark on these schizophrenics of long standing and that post-operative inertia is responsible for their present stage. In the single female schizophrenic in this category post-operative tension is greater than pre-operative and it appears that the operation has failed to check a progressive illness.

Examination of the results entails comparison between the 44 improved and the 24 unimproved patients and comparison between the whole group of hospitalized patients and the equal number of those who have been discharged. The results of the operation are stated by Freeman and Watts (1946) to be better in elderly patients than in the young on the grounds that the personality breaking down earlier is the more fragile. The age at operation would hardly seem to be an important prognostic factor in chronic psychotic patients hospitalized for many years, and there was little difference in the average age of those improved and unimproved, remaining in hospital or discharged.

Duration of the illness may have more bearing on the prognosis. In Table II this factor appears to be in inverse proportion to post-operative improvement, but statistical examination of the figures does not bear out that the trend is a significant one. When the two series of 68 patients are compared the differences are even less striking. When the duration of the present attack is less than 2 years, 5 patients are found to be in hospital and 8 discharged. When it is from 2 to 4 years, 17 are hospitalized against 18 discharged. With a present attack lasting from 5 to 9 years, 26 patients of each group are found. From 10 to 20 years, 20 remain in hospital and 16 are discharged. The average duration of illness of discharged patients was 6·4 years, of improved patients in hospital 7·5 years, and of unimproved 9·2 years.

The sex-distribution of improvement shows interesting if somewhat inexplicable results. In the hospitalized series patients showing improvement numbered 29 men and 15 women: those regarded as unimproved, 7 men and 17 women. The series of 68 discharged patients consisted of 28 men and 40 women. Totals for the two series are 64 men and 72 women. Female patients show a marked preponderance in the best and poorest categories of improvement. Frankl and Mayer-Gross have explained the greater number of female discharges by pointing out that one would expect women to be taken out of hospital more easily than men after a long illness. If this assumption is granted there follows a levelling-up of the sexes among those patients responding favourably to operation. Some of the group of 29 men who have improved have probably reached the standard attained by the women who have been discharged. Because of the greater responsibilities which await them in the outside world they are not yet considered fit to leave hospital. It is less easy

to explain why there should be a female preponderance amongst those who have failed to improve. The material published by the Board of Control showed better results in males, but the author pointed out that it did not seem reasonable to assume a sex differentiation in the results of the operation.

Findings are more definite when the diagnostic classification is considered. Nine-tenths of the hospitalized group are schizophrenics as against three-quarters of the discharged. There is no obsessional illness among the hospitalized and only three examples of affective psychosis, while the number of non-schizophrenics of these two categories among the discharged is 17. The schizophrenic patients remaining in hospital include 15 catatonic, 27 paranoid and 18 hebephrenic patients. The figures for the discharged group are 24 catatonic, 19 paranoid and 7 hebephrenic and simplex cases of schizophrenia.

The importance of pre-operative mental tension as a prognostic factor has been sufficiently stressed. In the series of 68 patients in hospital a mathematical assessment shows the group reacting better to the operation to have had greater tension. This bears out the well-established clinical opinion. A break with, or withdrawal from, reality which has also been considered to have prognostic significance was found to be harder to assess. The impression in regard to this factor was not susceptible of proof.

To sum up: There is no ready explanation for the partially successful or completely unsuccessful results among these 68 patients. It has been seen that among those reacting favourably to leucotomy are more cases of affective and obsessional illness, and of the catatonic and paranoid types of schizophrenia. Among those reacting unfavourably are more examples of schizophrenia itself and of the hebephrenic type in particular. Tension is greater and duration may tend to be less where the response is good. The prepsychotic personality has little bearing on the post-operative state of those patients remaining in hospital however it may modify the behaviour of those who have been discharged. There is, in short, no common factor running consistently through the groups of discharged and hospitalized, improved and unimproved. Indeed, in all these groups cases can be found with the same diagnosis, a similar duration and a comparable degree of tension. Frank (1946) considers leucotomy to be indicated and most successful in patients whose psychosis is sudden in onset, precipitated by psychological or physical trauma, and characterized by plasticity of symptoms and a cyclic tendency. It has been pointed out by Nolan Lewis (1946) that these factors have for many years been emphasized as favouring a good prognosis regardless of the type of therapy employed. The present writer finds himself in agreement with the latter half of Freeman and Watts' dictum: "In schizophrenia the percentage of patients in whom there will be good results may be predicted, but which individual patient will be improved cannot be determined." It seems certain that what may be called the accident of the operation has much to do with the clinical result. Meyer and Beck (1945) have drawn attention to the considerable variation in the plane and depth of the cut even although the surgeon thought he was carrying out the operation in standard fashion. There are certainly grounds for believing that with the present "blind" procedure no two patients will have an exactly similar amount of frontal lobe isolated.

