He has felt "dazed" after hard blows on the head. E.E.G. recordings taken at rest showed sporadic bursts of disordered activity in both "unipolar" and bipolar records (Fig. 1).

Case 2.—This man, aged 27, had boxed for the last five years. He did not complain of headaches or loss of memory, but had had one knock-out and was unconscious for eight hours (two years before the E.E.G. recording was made). His E.E.G. showed spontaneous bursts of disordered activity (Fig. 2).

Case 3.—This man, aged 21, had boxed from 1952 to 1956; he then stopped until 1960. He gave a history of having been struck by a stone on the head in 1954 and was unconscious for about two hours on that occasion. He complained of frequent attacks of headaches and was referred to us for an E.E.G. in May, 1960. The E.E.G. was reported as being within the limits of normal variation (Fig. 3). In August, 1960, he was sent for an E.E.G. as he was unconscious for about 20 minutes after a blow on the chin during a university boxing meet. This E.E.G. was taken three days after the "knock-out." The recording showed spontaneous bursts of disordered activity (Fig. 4).

FIG. 3.—Case 3. No abnormal E.E.G. changes before the knock-out. (Record taken in May, 1960.)

FIG. 4.—Case 3. Spontaneous bursts of disordered activity occurring in several leads. (Record taken in August, 1960.)

Discussion

The variations found in our control group of cases (8%) is well within the expected figures. The presence of disordered activity among 60% of the boxers is statistically very significant. Further, it is noticed that, although only 34% of the boxers gave a history of knock-outs, 60% showed disordered activity. Our findings therefore show that E.E.G. recordings of boxers taken under identical conditions (at rest) show a significant change in the wave form in a large percentage of cases.

We are grateful to the boxers for their help and also to the Rockefeller Foundation, New York, for the valuable apparatus with which we carried out this investigation.

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BLOOD-GROUP STUDIES IN FRIEDREICH'S ATAXIA

BY

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Few inherited characteristics can be followed accurately from one generation to another. Those that can be traced include sex, an ability to taste phenylthiocarbamide (P.T.C.), and the blood groups. While linkage of disease with sex has been known for a very long time, linkage of the blood groups ABO and rhesus with the hereditary conditions of the nail-patellar syndrome and oval red cells respectively has been discovered more recently (Renwick and Lawler, 1955; Goodall *et al.*, 1953). As the number of blood groups which have been discovered increases, the chances of detecting linkage become more probable, linkage being easiest to demonstrate in those groups whose alleles are fairly evenly demonstrated in the population, such as the Lewis factor (Race and Sanger, 1958).

In the hereditary ataxias, Hogben and Pollack (1935), Haldane (1941), and Schut (1951) have carried out linkage studies. Hogben and Pollack deal with 22 families affected by recessive Friedreich's ataxia; and by a production method devised by Hogben they found no reason to suppose that this type of Friedreich's ataxia could be linked with the inheritance of the ABO group or the ability to taste P.T.C. In Haldane's cases transmission in some cases was believed by him to be partially sex-linked, and in others it was dominant; in neither type was there any apparent linkage with ABO blood group or P.T.C. appreciation. Schut, who included in his paper the result of tests involving ABO, rhesus, MN, and Kell blood groups, the tasting of P.T.C., and the sex distribution, was investigating a family in which hereditary ataxia occurred in six generations. He could find no evidence to suggest linkage with these characteristics. Here transmission was by dominant genes, and not all the affected persons exhibited pure Friedreich's ataxia. There is little to suggest that recessive and dominant Friedreich's ataxia have anything in common genetically, although the neurological picture may vary only in age of onset.

The Investigation

The present study has been carried out on the members of the eight families described elsewhere (Powell and Childers, 1961), in all of which transmission was by recessive genes. Linkage has been sought between this condition and nine blood groups (see Table). The study includes all the surviving parents (11 out of 16), 17 of the affected members, and those healthy members who have not emigrated (14 out of a possible 31).

