is also estimated (B=the acid output in mEq). The percentage reduction of the augmented histamine response obtained from medical vagotomy (C) is readily obtained thus:

$$C=\frac{A-B}{A}\times 100$$

Where C is greater than 35%, vagotomy with a drainage procedure is selected as the surgical procedure; where C is less than 35% vagotomy with antrectomy is preferred.

This policy ensures that the majority of patients will be treated by the simplest and safest operation and also ensures that patients in whom vagotomy can be expected to give but a poor reduction in acid secretion will be given the greater guarantee from recurrent ulceration which is afforded by the combined procedure of antrectomy with vagotomy.

The main endeavour of the gastric surgeon to-day is to reduce the proportion of patients in whom the result is unsatisfactory. This will not be achieved by the adoption of any one standard operation, but by the clear definition of the situations in which each procedure is likely to be most effective. The hypothesis proposed in this paper provides a physiological basis for recurrent ulcer in a proportion of cases. It is important that the hypothesis, and the pre-vagotomy test which has stemmed from it, be subjected to further study.

Summary

The effect of hexamethonium and atropine (medical vagotomy) on the augmented histamine response has been studied in 40 duodenal ulcer patients with a view to predicting the effect of surgical vagotomy on this response. Good correlation exists between the reductions from medical and surgical vagotomy.

The medical vagotomy test picked out four patients who had a small reduction, and a similar reduction was found in these cases after surgical vagotomy. On this basis, a hypothesis has been formulated that duodenal ulcer patients may be divided into two groups: in the majority the nervous control of acid secretion appears to be dominant; a minority group with antral dominance would seem unsuited for surgical vagotomy and the medical vagotomy modification of the augmented histamine test described in this paper may be of value in selecting patients belonging to this group.

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The Atomic Energy Authority and the National Institute for Research in Nuclear Science have agreed that the development of particle accelerators hitherto carried out by the Accelerator Division, A.E.R.E., Harwell, should be the responsibility of the Rutherford Laboratory of the National Institute for Research in Nuclear Science.

SOME PSYCHIATRIC CONSEQUENCES OF GASTRECTOMY

BY

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Mental disturbances after surgical operation are fairly frequent and in most cases short-lived. Their clinical characteristics have been described in a number of papers under the heading of post-operative psychoses which are well recognized by surgeon and psychiatrist alike. Whereas the acute post-operative psychosis is fairly well documented less is known about the long-term effects upon the psyche of surgery. As Navratil (1959) points out, follow-up studies of surgical cases are usually carried out by surgeons, who are less likely to ask specifically about neurotic and personality disorders than are their psychiatric colleagues. An acute psychosis in the ward immediately after an operation cannot be ignored. Neurotic symptoms of fairly severe degree can be missed at a follow-up clinic unless specific questions are asked to elicit them.

Compared with most of his colleagues the psychiatrist sees a not inconsiderable number of patients who date their symptoms from the time of an operation. The woman who develops an intractable neurotic illness after a hysterectomy is a fairly familiar figure in the psychiatric out-patient department. Surprisingly little has been written on the psychiatric sequelae of partial gastrectomy and other surgical procedures for the relief of peptic ulcer, although European workers seem more familiar with the problem—particularly when alcoholism is concerned—than do their American and British colleagues. It was a chance observation of patients who had become chronic alcoholics after a partial gastrectomy that led to a further examination of a number who had been admitted to the psychiatric wards at some time after this operation.

Results

In all, 25 patients were examined (17 men and 8 women). At the time of their first admission to a psychiatric ward the men's ages ranged from 28 to 60 years, with a mean of 46, while the ages of the women varied from 37 to 55, with a mean of 47. Of the 17 men, nine were admitted directly or indirectly because of alcoholism, two for treatment of drug addiction, and the remaining six for mixed neurotic and depressive states. Three of the women were drug addicts, and the remainder had mixed depressive and anxiety symptoms. All except one of the women had been operated on for duodenal ulceration, and all except two of the men who had gastric ulcers were similarly affected. Only two of the women appeared to be in a good nutritional state, and all except four of the men were thin and underweight. Almost all the patients complained bitterly of severe dumping symptoms. The alcoholics and four of the drug addicts all said that their drug relieved these symptoms.

