D.M. THESIS

The Royal Free Epidemic of 1955

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CONTENTS

I

THE ROYAL FREE EPIDEMIC OF 1955

In July 1955 an epidemic occurred among the staff of the Royal Free Hospital, Gray's Inn Road, London. Its spread was explosive. The number of cases increased from less than 5 in mid-July to more than 100 a fortnight later. The hospital had to be closed on July 25; it remained closed until early October. New cases continued to occur during this three-month period but not at the initial rate and mostly at other hospitals in the Royal Free Group. Badly hit were the Liverpool Road and Lawn Road Branch Hospitals and the Preliminary Training School. The Elizabeth Garrett Anderson and Hampstead General Hospitals got off comparatively lightly. However, by the time it was all over - in late October - the total number who had been affected was over 300. Two-thirds of them had been sufficiently ill to need admission.

Originally the illness had been diagnosed as glandular fever: negative Paul-Bunnell tests disposed of this idea. Then, when paralyses developed in a number of cases the question of polio arose. However all cerebro-spinal fluids examined were normal. Puzzlingly the signs and symptoms failed to add up to any of the usual diagnoses. 'Royal Free Disease', it was conceded, was a bit of a mystery. The general consensus of opinion was that it was a viral infection of the central nervous system. Fortunately the disease proved relatively benign and, though a few of the affected suffered some disability for up to a year, no-one died of it.

The year after the epidemic a leading article appeared in The Lancet entitled "A New Clinical Entity?". In this article the name 'benign myalgic encephalomyelitis' was proposed for Royal Free Disease and certain similar illnesses (Lancet (1956)). When the medical staff at the Royal Free Hospital wrote their account of the

outbreak (Medical Staff Report (1957)) they also described the illness as an encephalomyelitis. The nature of the infective agent was admitted by all concerned to be obscure but considerable definition was claimed for the clinical syndrome. To quote the end of the Lancet article, "we believe that its characteristics are now sufficiently clear to differentiate it from poliomyelitis, epidemic myalgia, glandular fever, the forms of epidemic encephalitis already described and, need it be said, hysteria".

The concluding phrase seems a non sequitur. The case for hysteria was not examined in the article: indeed it received no consideration apart from this summary dismissal. The case is, in fact, well worth examining.

Epidemiology

Epidemic hysteria characteristically occurs in populations of segregated females - in girls' schools, convents and among female factory hands*. At the Royal Free, as at any other hospital, the female population is segregated to a very considerable degree: the attack rate among the females should, according to the hysterical hypothesis, be considerably higher than among the males. There is no dispute that this was so. The epidemiological study by Crowley, Nelson and Stovin (1957) of the Bacteriology Department of the Royal Free Hospital School of Medicine gives the following figures:

Males	27 out of 950	2.8%
Females	265 out of 2550	10.4%

These attack rates are for the whole institutional population (staff, students and patients) and include cases treated on an out-patient basis. Now the diagnosis of 'Royal Free Disease' was a notoriously difficult

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* The literature is surprisingly thin. Specific instances are: (for girls' schools) Schuler and Parenton (1943), Tan (1963), Moss and McEvedy (1966); McEvedy et al. (1966); (for convents) Huxley (1952); (for factory hands) Merckhoff and Back (1968).

business. There were no positive findings to help the clinicians distinguish the epidemic illness from the minor illnesses that are always occurring in any institutional population. Indeed, in mild cases 'Royal Free Disease' entered the differential diagnosis only because of the existence of the epidemic. There must have been many such cases for, to quote Crowley, Nelson and Stovin, "the hospital population was by the second week of the outbreak epidemic-conscious (and)...people report-ed sick with ill-defined malaise which at other times would have been called 'a touch of 'flu '".

The danger here is that people with irrelevant diseases are included in the epidemiological study: ordinary illnesses with a random sex distribution will lower the inequality of the attack rates for the epidemic illness. It is, therefore, important to define the epidemic illness as accurately as possible. This was well appreciated at the time. In February 1956 a list of all cases in which the epidemic illness had been suspected was circulated by the hospital authorities. In this, and four amending lists prepared over the following two months, a final diagnostic verdict was given for each individual (the verdict, of necessity, was purely clinical). The names in these lists are arranged in five categories: 1) Nurses 2) Domestics 3) Medical Staff 4) Medical Ancillaries 5) Patients. Each category was then sub-divided into those treated as in-patients and those treated as out-patients. The percentage of cases rejected in each group is of interest:

	IN-PATIENTS			OUT-PATIENTS		
	Number	Rejected	%	Number	Rejected	%
Nurses	170	22	13	7	3	43
Domestics	56	14	25	47	20	43
Medical staff	18	2	11	19	6	32
Medical ancillaries	17	3	17	47	22	47
Patients	39	25	64	58	38	66

The strikingly high rejection rate among patients renders the whole of this group suspect. The same is true of all those treated on an out-patient basis. On average these classes have a rejection rate of over 50%. The members of the nursing, domestic, medical and medical ancillary staff treated as in-patients provide, by contrast, a relatively securely diagnosed population with an average rejection rate of only 16%.