As the inheritance of Friedreich's ataxia in these families is by recessive genes (the parents being unaffected), the affected children will be homozygous and the parents heterozygous. In the affected generation, those without ataxia may be either heterozygous for the harmful gene or free of it. If Friedreich's ataxia is linked with any blood group, this group will have the same genotype in all the affected members of any one family, provided crossover has not occurred. In the ABO, P, Lutheran, Kell, Lewis, and Duffy systems it has been possible to establish only the phenotype: the healthy siblings who are heterozygous may appear to have the same group as the affected, but siblings with groups differing from the affected should be free of disease, assuming that linkage is present. Each family must be considered separately for each blood group.

More useful information has been obtained from some families than from others. Where the blood group of both parents is the same no information is available. This is to be expected where gene frequencies of alleles are unbalanced, as in the Kell and Lutheran groups (Race and Sanger, 1958), but has reduced the number of useful results also in the Duffy group, where gene frequency in the general population is more even. In our small population, made up of family groups, such selection is without significance. In blood groups with two alleles useful results can be obtained most often when one parent is homozygous and the other heterozygous. Where both parents are living and there are a large number of children, the inheritance of blood groups can be followed from one generation to another,

and the probable genotypes of the individuals can be surmised. In some instances where a parent has died it is possible to establish his or her blood group from an analysis of the group of the children and the other parent (for instance, blood group MN in family We.). Assuming linkage, a study of the genotype of the parents, where this is known, would show which child would be affected and which free. If there is no linkage, this distribution of blood-group genes among normal and affected children would not be followed, other than by chance.

In this way, and more directly by seeing if all affected members of a family have the same blood group, we have come to the following conclusions.

ABO group: Seven families (Da., De., H., McD., S., Wa., and We.) give information; from four of them (De., H., S., and We.) it appears that linkage is unlikely.

Rhesus group: Seven families (Da., De., G., H., S., Wa., and We.) give information; from four of them (G., H., Wa., and We.) it appears that linkage is unlikely. In Family Wa., if linkage were present A. Wa. should be affected.

MN group: Six families (Da., De., G., McD., S., and We.) give information; from four of them (De., G., S., and We.) it appears that linkage is unlikely.

Ss group: Five families give information (De., H., McD., S., and Wa.); from two of them (De. and H.) linkage appears unlikely.

P group: Three families (H., S., and Wa.) give information; the S. family suggests that linkage is unlikely.

Lutheran group: One family (We.) gives information, and suggests that linkage is unlikely.