Discussion.

The Problem of Relapse.

The literature of prefrontal leucotomy makes only brief mention of those patients who relapse after operation.

As the rationale of the operation itself has not yet been placed beyond doubt it is not surprising that no theories have yet been advanced to explain the mechanism of relapse. Cobb (1943) holds that improvement after leucotomy is due to the reduction of the number of possible circuits for association. The spread of stimuli to different cortical areas is thereby limited and the integration of present stimuli with past memories and habitual responses prevented. With too limited an operative procedure the disintegration may be minimal and the environment may assume great importance. In three of the nine cases discharged unsuccessfully, home circumstances appeared to precipitate a relapse and in some others the same factor could have played a part. The infinite lability of the nervous system has been stressed by Golla (1943). New pathways may take over the functions of the cut fibres. If this process in some cases leads to satisfactory social adaptation, it is equally possible that in others it may lead to relapse.

The question of relapse is closely linked to that of after-treatment and it has been shown above that electroplexy controlled impulsive outbursts and helped 12 patients over a relapse. Wider claims made by other writers for post-operative E.C.T. were not substantiated. The other major physical treatment used in this connection was a repetition of the operation itself made with benefit in two cases two years after the first leucotomy. It is felt that if gradual improvement and a fluctuating post-operative course are given due recognition in chronic psychotic patients re-operation might be considered more frequently when there is otherwise no reasonable hope of further betterment.

The Role of Leucotomy in Chronic Psychosis.

Moniz' procedure does not have a specific action on disease entities but acts primarily on their symptoms. Results in the small non-schizophrenic group confirm previous findings. It is generally accepted that there will always be a few cases of affective psychosis which prove refractory to convulsive treatment, and that these cases do well with leucotomy. Although the operation may be followed by epileptic convulsions it appears to have little effect on the rhythm of the seizures of established epilepsy. Hofstatter *et al.* (1945) noted that the behaviour disturbances in epilepsy may sometimes be modified and this has been achieved in two of the three cases considered here. Thorpe (1946) has reported improvement in the disordered behaviour which follows encephalitis, but the single case of post-encephalitic illness in this series is quite unchanged. It must be seldom that patients suffering from general paresis are submitted to operation. Here, as in schizophrenia, relief from tormenting hallucinations has been obtained.

The role of the operation in schizophrenia may be considered at greater length. Parker (1946) stated that " in schizophrenia, paranoia and para-

phrenia it is doubtful whether leucotomy is more efficacious than other methods of treatment." The point should be made that where other methods have been tried and repeated without success, leucotomy still offers hope of improvement. This may range from freedom from distress to social recovery and will include the majority of those brought to operation. The optimum time for operation is generally held to fall after the other physical therapies have failed and no reasonable hope of a spontaneous remission remains. But even when the disease has been present for years and has progressed to deterioration the patient may still be susceptible of improvement as long as he is still distressed by his illness. Schizophrenic deterioration is a common clinical concept and is generally taken to mean a progressive disintegration of the total personality with gross defect in volition, emotion and the thought-processes. Freeman and Watts (1946) state that, "a deteriorated schizophrenic looks and acts about the same with or without his frontal lobes." This dogmatic statement merits examination. As a rule of thumb these writers "employ three criteria in judging the emotional responses of the patient: severity of complaints, disturbing behaviour and autonomic imbalance. When none of these is present the patient is too deteriorated to warrant operation." Deterioration in the emotional field is therefore the contraindication found by these authors. They would appear to be describing the flat, "burnt-out" schizophrenic. Most psychiatrists would agree that such a patient is unsuitable for operation. But many of the schizophrenic patients of the present series before leucotomy were deteriorated in the sense in which that term is commonly used. Many were withdrawn and barely accessible, dissociated and incoherent in thought. Some had faulty personal habits. Some, for part of the time, showed flattened or incongruous affect, but the great majority were subject to bouts of violent or disturbed behaviour. The changes following leucotomy have been described. The 68 patients may be failures in that they have not attained recovery; but almost two-thirds of them have been freed from emotional tension and distress.