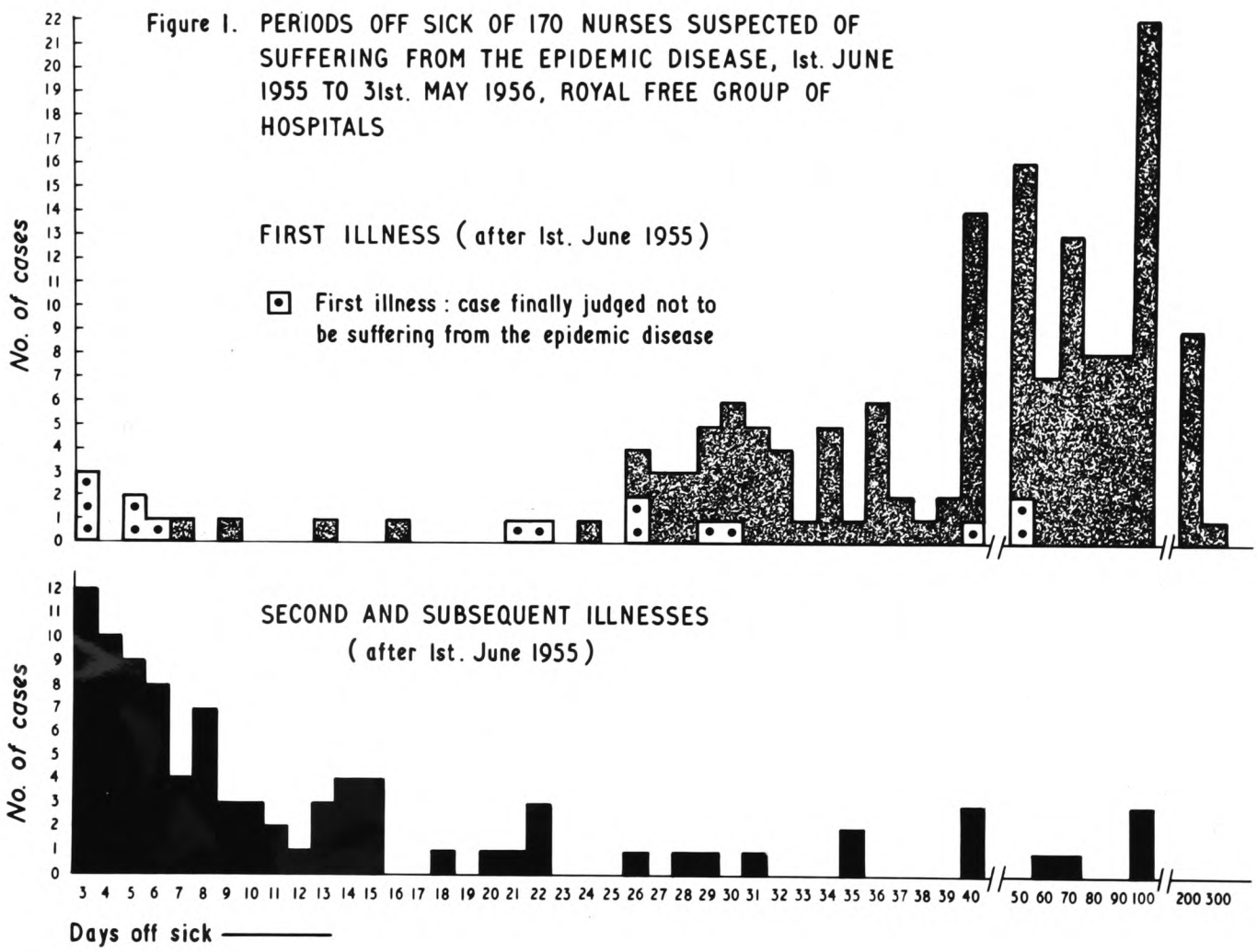
Discarding all the out-patients and the in-patients in the patient group- reduces the affected population from 323 to 220. A further increase in diagnostic security can be obtained at the price of two more subtractions - the first from taking definite dates for the beginning and end of the epidemic, the second from letting the illness define itself in terms of duration.

1. The surest starting point for the epidemic is the first day on which more than one case was admitted. This is July 16 1955 when four nurses were taken into the Gray's Inn Road sick bay. An acceptable end-point is the last day in October 1955, for there were 18 cases in that month but only one a month in November and December.

2. In Figure 1, the length of the first period of sick leave between June 1 1955 and May 31 1956 is plotted for nurses in the in-patient category on the list of suspects. The distribution indicates that the epidemic illness characteristically resulted in a minimum of 26 days sick leave. By comparison second and subsequent illnesses - representing non-epidemic periods of sick leave - are mostly below three weeks.

In many of the instances where a first illness lasted less than 26 days the patient was considered on clinical grounds not to have suffered from 'Royal Free Disease'. In others it is a matter of short periods of non-epidemic illness (colds etc.) before being involved in the epidemic at a later date. This last group supplies the majority of the longer second illnesses. Accordingly we can apply the criterion of a minimum period of sick leave of 26 days.

Figure 1. PERIODS OFF SICK OF 170 NURSES SUSPECTED OF SUFFERING FROM THE EPIDEMIC DISEASE, 1st. JUNE 1955 TO 31st. MAY 1956, ROYAL FREE GROUP OF HOSPITALS



These two definitions lead to the exclusion of 12 cases accepted as valid by the original investigators. Another 10 have been excluded because their records are now unobtainable. The details of this refining procedure can be summarised as follows:

	Accepted by the original investigators	Too early	Too late	Less than 26 days	No records available	Finally accepted
Nurses	148	2	2	3	3	138
Domestics	42	1	-	1	-	40
Medical	16	1*	-	-	6[x]	9
Ancillary	14	-	-	2[+]	1	11

* one male - could also be disqualified on the grounds that sick leave lasted less than 26 days

+ one male

x students - and therefore lacking the wage sheets on which periods of sick leave are recorded

Apart from the two cases indicated, all rejections are female.

As regards the populations at risk, the exclusion of the in-patient category reduces the totals by 320 (male) and 630 (female), the exclusion of the medical students by a further 30 (male) and 160 (female).

Using this more stringently defined population we can recalculate the attack rates as:

Males 5 out of 600 (0.8%)
Females 193 out of 1760 (11%)

This a very striking difference that fits well with the hypothesis of an hysterical epidemic. It is surely difficult to reconcile with an infective agent.

Another expectation in an hysterical epidemic is a higher attack rate in the younger age groups. Crowley, Nelson and Stovin give the following age incidences for the nursing population:

	Under 20 yrs	20 - 30	30 - 40	Over 40
Nos. at risk	200	450	120	30
No. affected	41	84	14	10
% affected	20.5	18.6	11.6	33.3

The figures suggest that a decline in incidence with age may well be present for, though the last rank reverses the trend, the numbers involved are relatively small and could be due to chance. Moreover, the population figures are obviously rounded and approximate. It seemed worthwhile to define the age ranks exactly and try to obtain exact figures for the population at risk by reconstructing the nursing staff situation during the epidemic period. Thanks to the meticulous records kept by the Matron's office it proved possible to do this for the Gray's Inn Road, Liverpool Road and Lawn Road hospitals and for the Preliminary Training School (no records were available for the Elizabeth Garrett Anderson or Hampstead General Hospitals as these hospitals have now left the Royal Free Group: they had only a few cases each so the figures for the affected remain much the same as those given by Crowley, Nelson and Stovin).

Initially the Gray's Inn Road population can be considered in isolation for in the opening two weeks when the attack rate was highest the epidemic was almost confined to this institution:

	At Gray's Inn Road	At Liverpool Rd, Lawn Rd and Prelim. T.S.
No. of cases July 16 - 31	54	4

The age incidences for the Gray's Inn Road population during this period are as follows:

	Under 20 (born 1.8.35 or later)	20 - 30 (born 1.8.25 - 31.7.35)	30 - 40 (born 1.8.15 - 31.7.25)	Over 40 (born 31.7.15 or earlier)
No. at risk	39	115	18	10
No. affected	17	31	4	2
% affected	44	27	22	20

It will be seen that the attack rate declines with each decade: the really explosive spread took place in the lowest age rank.

After July 31 the attack rate fell off, but the epidemic continued for a further three months. In a period as long as this many nurses are transferred from one branch to another and it is no longer possible to give populations at risk for an individual institution. So the second population given here lumps together 1) the Gray's Inn Road survivors who were still on duty after 31.7.55 2) the nursing population of the Liverpool Road and Lawn Road Branch Hospitals between 16.7.55 and 31.10.55 3) those attending the Preliminary Training School between 16.7.55 and 31.10.55. The figures for this population are:

	Under 20 (born 1.8.35 or later)	20-30 (born 1.8.25 -31.7.35)	30-40 (born 1.8.15 - 31.7.25)	Over 40 (born 31.7.15 or earlier)
No. at risk	118	195	57	33
No. affected	28	33	8	4
% affected	24	17	14	12

The trend is again consistent with the hysterical hypothesis.