Results in Eight Families

Name	ABO	C D E c	Probable Genotype	M N	S s	Probable Genotype	P	Lutheran ^a	Kell	Lewis ^a	Duffy ^a
Mrs. Da.	A	+ + - +	CDe/cde	+ +	+ +	MNSs	+	-	-	-	-
Mr. Da.	O	- + + +	cDE/cde	+ +	+ +	MMSS	+	-	-	-	+
J. Da.	A	- + + +	cDE/cde	+ +	+ +	MNSs	+	-	-	+	-
A. Da.	A	- + + +	cDE/cde	+ +	+ +	MNSs	+	-	-	+	-
M. Da.*	O	- - - +	cDE/cde	+ +	+ +	MNSs	+	-	-	-	NT
Mrs. De.	A	- - - +	cde/cde	+ -	+ -	MMSS	+	-	-	-	+
J. G. (née De.)	O	- + + +	cDE/cde	+ -	- +	MMSS	+	-	-	-	+
M. De.*	A	- - - +	cde/cde	+ -	- +	MMSS	+	-	-	-	+
N. De.*	O	- - - +	cde/cde	+ +	+ -	MNSS	+	-	-	-	+
Jo. De.*	O	- - - +	cde/cde	+ +	+ -	MNSS	+	-	-	-	+
S. De.	A	- - - +	cde/cde	+ -	- +	MMSS	+	-	-	-	+
Mr. G.	A	+ + - +	CDe/cde	+ +	- +	MNss	-	-	-	-	+
Mrs. G.	A	- - - +	cde/cde	+ +	- +	MMSS	-	-	-	-	+
Le. G.	A	+ + - +	CDe/cde	+ -	- +	MMSS	-	-	-	-	+
A. G.	A	+ + - +	CDe/cde	+ -	- +	MMSS	-	-	-	-	+
E. G.*	A	+ + - +	CDe/cde	+ +	- +	MNss	-	-	-	-	+
Lu. G.*	A	- - - +	cde/cde	+ -	- +	MMSS	-	-	-	-	+
Mr. H.	AB	- + + +	cDE/cde	+ -	+ +	MMSs	+	-	+	-	+
Mrs. H.	A	+ + - +	CDe/cde	+ -	- +	MMSS	-	-	-	-	-
D. H.*	AB	- - - +	cde cde	+ -	- +	MMSS	-	-	+	-	-
B. H.	B	+ + + +	CDe/cDE	+ -	+ +	MMSs	+	-	+	-	+
Y. H.	AB	+ + + +	cDE/cde	+ -	+ +	MMSs	+	-	+	-	+
J. H.*	A	+ + + +	CDe/cDE	+ -	+ +	MMSs	-	-	-	-	+
Mr. McD.	O	+ + - +	CDe/cde	+ +	- +	MNss	-	-	+	-	+
E. McD.	A	- + - +	cDE/cde	+ +	- +	MNss	-	-	+	+	+
La. McD.*	O	+ + - +	CDe/cde	+ -	+ +	MMSS	+	-	+	-	+
El. S.*	O	+ + + +	CDe/cDE	- +	- +	NNss	-	-	-	-	+
J. S.*	O	+ + + +	CDe/cDE	- +	- +	NNss	-	-	-	+	+
Ed. S.*	B	+ + + +	CDe/cDE	+ +	- +	MNss	+	-	-	-	+
Mr. Wa.	B	- + + +	cDE/cde	+ -	+ +	MMSs	-	-	-	NT	NT
Mrs. Wa.	O	- + - +	cDE/cde	+ -	- +	MMSS	+	-	-	-	"
J. Wa.	O	- + - +	cDE/cde	+ -	- +	MMSS	-	-	-	-	"
M. Wa.*	B	- + + +	cDE/cde	+ -	+ +	MMSs	+	-	-	NT	"
A. Wa.	B	- + + +	cDE/cde	+ -	+ +	MMSs	+	-	-	-	"
P. Wa.	O	- + - +	cDE/cde	+ -	+ +	MMSS	+	-	-	-	"
Mrs. We.	A	+ + - +	CDe/cde	+ -	+ -	MMSS	+	+	-	-	+
C. We.	A	+ + - +	CDe/cde	+ +	+ -	MNSS	+	+	-	-	+
B. We.*	O	- - - +	cde/cde	+ +	+ -	MNSS	+	+	-	-	+
S. We.	A	- - - +	cde/cde	+ -	+ -	MNSS	+	+	-	-	+
A. We.*	O	+ + - +	CDe/cde	+ -	+ -	MMSS	+	+	-	-	+
J. We.*	A	- - - +	cde/cde	+ -	+ -	MMSS	+	+	-	-	+
N. We.*	A	+ + - +	CDe/cde	+ -	+ -	MMSS	+	-	-	-	+

* Affected. NT=Test not carried out.

Kell group: Two families (H. and McD.) give information; the H. family suggests that linkage is unlikely.

Lewis group: Three families (Da., McD., and S.) give information; the S. family suggests that linkage is unlikely.

Duffy group: One family (H.) gives information, and suggests that linkage is unlikely.

All the unaffected persons on whom these results are based have passed the age when their siblings developed ataxia.

Discussion

Linkage between two genes is said to occur when they are situated on the same chromosome. If these genes are far apart, such linkage may be difficult to establish, as the chromosomes may cross over each other and disturb the gene pattern. In those blood groups where the evidence that there is no linkage is based on one family, it may be that a cross-over has occurred and masked a linkage which is, in fact, present. For this reason further work among other families with Friedreich's ataxia in the blood groups P, Kell, Lutheran, Lewis, and Duffy is necessary before linkage can be disproved.