Summary and Conclusions.

1. The results of prefrontal leucotomy are reported in 68 cases of a chronic mental illness still resident in a mental hospital after a post-operative period of from one to four years. Of these, 44 patients improved in varying degree and 24 are considered to be unimproved. These results are analysed in terms of age, sex, duration of the illness, diagnostic classification.

2. Post-operative signs are listed and the main findings are seen to be euphoria, an elevation of mood to a lesser degree and inertia. The occurrence of these signs of frontal lobe deficit is charted in relation to improvement and their effect in modifying the psychosis is described.

3. After-treatment includes E.C.T. and re-operation and the effect of these measures on relapse is described. Regression occurred transiently in 16 patients and permanently in 14 patients. Its theoretical aspects are discussed.

4. Changes in body-weight following leucotomy are described. No correlation is found between increase in weight and improvement in mental state.

5. Two factors in the pre-operative state thought to influence the prognosis are examined in relation to post-operative improvement. Those cases which improved after leucotomy had in aggregate a greater degree of mental tension than those not improving. No such prognostic significance could be attached to the other factor, the degree of break with reality.

6. The lack of finality in the reported results is mentioned. The results in a combined group of 136 patients, discharged and hospitalized, are compared with the results published by others. The significance of the result "worse" is discussed.

It is concluded that leucotomy acts by removing mental tension and that where this is marked there is hope of improvement even if the patient is considered to be "deteriorated."

It is further concluded that while mental tension tends to be greater where the response to operation is good, there is no common factor or group of factors in those patients who improve or fail to improve after leucotomy. The results in individual cases of chronic mental illness are at present unpredictable before operation, but the value of this method of treatment in such cases is fully confirmed.

Acknowledgments.

I am indebted to Dr. P. K. McCowan for permission to publish this material and for helpful criticism; to Mr. R. L. Beveridge who operated on most of the cases, and to Dr. W. W. Roberts for help in the statistical treatment of some of the results. My special thanks are due to Dr. W. Mayer-Gross for his unstinted advice and interest.

References.

Berliner, F., Beveridge, R. L., Mayer-Gross, W., and Moore, J. N. P. (1945), *Lancet*, **2**, 325.
Board of Control (1947), *Prefrontal Leucotomy in 1000 Cases*. London.
Cobb, S. (1943), *Borderlands of Psychiatry*. Cambridge, Mass.
Egan, G. P. (1949), *J. Ment. Sci.*, **95**, 115.
Frank, J. (1946), *ibid.*, **92**, 497.
Frankl, L., and Mayer-Gross, W. (1947), *Lancet*, **2**, 820.
Freeman, W., and Watts, J. W. (1942), *Psychosurgery*. Springfield, Ill.
Idem (1946), *Amer. J. Med. Sci.*, **211**, 1.
Idem (1946), *South. Med. and Surg.*, **108**, 241.
Idem (1946), *Progress in Neurology and Psychiatry*, **1**, 649.
Idem (1947), *ibid.*, **2**, 461.
Golla, F. L. (1943), *J. Ment. Sci.*, **89**, 189.
Hofstatter, L., Smolik, E. A., and Busch, A. K. (1945), *Arch. Neurol. Psychiat.*, **53**, 125.
Lewis, N. D. C. (1946), *The Yearbook of Neurology, Psychiatry and Neurosurgery*. Chicago.
Meyer, A., and Beck, E. (1945), *J. Ment. Sci.*, **91**, 411.
Moore, N. P. (1943), *ibid.*, **89**, 257.
Parker, C. S. (1946), *ibid.*, **92**, 719.
Rylander, G. (1939). *Personality Changes after Operation on the Frontal Lobes*. London.
Thorpe, F. T. (1946), *Brit. Med. J.*, **1**, 312.