Clinical data

The main published source of clinical information on those affected by the epidemic is the Medical Staff Report of 1957. There are also accounts by Richardson (1956), Geffen (1957) and Dimsdale (1957).

The illness usually began "with symptoms common to the prodromal stage of most infections" (Medical Staff report, p. 896). A minority of the admitted patients did not progress beyond this phase and gradually recovered over a few weeks. About three quarters deteriorated, entering

a phase of some central nervous system disturbance which lasted weeks or even months. For simplicity's sake, it is easiest to keep this division into a prodromal stage and a stage of central nervous system disturbance but it would be wrong to suggest that the two degrees of illness were invariably successive. "A clear division of symptoms into those appearing early and late is not possible " (ibid. p. 896).

Two further sentences from the same page of the Medical Staff Report are worth quoting as they appear to be relevant to the whole course of the illness:

> "The intensity of the malaise, particularly when related to the the slight pyrexia in this disorder, requires emphasis"
>
> "Spontaneous pain was the commonest sensory manifestation (and) its part in the clinical picture cannot be over-emphasised".

The prodromal stage

A list of the initial manifestations is given in Table 1 of the Medical Staff Report, here reproduced as part of Table 1. It will be seen that these manifestations are all subjective complaints. Placed alongside this table are figures for the frequency of these or equivalent complaints among 154 schoolgirls involved in an epidemic of overbreathing (Moss and McEvedy (1966)).

TABLE I.—*Incidence of Various Prodromal Symptoms in the Royal Free Epidemic and of Equivalent Symptoms among Schoolgirls Involved in an Hysterical Epidemic*

Incidence of Various Prodromal Symptoms; Royal Free Hospital Epidemic		Incidence of Equivalent Symptoms Among Schoolgirls Involved in an Hysterical Epidemic	
Headache	77%	Headache	59%
Sore throat	63%	No equivalent	
Malaise	62%	General weakness	40%
Lassitude	51%		
Vertigo	47%	Dizziness	63%
Dizziness	33%		
Nausea	40%	Nausea	44%
Pain in limbs	46%	No equivalent	
Pain in back	32%	Pain in back or abdomen	44%
Pain in abdomen	14%		
Stiff neck	32%	Pain in chest or neck	18%
Depression	19%	Feeling of panic	25%
Vomiting	12%	Vomiting	<10%
Diplopia, tinnitus, diarrhoea	<10%		

The schoolgirls also complained with high frequency of pins and needles, feeling hot and cold and areas of altered sensation, mostly peripheral. Their teeth often chattered, they shivered, 40% were overtly hyperventilating on admission and a third suffered tetanic spasms. Disorientation, bladder dysfunctions and specific pareses were occasionally present.

Though paraesthesiae and altered sensations are not tabled in the Royal Free list of prodromal symptoms the "numbness and coarse tinglings" described later on in the Medical Staff Report (p. 897) could be taken as an equivalent phenomenon. Richardson (p. 82) states "Initially, the neurological symptoms usually consisted of vertigo, generally transient but sometimes persistent, and accompanied by blurred vision or diplopia. Motor weakness and sensory disturbances of variable distribution and duration followed and, in particular, coarse paraesthesiae were experienced" (my italics). Paraesthesiae were certainly common enough among the Royal Free cases to be asked for as a routine on admission. A check on the hospital records indicates that approximately 40% of those affected experienced them. It is possible that the lowered pain threshold characteristic of the disease caused the paraesthesiae to be tabled as 'pains in the limbs'.

Richardson also remarks on "the tendancy for the limbs to develop spasm in response to sensory stimulation" while the Medical Staff Report refers to "severe and prolonged painful muscle spasms".

As to emotional state, "disproportionate depression and emotional lability" were frequently present at the start of the illness (ibid. p. 895).

It will be seen that there is a fair case for regarding these symptoms as the subjective complaints of a frightened and hysterical population whose overbreathing was intermittent and covert but sufficient to bring their limbs to the threshold for tetanic spasm. On this view the sore

throat - which is described as 'mild' - would be partly a complaint partly an objective, but incidental, finding to be related to the statement in the Medical Staff Report (p. 898) that "a small outbreak of streptococcal sore throat affected a group of nurses". The much lowered pain threshold which was such a marked feature of the epidemic could well cause a positive reply to a routine enquiry for sore throat.

The objective changes one might expect in the prodromal stage of an infective illness were only exceptionally present: pyrexia over 100°F in 4.5%, E.S.R.s over 20 mm. in the hour in 1.5%. The white blood count was said to show a "tendency for a low-normal neutrophil count with a high-normal lymphocyte count in about half the cases". As this was no more than a tendency (which could well have been balanced by an opposite tendency in the other half of the cases) it appears that all white counts were within normal limits.

The stage of severe central system disturbance

Sensory symptoms On discharge from in-patient care, the affected were graded into three categories of neurological involvement - slight, moderate and severe.

I have taken 20 cases for re-study of the sensory symptoms. The series is made up of all the 17 cases marked severe plus one (case 14) whose summary is lost but who must have been considered severe as she was in hospital as a result of the illness for over a year plus two more (cases 19 and 20) considered moderate but who had charts of sensory disturbance drawn. The population is, accordingly, made up of two overlapping but complete and objectively defined series:

Cases 1 - 18 - the clinically severe cases
Cases 2, 4, 10, 12, 14, 17, 19and 20 - the cases forwhich sensory charts were drawn

As will be seen from Table II only 16 of the 20 cases showed an anatomically defined sensory change and study of this table and of Fig. 2, where the sensory charts are reproduced in facsimile, indicates that of these 16 cases, the distribution of the change in 13 is of the glove and/or stocking type.

It seems fair to say that the characteristic pattern of sensory loss is a classically hysterical one.

Motor symptoms and signs

According to the Medical Staff Report "The usual initial distribution of weakness was hemplegic, or less commonly monoplegic or paraplegic, but later the remaining limbs were often affected to some degree... The tendon jerks were preserved.... In only two cases were frank extensor plantars encountered.... Wasting of muscles was exceptional".