On the evidence of four families each, linkage between Friedreich's ataxia and the blood groups ABO, rhesus, and MN has been excluded, and on the evidence of two families, blood group Ss.

The search for linkage in hereditary diseases is an interesting one. At the present state of knowledge, advice to relatives on the chances of their transmitting the disease can be based only on mathematical chance. If close linkage with an easily detected gene were discovered it would be possible in some families to tell the parents if younger children were to be affected, and to tell unaffected siblings if it was possible for them to transmit the disease or not. It can be seen from this study that not all matings give information; if linkage is not close cross-over may occur, and this would tend to invalidate prognosis. Although it appears unlikely, different genes may be responsible for the recessive form of Friedreich's ataxia; if this is the case, linkage patterns are likely to remain obscure.

Summary

In a study of inheritance in recessive Friedreich's ataxia no evidence of linkage between this disease and nine blood groups could be detected. The limitations of this type of study are discussed.

I would like to make my acknowledgments to the National Blood Transfusion Association of Ireland, and to Mr. Cann, chief technician, who undertook the blood-grouping.

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"A complaint that chocolate sweets bought in a cinema were stale was fully confirmed by both their taste and appearance. Further inquiries elicited the astonishing facts that no sort of routine turnover of stock existed and that sweets three years old were sold next to fresh stock of the same pack. These facts were firmly pointed out to the manager concerned." (Birmingham City Analyst, Report for Fourth Quarter, 1960.)

BLOOD GROUPS AND SECRETOR STATUS IN ULCERATIVE COLITIS

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Since the original observations of Aird *et al.* (1954) it has become well established that there is an association between blood groups and certain diseases of the upper gastro-intestinal tract—namely, gastric ulcer, duodenal ulcer, and gastric carcinoma. In addition, there is an association between duodenal ulcer and the secretor status (Clarke *et al.*, 1956). In a review of the whole subject of blood groups and disease, Roberts (1959) made no mention of ulcerative colitis. The purpose of the present study was to assemble data relevant to this disease.

Sources of Data

The blood groups of ulcerative colitis patients were derived from two sources. First, information was obtained from the case records of in-patients who had been treated with blood transfusion. Secondly, a considerable number of patients with the disease currently attending a special clinic had their blood groups and their secretor status determined by one of us. All the patients were examples of classical ulcerative colitis. Patients in whom the disease was confined to the rectum and recto-sigmoid region—so-called haemorrhagic proctitis or proctosigmoiditis—were excluded.

The controls were obtained from the Oxford Regional Blood Transfusion Centre, and consisted of the blood groups of all donors of the Oxford Region attending during August to November, 1959, inclusive.

Distribution of ABO Blood Groups Among Patients with Ulcerative Colitis and Blood Donors

ABO Blood Group	Actual No. of Subjects		Percentage Distribution	
	Ulcerative Colitis	Blood Donors	Ulcerative Colitis	Blood Donors
O	147	6,010	46.37	46.88
A	124	5,382	39.12	41.98
B	33	1,027	10.41	8.01
AB	13	401	4.10	3.13
Totals	317	12,820	100%	100%

Statistical significance of differences: $\chi^2 = 3.74$. $P \approx 0.3$.

Results

The Table shows the results for the ABO blood groups. It will be seen that the ulcerative colitis patients closely resemble the controls in relation to blood-group distribution. In view of the fact that the ulcerative colitis group is a large one, the possibility of any significant association between ABO blood groups and ulcerative colitis appears to us to be remote. In this we are in agreement with the studies of Buckwalter *et al.* (1956) and Winstone *et al.* (1960).

Among 101 of our patients with ulcerative colitis there were 24 "non-secretors" (23.8%), a proportion which is closely similar to that found in healthy subjects (Clarke *et al.*, 1956; Wallace *et al.*, 1958). Once again we are in agreement with the findings of Winstone *et al.* (1960).