It was difficult to obtain a clear picture of the premorbid personalities of these patients, and only the most general features emerged. Judging by work record, by absence of overt psychiatric illness, and by the general level of social adaptation, three of the male alcoholics had been normal up to the time of operation, five had

shown psychopathic features, and one had a former neurotic breakdown. Both the addicts had managed well up to the operation. All except one of the men affected by mixed anxiety and depressive symptoms had appeared normal prior to operation. Of the female addicts, one was normal, one was psychopathic, and one was neurotic before their partial gastrectomy. Three of those admitted with anxiety and depressive symptoms had managed well before operation, whereas two had had previous neurotic breakdowns. When it was possible the premorbid personality was checked by a history obtained from a relative, but it was not possible to do this in all cases. Of the nine alcoholics, five had been moderate and four heavy drinkers before operation. Despite this, their drinking had not been of such intensity as to warrant their seeking medical advice, and they had been able to carry on at work.

Since the time of their first psychiatric admission three of the patients had died, two being male alcoholics and the other a woman suffering from a variety of psychosomatic disorders and depressive symptoms. This patient, who had already made one suicidal attempt with barbiturates, eventually succeeded in ending her life with these drugs. The two alcoholics died as a direct result of their drinking, one accidentally suffering fatal burns while in an alcoholic stupor, the other from liver failure and bronchopneumonia.

The following abbreviated case-histories of some of the patients indicate the nature of the problem and its relationship to the treatment of their peptic ulcers.

Male Cases

Case 1.—A married salesman aged 58 was admitted to hospital for treatment of alcoholism. He developed symptoms of duodenal ulcer at the age of 28. Between the onset and his partial gastrectomy at 48 he perforated on two occasions. Although he drank fairly heavily at about the age of 25, his wife confirmed that he drank only moderately until after his partial gastrectomy. He had worked well and had advanced to a position of some responsibility in his firm. There was evidence to suggest some degree of sexual impotence at different times during his marriage; but he had one son, and his wife spoke well of him as a likable and reasonable man until the age of 48. Since then he has suffered severely from dumping symptoms, claiming that beer and cider relieve these. When admitted he was an obvious chronic alcoholic, and, although there was some preservation of his self-respect, he was untruthful and unreliable. He refused treatment for his drinking, but eventually returned and was placed on disulfiram with success. However, he relapsed, and for the past six weeks had been drinking very heavily again and refusing all offers of help.

Case 2.—A married labourer aged 38 was admitted to hospital after an attempt at suicide with barbiturates while intoxicated with alcohol. Symptoms of duodenal ulcer had developed at the age of 20. Partial gastrectomy was performed at 29. He first married in 1938, when aged 18, but the marriage broke up during the war, and he obtained a divorce at the age of 26. He remarried shortly afterwards. He had had a number of unskilled labouring jobs but had not been unemployed except for medical reasons until after his gastrectomy. Since then his work record had gradually deteriorated, and he had done little work in the year prior to admission. Before operation he had been a moderate drinker—a fact confirmed by his wife—but since operation he had complained of dumping symptoms, and drank heavily to relieve them. He said that before operation he had to limit his drinking as his ulcer would become active if he over-indulged. Since operation he had also been resorting to barbiturates in increasing dosage to combat insomnia and depression. Between admission and the time of his death he was readmitted twice, both after suicidal acts while intoxicated. One such act was precipitated because of a charge for breaking open a gas-meter to obtain money for more alcohol. He was placed on probation, but despite continued treatment he went on drinking. Eventually his wife left him, and he was discovered dead in his house, having accidentally set himself on fire with a cigarette when in an alcoholic stupor.

Case 10.—A married coal-miner aged 39 was admitted for treatment of addiction to phenadoxone hydrochloride. He developed symptoms of duodenal ulcer at the age of 23 while in the Army. Ten years later a partial gastrectomy was followed by severe dumping symptoms. He was given phenadoxone, and he discovered that this relieved his symptoms. In the years after his operation he became addicted to this drug, requiring up to eight 10-mg. tablets daily. He also drank moderately, as he found that alcohol relieved his symptoms. He had not required psychiatric treatment before his operation and his work record was reasonably good.

Case 11.—A married fishmonger aged 53 was admitted for treatment of morphine addiction. Duodenal ulcer symptoms started at the age of 33, and he had a vagotomy at 41 followed by a partial gastrectomy two years later. Before his vagotomy he had been given morphine occasionally, but since his gastrectomy he had been requiring up to four ½-gr. (32-mg.) tablets of morphine sulphate a day. He was unable to manage without this dose, but it was possible to admit him and treat him successfully. He seemed to have managed his business well, and there was no clear evidence of personality disturbance before his operation. He drank moderately because he believed it was good for his stomach. Despite the operation he had an active gastric ulcer which was causing symptoms.