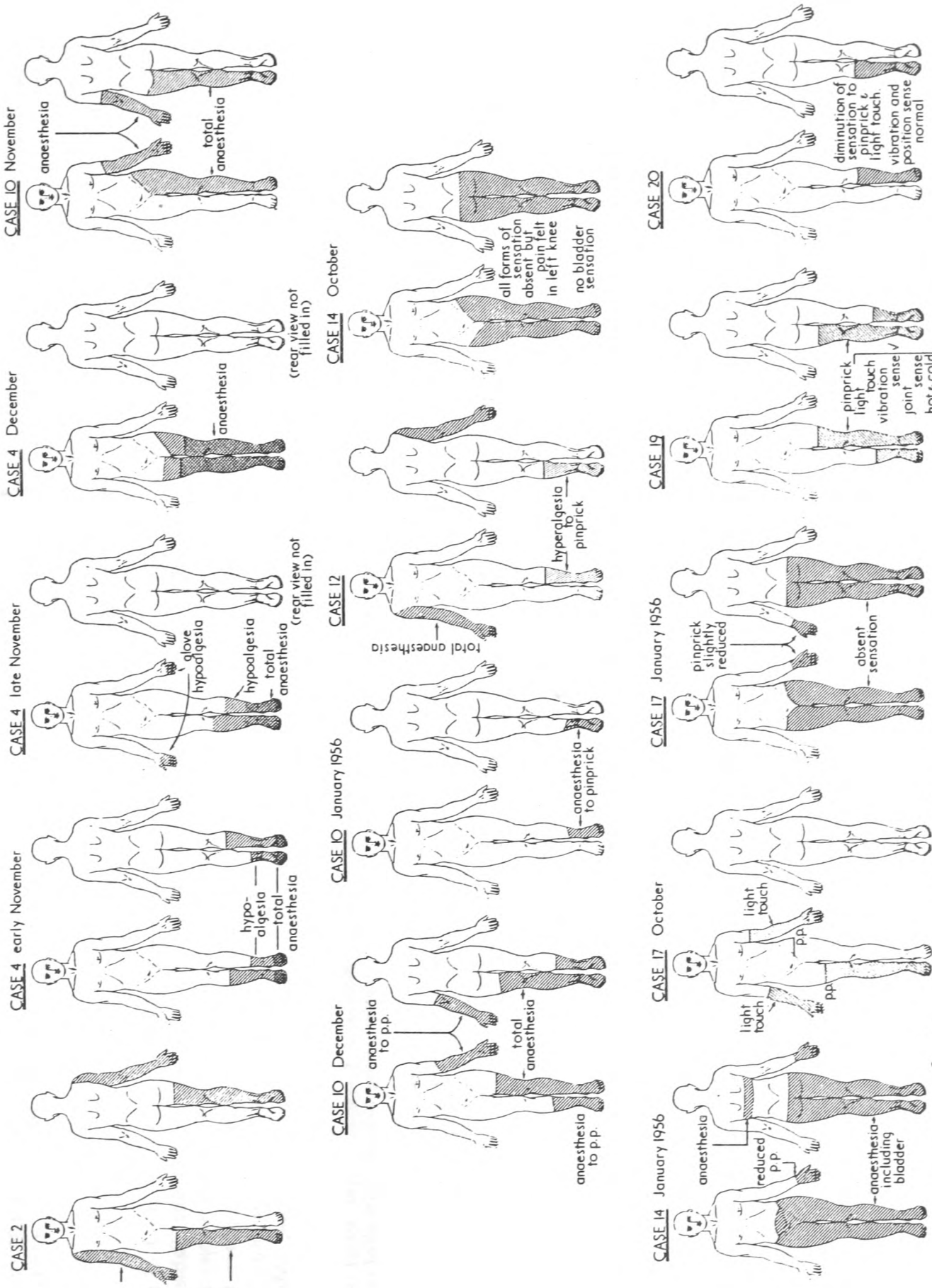
Richardson says "An important diagnostic feature was the apparent contrast between the severe disturbance of volition and the minimal disturbance of the reflexes. Thus, in two cases of flaccid paraplegia of

TABLE II.—*Sensory Signs in Clinically Severe Cases. The Dates in Parentheses refer to the Entry in the Patient's Notes*

Case No.	Changes in Arms	Changes in Legs
1	"Glove" (6/9)	"Stocking" (26/8)
2, 4	See Fig. 2	See Fig. 2
5	"Pinprick impaired up to elbow"	"Pinprick impaired up to knee" (16/9). Described as stocking loss in summary
6	"Left hand and foot hypoalgesic" (4/8)	
9	"Peripheral loss arms and legs" (see also note below)	
10	See Fig. 2	See Fig. 2
11	Nil	"Both legs anaesthetic up to groins" (14/9)
12	See Fig. 2	See Fig. 2
13	Sensation noted to be altered in feet and diminished in finger-tips of right hand the day after an overbreathing attack in which the patient "became hot, [had a] tight feeling in throat, could not breathe, could not take deep breaths, upper part of chest would not work. Respiratory rate went up to 30" (10–11/8)	
14, 17	See Fig. 2	See Fig. 2
18	"Hypoaesthesia of glove distribution both hands" (23/8)	"Pinprick diminished stocking distribution" (25/8)
19, 20	See Fig. 2	See Fig. 2

Cases 7, 15, 16: No note of any sensory impairment.
Case 3: Only note of sensory impairment is "generalized hypoalgesia."
Case 8: Left hemihypoalgesia, including left face.
Case 9: Also loss over left side of face, neck, and shoulder, sparing the nose and corneal reflex.

Fig.2. Facsimiles of charts of altered sensation.
(Bracketed comments are mine)



several months duration jerks were retained, and in two hemiplegias jerks did not become exaggerated, abdominal reflexes were retained and extensor plantars did not develop"*.

The onus is surely on the organicist here, for traditional diagnosis regards normal reflexes as proof that a paralysis is functional. Indeed, the formulations quoted fit so readily into the hysterical hypothesis that an organic theory only seems worth considering if other evidence can be brought in to support it. Some have seen such evidence in Richardson's electro-diagnostic investigations. As the point is crucial, it is worth considering the results of his careful (and carefully reported) studies in some detail. He found that:

1. With one exception the muscles tested satisfied the criteria of normal innervation.

2. With one exception (the same) no fibrillation potentials were found in the muscles with established paralysis.

3. Nerve conduction was within normal limits in all cases tested. "The medial popliteal reflexes, even after 8 months of flaccid paraplegia, were found to be normal ".

4. Some of the electromyograms taken from affected muscles showed a peculiar bunching of the action potentials, groups of roughly half a dozen spikes being separated by electrically quiet intervals.

The first three points are obviously no help to the organicist. The fourth point is taken by Richardson to indicate no more than "a severe disturbance of volition", a lesion that is surely characteristic of hysteria.

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*The passage continues "In fact, frank extensor responses occurred in only three cases and persisted in one". The case in which the plantars became and remained extensor had disseminated sclerosis. She is actually excluded from the epidemic population as I have defined it because she had been ill for some weeks before July 16 1955. Her condition is considered in detail (as Case A) at a later point in this study;- here it is sufficient to say that autopsy material (Medical Staff Report p. 901) left no doubt as to the diagnosis of disseminated sclerosis and provided no evidence of any other pathology.

However, a hasty reader might get the impression that the peculiarity demonstrated was unphysiological and that the electromyograms therefore provide support for the organicist. Neither statement is true and the first is easily disproved by experiment.

Although motor units fire rhythmically, different units are rarely in phase and the electromyographic picture obtained with increasing muscular activity is a fairly steady filling-in of the trace as asynchronous rhythms are superimposed. The peculiarity observed in the Royal Free cases lies in the synchronous firing of the motor units; macroscopically the effect would presumably manifest as a fast tremor. In practice it is quite easy to obtain this type of trace by encouraging one's rigid outstretched arm to tremble. Fig. 3 shows a trace of Royal Free type, a normal trace (same case) and a trace produced in a deliberate and not unsuccessful attempt to simulate the first by the author.

Far from being unphysiological, this type of trace suggests that the weakness is produced by a process similar to that used in its simulation - a 'maximum effort' in which agonist and antagonist counteract each other.

It is interesting to note that in his classic work on hysteria, Janet (1907) observes of hysterical tremors that they characteristically show a regular rate averaging between 5 and 9 a second (p.129. He prints a smoke drum trace of such a tremor on p.130). The rate in the Royal Free cases falls at the upper end of this range.

Convulsive episodes

'Fits' of one sort or another, though only mentioned once in the Medical Staff Report, appear to have been of relatively frequent occurence. For example, the clinical notes record convulsive episodes in ten of the

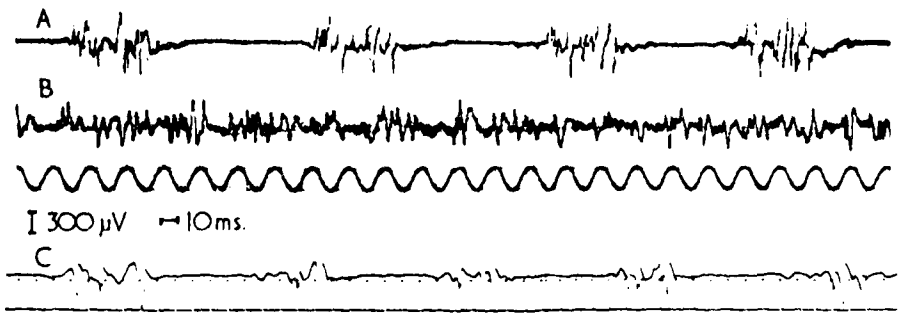

Fig.3. Trace A: weak tibialis anterior muscle on maximum sustained volition. Trace B: normal contralateral tibialis anterior on maximum sustained volition. These two traces are photocopied from Fig.6 in the Medical Staff report. Trace C: normal extensor digitorum. I obtained this trace by extending my arm rigidly and encouraging my natural tremor.

eighteen cases considered to be severely affected.

Case 2	24/8	"Fit lasting about 20 minutes consisting of throwing limbs about, foaming at the mouth, staring eyes. Said afterwards that she did not know anything about it"
	25/8	Similar attack, less severe
	8/9	"Query hysterical attack; jerking and throwing herself about "
Case 3	14/9	"Started havin g fits. Arms flexed, rigid, shaking. Teeth clenched. Slight breath holding, followed by irregular breathing"
	Later the same day	"Arms and legs rigid, and shaking. Breath holding lasted longer; patient went red, blue,then livid before recovery. Query voluntary".
Case 6	13/8	Attacks of muscle spasm mainly in the legs but occasionally generalised. This patient also complained of feelings of suffocation and generalised tingling.
Case 8	26/8	Outbursts of screaming and struggling with stridor Similar attacks almost daily thereafter for the next six weeks.
Case 9		During convalescence had a fit heralded by paraesthesiae, first in the right arm and leg then in all limbs. The fit was a tonic convulsion followed by paralysis and anaesthesia.
Case 10	19/10	"Attacks of diaphragmatic spasm and breath holding. Uncommunicative, cannot speak, incontinent."
	28/1	Similar attack considered hysterical.
Case 12	13/9	Shivering attack followed by severe spasm of left leg.

	7/10	"Screaming fits" Frequent spasms thereafter. (This is the case mentioned in the Medical Staff Report which records "an episode of behaviour disorder with screaming, followed by stupor for 45 minutes" during the ninth week of the patient's admission)
Case 13	10/8	Overbreathing attack as already noted under Sensory Signs. Respiratory chart, showing spike up to 32 on 2/8, indicates that there had been at least one similar attack during the first week of admission. The clinical summary states that "attacks of violent shivering associated with spasm of the respiratory muscles" started in the fourth week and continued at intervals for six weeks. In the case-record there are notes of a shivering attack with considerable distress on 25/8 when the patient was about to be discharged for convalescence. On 26/8 she had another attack in which she was terrified and had a feeling of strangulation. This attack was said to be similar to the preceding one and was described as a rigor (the patient's temperature was normal). Further 'rigors' with dyspnoea occurred over the next fortnight. On 7/9 after an attack of this type the left arm and hand went into spasm. On 8/9 an attack occurred during a medical examination: the respiratory rate was charted at 28.
Case 16		Fits of jerking daily from 27/8 to 9/10. "Respiration increased" (29/8), "irregular breathing " (31/8), "respiratory spasm" (19/9).
Case 18	7/9	"Had an attack in which whole body went stiff and twitched for three to five minutes; hands then went dead for five minutes". Respiration charted at 30.

The last two in the series are an interesting contrast. Case 18 provides a perfect correlation between the clinical description and a spike on the respiratory chart, whereas Case 16 shows an undisturbed

respiratory rate of 20 five times a day despite daily 'fits' and clinical notes of a disturbed respiratory rate. Obviously there is every chance that an observation made in half a minute a mere five times a day will miss the vast majority of episodes of hyperventilation that it seems fair to hypothesize on the basis of the sample set out above. In fact the surprising thing is how often spikes do occur.* For the cases considered above there are additional spikes that pass unremarked in the notes (Case 2, spikes to 32 on 26/7 and to 28 on 27/7. Case 3, spike to 30 on 11/8. Case 18, spikes to 28 on 11/9 and 21/9). For the cases where there is no written evidence of episodes of altered respiratory rate spikes can be found in the records of Cases 4 (to 28 on 21/9), 14 (to 28 on 3/9, 4/9 and 2/10), 15 (to 28 on 19/7) and 17 (to 34 on 6/10). This means that among the series of 18 severe cases there is evidence of one sort or another for paroxysmal episodes of hyperventilation in 14.

It is surely arguable that hyperventilation as a result of anxiety was the primary disorder underlying the convulsive episodes, that the resulting parasthesiae increased the anxiety and that the 'fits' were probably partly tetanic and partly a direct expression of overwhelming anxiety.

Special investigations

As already remarked, laboratory and other aids proved of no help in diagnosis. The Paul-Bunnell test was negative in 246 out of the 250 patients tested, liver function tests were normal in 115 of the 119 patients tested, the electrocardiogram was normal in 39 out of 42 patients tested and the cerebrospinal fluid was normal in all 18 cases examined. The few abnormal results cannot be regarded as significant in an illness so difficult to define: inevitably a minority of the cases included in the series will have been suffering from illnesses other than the epidemic affliction.

*I use the term 'spike' to indicate a recorded rate of 28 or more respirations a minute, flanked by readings at a steady 20.

For example, one case became jaundiced. This male doctor satisfies the epidemiological criteria we have used to define the affected population but it is difficult to read through his notes without feeling that, at any other time, he would have been diagnosed as an uncomplicated case of infective hepatitis. Jaundice was not part of the picture of the epidemic illness and the malaise he felt is more simply explained as a consequence of his hepatitis than of a superadded 'viral encephalomyelitis'.

Histopathology

Two patients who were thought to have suffered from the epidemic illness died a few months after the epidemic was over. One death was due to an ovarian carcinoma: no lesions were found in the central nervous system of this case. The second death was due to an overdose and autopsy showed only lesions attributable to disseminated sclerosis.