Case 12.—A married labourer aged 31 was admitted for treatment of phobic anxiety and depressive symptoms. At the age of 20 he developed symptoms of peptic ulceration, and he had a partial gastrectomy at 27. He was found to have a gastric ulcer. After his operation he developed severe dumping symptoms, and became tense, morose, and anxious. According to his wife he had always been a cheerful man until his operation, since when he had been constantly depressed and had lost a lot of work. He drank beer in moderation, as he found this relieved his depression. At no time had he been a heavy drinker. There was no clear evidence of neurotic personality traits during childhood and adolescence. His work record was good and his marriage stable and satisfactory.

Case 13.—A married sales-representative aged 44 was admitted for symptoms of fatigue and depression. Gastric ulcer symptoms began at the age of 35, and he had a partial gastrectomy at 41. Before operation he had worked himself into a position of executive responsibility, but since then had lost confidence in his ability, and had had to take a more humble post. To use his own words, "I hadn't the stomach for the job." He complained of dumping symptoms, was depressed, wept easily, and had lost weight. Because of his symptoms he had lost a lot of time off work, whereas formerly he had rarely been off for reasons of ill-health. There was no clear evidence of neurotic illness in the past, and although he had shown certain obsessional personality traits he seemed to have managed his life successfully up to the time of operation.

Female Cases

Case 18.—A housewife aged 46 was admitted to hospital for what was regarded as an agitated depression complicated by auditory hallucinations. There was much evidence to suggest that she had been taking "drinamyl" in steadily increasing doses and that this was responsible, in part, for her symptoms. She had been in hospital for treatment of depression at the age of 36. Duodenal ulcer symptoms started at 34, and she had a partial gastrectomy following a perforation at 40. After operation she complained of

dumping symptoms, and used drinamyl by day and barbiturate sedatives at night to counter these. For four months before her second admission at the age of 46 she had been becoming increasingly depressed and agitated. Her hallucinatory symptoms subsided soon after admission, when all drugs were withheld. She had always been an anxious person, but seemed to have managed her marriage and two children with success.

Case 19.—A housewife aged 40 was first referred at the age of 37 after a partial gastrectomy for duodenal ulcers one year before. Since her operation she had experienced severe dumping symptoms, for which she consumed large quantities of bismuth and kaolin mixtures containing tincture of chloroform and morphine. She admitted to taking 1½ to 2 bottles each day, and it was reckoned that she was receiving between ½ and ¼ gr. (30 and 20 mg.) of morphine each day. She had married at the age of 19 and had three children. The marriage had not been a happy one, and the husband was unreliable and violent. There was no clear evidence of psychopathy or neurotic disturbance in the patient before her operation. Since then she has lost weight, complained of vomiting, loss of sleep, depression, and fatigue. She claimed that the gastric sedative mixtures alone helped her to continue.

Case 20.—A housewife aged 31 was admitted for treatment of addiction to a patent preparation containing carbromal. She was treated for a duodenal ulcer by partial gastrectomy at the age of 26. Her ulcer symptoms are said to have started at 17, but there is reason to believe that this is not true. Throughout her life she has exhibited features of psychopathic behaviour, and it was difficult to rely on her history. Her husband said that she started taking drugs about one year after her operation when she was depressed. For this reason he left his work in the south and moved north for the patient to be near her own family. After a suicidal attempt at the age of 30 she was admitted for treatment of mixed depressive-anxiety symptoms. Since then she admitted to always requiring a sedative at night, and that she sometimes took it by day as well. She appeared to be receiving thalidomide from her practitioner.

Case 21.—A widow aged 51 was admitted for treatment of depression. Peptic ulcer symptoms began at the age of 33, and she had a partial gastrectomy for a duodenal ulcer at 43. Her husband was killed in the war in 1942, and since then she had continued at work to bring up her two children. After her gastrectomy she had not worked, had felt miserable, and had complained bitterly of dumping symptoms. For the past eight years she had required regular night sedation, had lost weight, and had been admitted on a number of occasions for treatment of her post-gastrectomy syndrome. On admission she was thin, looked older than her stated age, and was depressed and anxious.