DISCUSSION

Encephalitis versus Mass Hysteria

The manifestations of encephalitis are extremely variable and at first sight a diagnosis of encephalitis seems logical in an illness with such protean central nervous system symptomatology as 'Royal Free' Disease'. However, inherent in the diagnosis are expectations which, despite the large number of cases, were never in any instance borne out. Encephalitis is a serious illness: in at least some cases one would expect a high temperature and prolonged disturbance of consciousness. One would expect a mortality. One would expect, at least in some cases, involvement of the menninges and alterations in the cerebro-spinal fluid. The culture of an infective agent, if viral, could only be hoped

for but some signs of its effect in post-mortem material would seem likely.

In the Royal Free epidemic the temperature rose above 100°F (37·8°C) in only 9 out of 200 cases. This could well be within normal limits for this population over a three month period. There were no sustained comas and no deaths. There was complete failure to obtain objective evidence of any inflammatory response in the blodd or cerebro-spinal fluid. There was an equal failure to elicit clinical signs of the type classically expected in organic dysfunctions of the central nervous system.

The hypothesis of an hysterical epidemic seems to fit well with these and other findings. The greater susceptibility of the segregated female would explain the failure of the epidemic to propagate beyond the institutional population or, within the institution, to affect significantly the males and the patients. It would explain the other epidemiological findings and also the observation that non-residence had a protective effect (Crowley, Nelson and Stovin (1957) p.110). Not only the negative but also the positive clinical findings - the prodromal complaints, the glove and stocking anaesthesias, the flaccid paralyses with preserved reflexes, the paroxysms of hyperventilation and the high incidence of difficulty in micturition (26%. Medical Staff Report p. 897) - fall into place as part of this picture.

The initial stage of the epidemic: a possible reconstruction

In the original investigators' list of suspected cases there are only four who were off sick before July 16 1955. Two of these do not really merit consideration as initiators.

Case C A domestic who was in hospital for appendicectomy from

June 24 to July 24 and only developed symptoms of 'Royal Free Disease' on the second date.

Case D A male doctor who was admitted on July 13 with a temperature of 101°F and a three-day history of sore throat, lassitude and headaches. His symptoms subsided over the next few days, he was discharged after six days and back at work after a total absence of 12 days. The short duration of this illness is quite atypical of 'Royal Free Disease' and it seems likely that this was a case of 'flu admitted to hospital only because the white blood count was (wrongly) considered to be "typical of glandular fever".

The remaining pair of cases (Cases A and B) would seem to represent the genuine starting point of the epidemic.

Case A This case, a Sister in the E.N.T.Department at Gray's Inn Road, is the one who died as the result of an overdose two months after the end of the epidemic. The autopsy demonstrated that she had been suffering from disseminated sclerosis, a diagnosis that had been sonsidered at intervals throughout her period of ill-health. This began in May 1955. In June she was admitted to the Nurses Sick Bay at Gray's Inn Road for a week (22 - 29/6) followed by a week's convalescence. She then attempted to return to work but felt too ill and required readmission to the sick bay on July 8. During her first admission to the sick bay "she was frequently visited by another sister who had prodromal symptoms on July 6 and became the third case" (Crowley et al. (1957)p.105). Crowley's second case is my Case D (see above). This leaves us with a simple transmission from Case A to the second sister who is our Case B.

Case B worked in the same section of the hospital as Case A and they were in every sense close contacts. Case B was admitted to the

Sick Bay on July 13. The 4th, 5th 6th and 7th cases followed on July 16. We have no information as to where these nurses were working at the time except that Fig. 5 in Crowley, Nelson and Stovin (1957) indicates that the first rush of cases came from the same section of the hospital - the E.N.T/ Eyes/V.D. section.

Case A was not only in the early stages of disseminated sclerosis, she was also psychiatrically unstable (see the Medical Staff Report p. 898, in paragraph 2 of 'Psychiatric Aspects' the third sentence refers to Case A.). She had a lot to be frightened about and, I would suggest, succeeded in communicating her fear to Case B. The first epidemic cases were recruited from the social sub-unit of which Cases A and B had been senior members. Finally the spread became explosive.

At this point the hospital was closed, which quickly put an end to the Gray's Inn Road outbreak. The effectiveness of the closure of an institution in ending an outbreak of hysteria is well known: it was a striking feature here. Geffen (1957) in an account of the epidemic written from the public health point of view, stresses the importance of rapid closure as a preventative measure, particularly in respect of a small recrudescence of the illness in 1956*. Geffen also comments that the decision to admit the Gray's Inn Road cases to the branch at Liverpool Road resulted in the disease spreading to this institution but, whereas he mentions that the later cases were looked

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*Ten months after the original outbreak the illness reappeared among nurses in the Preliminary Training School. The population at risk was 38, all female: the number of cases was 7. Geffen and Tracey (1957) sum up this episode as follows:

"The outbreak was of short duration and it is possible that this was due to quick administrative action following the experience in the Group in the previous year. As soon as it became obvious that there was an outbreak of acute infective encephalomyelitis the Preliminary Training School was disbanded, and all those residents who were not ill were sent home. Close contact was kept with them and in no case did they or any of their home contacts develop illness".

after at the Lawn Road Branch, he does not say that this caused a flare-up of the illness at this hospital too. In fact, the July cases were almost entirely confined to the Gray's Inn Road staff, those in the first three weeks of August to the Liverpool Road Staff and those in the last week of August and first three weeks of September to the Lawn Road staff.

This 'high infectivity' for the nursing staff and 'low infectivity' for those who were not members of the social unit represented by the Royal Free Group of hospitals is in itself strong evidence for hysteria. It cannot be attributed to the hospital as a geographical (as opposed to social) unit for, as Geffen remarks "one of the most extraordinary features of the epidemic was that it affected....the staff, yet left the patients clear".

Many commentators have found many features of the epidemic extraordinary, peculiar or puzzling. It is indeed a difficult episode to understand on any organic hypothesis. By contrast the hypothesis of mass hysteria seems to me to be relatively free from intellectual difficulties.

II

SOME SIMILAR EPIDEMICS

Acheson, in a review article on 'benign myalgic encephalomyelitis' (1959), enumerated fourteen epidemics that he considered belonged in this category. A fifteenth has been reported since (Daikos et al. (1959)). The term 'benign myalgic encephalomyelitis' was only proposed in 1956 (Lancet), so the dozen outbreaks before this date have received the label retrospectively. However the outbreaks have so many features in common that the case for regarding at least the epidemic form of the illness as a unitary phenomenon is a very fair one.

In the first section of this thesis I have presented the evidence for regarding one of the most striking epidemics in the series - the Royal Free Hospital outbreak of 1955 - as an hysterical phenomenon. Can this formulation be applied to any or all of the other fourteen? After looking at the published reports on these epidemics and, in one instance, studying the original clinical data, my conclusions is that two mechanisms are at work, both psychosocial. I believe that between them they account for the phenomenon of benign myalgic encephalomyelitis.