Case 23.—A widow aged 59 was first admitted after a suicidal attempt at the age of 54. Duodenal ulcer developed at the age of 42, and was treated by partial gastrectomy at 51. She married when aged 21, had two children, and her husband died when she was 48. Throughout her life she had indifferent health. A hysterectomy was performed at the age of 34 and a nephrectomy at 42. She had not come under psychiatric care until her suicidal attempt when aged 54. After her gastrectomy she became depressed and solitary. She also developed attacks of asthma. Between 1955 and 1958 she continued to attend the psychiatric out-patient department intermittently. She was readmitted in 1958 and again in 1960 for depression. After her last admission she was seen as an out-patient, continued to complain of anxiety and depressive symptoms, and finally committed suicide by taking an overdose of barbiturates.

Discussion

These brief case histories serve to indicate the general nature of the problem. Quite obviously, from a total of 25 cases it would not be possible to derive statistical information which can be related to the general problem of post-gastrectomy syndromes. Nevertheless, certain facts emerge.

The outstanding feature is the high incidence—56%—of alcoholism and drug addiction in this small series. To some extent this could be explained on the grounds that alcoholism and drug addiction are frequent causes of admission to psychiatric wards. On the other hand, so are symptoms of depression and anxiety. Consequently it seems remarkably unlikely that the 56% incidence of alcoholism and drug addiction can be explained on a basis of selection. In any case, there are reasons to believe that the association between partial gastrectomy and these two addictions is not a chance one.

Review of the Literature

Hagnell and Wretmark (1957) quote Engest's observation that of 419 alcoholics 17.7% had had a peptic ulcer, compared with an incidence of 12.8% in the general population. 31% of cases had had a partial gastrectomy, compared with 12% among non-alcoholic cases of peptic ulcer. In their own series of 130 male alcoholics 18.5% of cases had had a peptic ulcer, compared with 8.1% in their controls. Of the alcoholic peptic ulcer cases 29.2% had had a partial gastrectomy, and over half their alcoholics with peptic ulceration had their ulcers before they developed alcoholism. The D.U./G.U. ratio was 7:1 among the alcoholics, compared with 2.3:1 in the non-alcoholics.

Lereboullet *et al.* (1955) note that partial gastrectomy for duodenal ulcer was four times as frequent among alcoholics as among non-alcoholics. In about half their cases the addiction started between three months and five years after operation. Martimor *et al.* (1956) found partial gastrectomy four times more common among hospitalized alcoholics than among those suffering from other mental disorders. Delore and Chaupy (1956) observed 13 men requiring treatment for alcoholism after partial gastrectomy, but felt that the association was a chance one. Levrat *et al.* (1958) comment on the bad operational risks where alcoholism and peptic ulceration coincide.

Navratil and Wenger (1955) found that 24.5% of 200 male alcoholics had a peptic ulcer and that 19% had had a partial gastrectomy. Soeder (1957) feels that there is a special tendency for gastrectomized patients to develop alcoholism, instancing 14 cases of his own, all of whom came into his class of neurotic drinkers who drank to relieve their symptoms.

Dick *et al.* (1959) review a number of papers on alcoholism and gastrectomy in which the incidence of post-operative alcoholism varies from 5.4 to 70%. From their own experience they did not feel that the risk of causing alcoholism by partial gastrectomy was sufficient to deter them from continuing with the operation. In a further paper, Navratil (1959) criticizes the report of Dick *et al.*, going on to summarize the findings in 500 patients with alcoholism, of whom 103 became so afflicted after partial gastrectomy.

Little attention has been paid to this matter by English and American workers. Kapp *et al.* (1947) studied a small group of men who had had psychiatric breakdowns associated with peptic ulceration, and comment on eight cases of alcoholism. None of their cases had been treated surgically. Browning and Houseworth (1953) examined the effect of surgery on 30 patients with duodenal ulcer, compared with the same number treated

medically. No specific mention of alcoholism is made, but they noted a 50% increase of psychoneurotic symptoms in their gastrectomized patients.

In a brief note Poloni (1953) observes that one-tenth of a series of partial gastrectomies became severe alcoholics.

Relation Between Gastrectomy and Alcoholism

From this brief summary of the literature there seems to be evidence to indicate that partial gastrectomy bears a causative relationship in a proportion of cases to subsequent alcoholism, drug addiction, and psychoneurotic illness. Opinions differ over the nature of this relationship. It is the question of alcoholism and partial gastrectomy which appears to have attracted most attention in the past, and, contrary to what might be expected, the peptic ulceration is often present before heavy drinking has become a problem. There is not much reason to believe that alcoholism is a direct cause of ulceration, although it is a fruitful cause of chronic gastritis. After a partial gastrectomy the speed of absorption of alcohol into the blood-stream increases. Because alcohol is a drug of addiction it is arguable that repeated exposure of the brain tissues to intoxicating doses increases the craving for more. This might be the explanation in a proportion of cases, but it is doubtful if it is the whole explanation. A number of patients continue to drink in moderation after a partial gastrectomy, and, whether or not they have other psychiatric symptoms, they do not become chronic alcoholics.

A matter of greater importance is the attitude of the patient to dumping symptoms. This is a common post-operative complication, and all the alcoholics said that they drank to relieve these symptoms and the depression brought on by their uncomfortable physical state. Intoxicated, their spirits rose, only to sink lower as the effect of drink wore off. Similar considerations apply to four of the five drug addicts who used their chosen anodyne to relieve them of the symptoms of the post-gastrectomy syndrome. However, the fact that the effect of dumping symptoms is not the whole explanation was made clear by a patient—not in this series—who attempted suicide shortly after a partial gastrectomy. When seen six months later he was cheerful and well. He admitted to having dumping symptoms which did not upset him greatly. He enjoyed his meals, and took alcohol in moderation. He denied vigorously that the after-effects of gastrectomy had anything to do with his suicide attempt, which was precipitated by anxiety lest a minor fraud he had committed should be discovered. Once this matter was put right he regained his spirits and returned to work.

There is evidence to suggest that the personality of the sufferer from duodenal ulceration differs from that of one afflicted with a gastric ulcer. In this series all the alcoholics and drug addicts had had their partial gastrectomy for relief of duodenal ulcer symptoms. On theoretical grounds one might assume that those suffering from duodenal ulcers had unconscious conflicts of an oral nature which, given a change of circumstances, could be expressed through alcoholism and addiction to a drug. The absence of any satisfactory information about the premorbid personality of these patients makes it difficult to test this hypothesis, but the high correlation of alcoholism and drug addiction in this group of post-gastrectomized patients with a pre-existing duodenal ulcer makes it at least a possible or partial explanation.

A further concept adds point to this theory. It is often stated that psychosomatic illness can in some way protect a patient from a more serious underlying psychotic breakdown if the psychosomatic symptoms are relieved. The evidence for or against this idea has been debated for some years. If it is correct it would account for the consequences of gastrectomy in this series of patients. Whatever else might be said about their illnesses there seems to be little doubt that their social adjustment when they had peptic ulceration was greatly to be preferred to the state of affairs existing after operation. Among the alcoholics it did seem that an existing ulcer acted as an efficient brake on excessive drinking. Alternatively, it gave them an escape route when their normal, but possibly precarious, adjustment was threatened. The ulcer pain became more active, they had to stop work, go on a diet, stop drinking, or even go to bed.

Once the ulcer was removed they had no further pain. Instead they had dumping symptoms which added to their discomfort, leading to increasing consumption of alcohol or drugs for relief. The ulcer no longer acted either as a brake or as a safety-valve. As an intelligent alcoholic commented, "Once I had my operation I no longer got a hangover, and I could go on drinking the next day without trouble." This admittedly was not the usual experience of these patients, but they all commented on the relief they obtained from drinking. Although they implied that it was dumping symptoms for which they sought relief it appeared that the depression and anxiety was of greater concern to them. No longer having an active ulcer, drink or drugs was their only way of escape. As is so often the case, the novelist has made his own independent observations before the psychiatrist:

> "A fresh tray of drinks was thrust in his hands. 'Stiff ones,' Leslie whispered fierce in his ear; 'they've had a couple of rounds of water, this'll put some gyp into things.' But then his ulcer rose to help him, the pain hit so suddenly he could only push the tray back into Leslie's hands. It often discovered its own escape route this way."—William Plomer, *The Loving Eye*.

The fact that there were no alcoholics among the women can possibly be explained by cultural factors. Addiction in three cases to narcotic drugs is probably fortuitous in that these drugs were prescribed for relief of pain. If, however, there is a special tendency for some post-gastrectomized patients to become addicted it is plainly desirable that such drugs should be prescribed with caution. Once the habit was formed the unpleasant withdrawal effects made it very difficult for the patient to give up the drug unaided.

How far the occurrence of psychoneurotic symptoms in this series is coincidental rather than causally related to the operation is not easy to say. Certainly in some cases there was an abrupt change in behaviour pattern indicated by the development of intractable depressive and anxiety symptoms in a person who up to the time of operation had been functioning with reasonable efficiency. However, it would be hard to make out a case for the suggestion that the gastrectomy was a specific cause of the breakdown in the same way as seems likely in the cases of alcohol and drug addiction. In all probability the operation came as a particularly stressful experience to a vulnerable personality who thenceforth was unable to cope with the additional burden of post-operative symptoms.