Hospital Outbreaks

Of the fifteen recorded outbreaks of benign myalgic encephalomyelitis eight have occurred among nurses at hospitals. This is a remarkable fact in itself and one which suggests that social factors may well be important in the illness. However the first use of the peculiarity is simply to separate these epidemics from the other seven. More information is available about these epidemics and, as the population at risk is relatively easy to define, the information is easier to assess.

The leading points about the eight reported hospital epidemics are set out in Table III.

TABLE III

Year	Hospital	Initial Diagnosis	No. of Cases			Female Cases as % of total	No. of Cases Among Nurses	Cases among nurses as % of No. of female cases	Attack Rates			Mortality	Cerebro-spinal fluid; results of lumbar puncture	Reference
			Total	Male	Female				Male	Female	Nursing population (female only)			
1934	Los Angeles County Hospital, Los Angeles, U.S.A.	Poliomyelitis (concurrent epidemic of confirmed poliomyelitis in Los Angeles)	196	28	168	86	131	78	1·6	6·6	12·0	0	Negative in 53 out of 59	Gilliam (1938)
1952	The Middlesex Hospital, London, England	Poliomyelitis	14	0	14	100	14	100	0	0·25	2·0	0	Negative in 6 out of 6	Acheson (1954)
1953	The Whitley Hospital, Coventry, England	Poliomyelitis	13	0	13	100	8	62	—	—	20·0*	0	Negative in 9 out of 9 and 4 out of 5 repeats	Macrae and Galpine (1954)
1953	Chestnut Lodge Hospital, Washington, D.C., U.S.A.	Poliomyelitis	50	2	48	96	47	98	—	—	42	0	Negative in 25 out of 25 and 8 out of 8 repeats	Shelokov *et al.* (1957)
1955	Addington Hospital, Durban, Union of South Africa	Poliomyelitis (concurrent epidemic of confirmed poliomyelitis in Durban)	90	0*	90*	100*	—	—	—	—	20·0*	0	"Normal in all but a very small minority"	Alexander (1956). Clinical Meeting (1955). Hill (1955)
1955	The Royal Free Group of Hospitals, London, England	Glandular fever	292 198	27 5	265 193	90 97	149 138	56 72	2·8 0·8	10·4 11·0	18·5 28·0†	0 0	Normal in 18 out of 18	Crowley *et al.* (1957). McEvedy and Beard (1970)
1956	Preliminary Training School of the Royal Free Group of Hospitals, London, England	Recurrence of the 1955 epidemic	7	0	7	100	6	86	0‡	18	20	0	No determinations	Geffen and Tracy (1957)
1958	Queen Frederica School for Midwives, Athens, Greece	Benign myalgic encephalomyelitis	27	0	27	100	26	96	—	—	—	0	Normal in 3 out of 4	Daikos *et al.* (1959)

* Figures quoted by Acheson (1959, p. 571).
† Calculated for the four most severely affected institutions within the Royal Free Group of Hospitals.
‡ An eighth case, also a nurse, occurred at the main hospital. The exposed population could be taken either as that of the whole Royal Free Group, or simply as that of the preliminary training school. On the latter view no males were exposed.

Before discussing the group as a whole, I will take a look at two of them in some detail. They are the Los Angeles epidemic of 1934 (because an excellent report has been published by the United States Public Health Service (Gilliam 1938)) and a second outbreak that occurred at my own hospital (and so I have had access to the clinical notes made at the time).

The Los Angeles outbreak of 1934

As will be seen from Table III this outbreak took place at a time when a poliomyelitis epidemic was under way in Los Angeles. The influx of poliomyelitis cases led to the opening of five emergency wards at the Los Angeles County Hospital during May 1934. A further ten were opened in June. However the emergency wards opened in June were largely filled with suspected cases that had occurred among the nursing staff of the hospital. The attack rate among the nurses was extraordinarily high (12% as compared to 0.073% for the population of Los Angeles City and County). Moreover it soon became apparent that the illness that had broken out among the nurses was not poliomyelitis. Whereas the cases admitted from outside had the clinical, laboratory and autopsy findings characteristic of poliomyelitis the nurses had :

1. Temperatures fluctuating between 97^0 and 98^oF
2. More sensory than motor disturbance, with paraesthesiae, muscle tenderness and general hyperaesthesia prominent
3. Muscular weakness only rarely associated with atrophy
4. An unusually high frequency of 'insomnia, emotional upsets, other disturbances of the sensorium, joint changes, trophic changes, oedema, cystitis and menstrual disturbances'
5. A normal cerebrospinal fluid
6. A clinical course marked by relapses that were often as severe as the original illness
7. A zero mortality

This is the clinical picture that has since been termed benign myalgic

encephalomyelitis.

The full epidemiological data in Gilliam's report enabled me to calculate the attack rates for the nursing staff by age groups (Fig. 3). There is a rapidly declining incidence with increasing age. The youngest age rank has a lower incidence than might be expected for an hysterical epidemic, but this could be a reflection of 'the policy of the hospital not to permit pupil nurses to work on contagion during this epidemic' (Gilliam p. 45*).

Another epidemiological point of interest is the immunity of a second hospital that lay within the same grounds as the County Hospital. The staff at this institution (the County Osteopathic Hospital) had a very different age and sex distribution from the County Hospital proper. At the Osteopathic Hospital 44% of the staff was male (as compared to 27% at the County Hospital); of the females only 2 out of 5 were under 30 years old (as compared to 3 out of 5 at the County Hospital). Despite the fact that the Osteopathic Hospital was also admitting poliomyelitis cases only two of its nurses came down with benign myalgic encephalomyelitis.

Other local institutions did not fare so well. Leake et al. (1934) mention "a sharp focus in May in the Ruth Protective Home, an institution for infants, children, and young women, located about 3 miles east of the city limits". Eleven of the approximately 100 inmates