It is not easy to see what should be done to prevent symptoms of the kind described in this paper. Faced by a patient with a duodenal ulcer who is known to be a moderate drinker and who has had a number of acute complications of his ulcer, the surgeon must choose whether or not to operate. If he does not do so he may endanger the life of his patient. If he carries out a partial gastrectomy he might convert a reasonably adjusted individual into a chronic alcoholic, incapable of work, a burden to himself and his family alike. A warning about the possible effects of drinking after operation should be given, and if the patient is obviously drinking to excess he should be referred for psychiatric help. Undue preoccupation with dumping symptoms, persistent loss of or failure to regain weight, and repeated requests for potentially habit-forming drugs should all be regarded as warning signals indicating that the patient might be heading for a breakdown or addiction.

In the absence of any clearly defined pattern of behaviour or of personality it is not easy to avoid operating on those who might thereby be exposed to a special risk of breakdown. Those who show psychopathic features or who are prone to resort to drink to relieve their anxieties should be detected before operation so that psychiatric treatment can be started before and continued after operation. By doing this one might hope to avoid some of the unfortunate consequences of partial gastrectomy described in this paper.

Summary

25 patients (17 men and 8 women) were admitted for psychiatric treatment after a partial gastrectomy. In most cases this was done for relief of symptoms of duodenal ulcer. 56% of these cases were admitted for treatment of alcoholism or drug addiction. A review of previous work suggests that there is a special relationship between the operation and subsequent addiction to alcohol and drugs. This special relationship may not hold when psychoneurotic illness follows partial gastrectomy. In such cases the operation probably acts as a non-specific stress in a vulnerable personality.

The implications of these findings are discussed, and it is suggested that the development of certain symptoms post-operatively may indicate the need for psychiatric treatment.

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Copies of *The Prevention of Accidents in Childhood*, a report of a seminar sponsored in 1958 by the Regional Office for Europe of the World Health Organization, are available for persons officially or professionally concerned in this field of study on request to the W.H.O. Regional Office for Europe, Copenhagen, Denmark.

CYTOGENETIC STUDIES IN ACUTE LEUKAEMIA

BY

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Abnormalities of the chromosomes of leukaemic cells in human acute leukaemia have now been the subject of several reports (Ford *et al.*, 1958b; Baikie *et al.*, 1959; Ford, 1960; Sandberg *et al.*, 1960). It would appear that in about half the cases reported some abnormality has been found, including aberrations of chromosome number, morphology, and sometimes both of these. Among the reported cases no two appear to have had an identical abnormality. In this respect, and as regards their frequency of occurrence, the chromosome abnormalities in acute leukaemia may be contrasted with the apparently specific chromosome abnormality which may be found in most cases of chronic myeloid leukaemia in man (Nowell and Hungerford, 1960; Baikie *et al.*, 1960; Tough *et al.*, 1961). It has not yet been possible to correlate any of the clinical or haematological features of acute leukaemia with the varied chromosome abnormalities which have been found. If any such correlations exist it seems probable that they will emerge only after the publication of many more data than are at present available. For this reason we now publish our accumulated cytogenetic results in 22 cases of acute leukaemia in adults, together with the relevant haematological data.

Seven of the 22 patients had a history of significant exposure to ionizing radiation. All seven had, during the preceding 12 years, received radiotherapy for some condition other than leukaemia, involving the irradiation of a large volume of tissue. None of the other patients had any history of radiotherapy. Our knowledge of the occurrence of leukaemia in irradiated individuals indicates that after a single heavy exposure the possibility of leukaemia being diagnosed rises to a maximum between the third and eighth post-exposure years, but may not have returned to normal levels in the twelfth year (Medical Research Council, 1960). In our seven patients with a history of previous radiotherapy there is therefore a high probability that leukaemia was radiation-induced. Inspection of our results suggests that demonstrable chromosome abnormalities may be relatively more frequent among cases of acute leukaemia which may be radiation-induced. Similarly, demonstrable chromosome abnormalities may be relatively more frequent in cases with unusually low white-cell counts. These possible associations can be confirmed or refuted only by the publication of many more data than are now available. With the continued accumulation of results, other associations of possible aetiological or pathogenetic significance may emerge.

In our previous paper on chromosome studies in acute leukaemia we published detailed results in one case and summarized data for four others (Baikie *et al.*, 1959). The complete data for these four cases are now reported together with results in 17 other cases, all of which were