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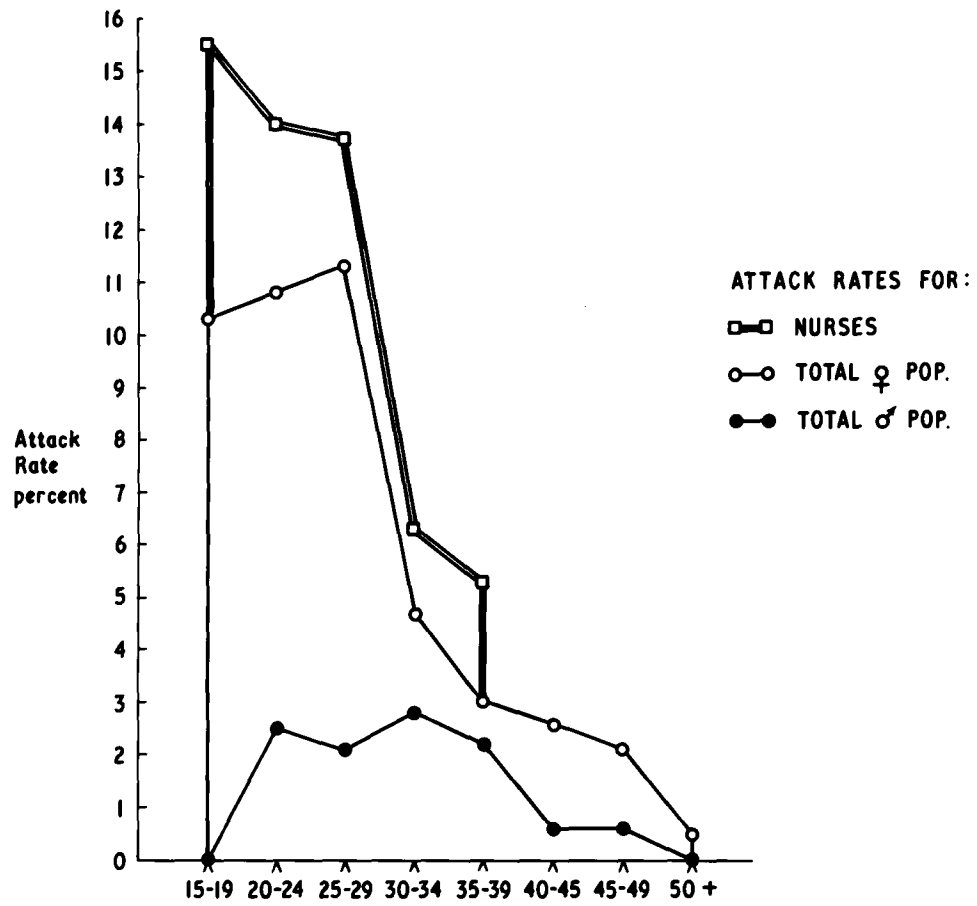
*Gilliam (p. 43-44) also says "It is probable that the average age of personnel in occupational group A, particularly nurses, who comprise the largest portion of this group, was somewhat higher than indicated in Table 17. It was a definite impression that temporary employees of this group, who entered employment during the emergency, were older than those remaining in service in November. The effect of this error has been to make the computed attack rates in females of the younger ages somewhat lower than they actually were, and the computed rates in others correspondingly greater".

Fig. 3



NURSES	7/45	65/461	43/314	11/175	5/94			
TOTAL FEMALES	7/68	69/637	53/468	17/360	9/304	8/305	4/189	1/205
TOTAL MALES	0/8	5/202	9/438	7/246	5/226	1/157	1/166	0/335

Data from Gilliam, op.cit. Table 29, p.57

Data from Gillian, op.cit. Table 24, p.50

required admission. This last is classically the sort of institution liable to mass hysteria: conversely in an hysterical outbreak one would expect the Osteopathic Hospital to be resistant, for three quarters of its staff were either male or over 30 years old.

The epidemiological peculiarities of the Los Angeles outbreak - the predilection for young women and for institutions containing an undue proportion of them - provide good positive evidence for mass hysteria as an explanation of the illness. The stress on the hospital staff from the poliomyelitis epidemic was obviously great: how great is illustrated by the following quotation (Stevens (1934)):

"During the heavy month of June, the average daily number of suspects admitted was 103, of cases of poliomyelitis 22...Patients were parked on stretchers and in automobiles in the court awaiting admission. Doctors, nurses, orderlies, maids, ambulance drivers, and all others worked overtime, often for 24 to 48 hours without let-up. Fatigue, loss of sleep, and constant exposure to poliomyelitis in its most infectious stage was common to all."

The clinical data reported are compatible with a functional diagnosis. Points 1, 4 and 7 in the already quoted summary of symptoms (normal temperature, normal cerebrospinal fluid, zero mortality) are hardly evidence for organicityand, in points 2 and 3, the prominence of paraesthesiae and general hyperaesthesiae and the absence of atrophy in paretic muscles are more suggestive of functional than organic neurological disability. This view is in fact compatible with Gilliam's conclusion. He says (p. 68)"the facts appear to be consistent with an hypothesis of spread by direct personal contact with cases and carriers, with the former playing the most important role".

The hysterical hypothesis was apparently favoured by at least some contemporary opinion. In the last paragraph of his 69-page report Gilliam says "From the clinical viewpoint little may be added by discussion. It should, however, be pointed out that certain observers were of the privately expressed opinion that hysteria played a large role in this outbreak". This represents my view exactly. For though I think it of major importance I do not believe that mass hysteria was the sole factor at work in this outbreak. The possible supplementary mechanism will be discussed after consideration of the next epidemic in the series.

The Middlesex outbreak of 1952

This outbreak involved 14 nurses over a 10-week period. Case 1 reported ill on July 7 with headache, malaise, sore throat and pains in the knees.* Her temperature was 103.4 and her tonsils considerably inflamed. She was diagnosed as a case of tonsillitis and admitted to Princess Alice Ward. Penicillin was given for the next three days, her temperature fell to normal and on July 11 she was noted to be quite well and fit for discharge the next day. (It is worth interpolating here that the patient had an exactly similar illness in 1957 when she was again diagnosed as having tonsillitis. On that occasion she was discharged after four days as an in-patient).

At 6 am. on July 12 Case 2 reported sick complaining of headache, malaise, cramps in the legs, pain in the abdomen and back and dizziness. There was no fever and no abnormality in the central nervous system but she was considered to be a possible case of poliomyelitis when examined at 10.0 am. At much the same time Case 1 complained that

*The numbering of the cases is that used by Acheson in his paper on the epidemic (Acheson (1954))

she had had a headache since the night before and now felt sick: note was made of a possible reduction of the triceps and supinator jerks on her left side. Both patients were seen again in the course of the afternoon and it was then agreed that they should be 'nursed as suspected polio'. Various measures were taken in accord with this possibility: the remaining patients in Princess Alice Ward were sent home or put out on the balcony and visiting was forbidden. Admissions of children were stopped and operations on children and tonsillectomies on those under 21 were cancelled. Children already in the hospital were nursed with masks. The contacts of the two affected nurses were told to report daily to the sick bay "to have their temperatures taken and for general supervision". Princess Alice Ward was set aside for any further cases that might arise.

In fact nothing happened from July 12 to July 29 when Case 3 reported sick. This nurse had been ill with vomiting and fatigue in May. As she was pigmented and the pigmentation was increasing she had been admitted for investigation at that time with a presumptive diagnosis of early Addison's Disease. All blood tests were negative - as they were during her epidemic admission and during a third admission in 1953. On that occasion, however, it was considered that the diagnosis of Addison's Disease had to be accepted on clinical grounds. In 1957 an A.C.T.H. test confirmed the diagnosis. Later the same year the patient collapsed and died while in labour; autopsy showed extensive suprarenal hypoplasia. The symptoms with which the patient reported at her epidemic admission on July 29 1952 were the same as during her earlier and later admissions: nausea and vomiting, plus headache, to which she was always liable. However, when the serum electrolyte sample taken on July 29 came back normal it was felt that the diagnosis

of Addisonian crisis could not be retained and on July30 she was transferred to Princess Alice Ward as the third case of suspected polio.

Case 4 reported sick on August 8 with diarrhoea and neck stiffness. Kernig's sign was positive so she was admitted to Princess Alice. There were no other abnormal findings. The next 6 cases came, comparatively speaking, in a rush. Case 5 complained of headache and aching in the legs on the 10th, Case 6 of stiff neck and sore throat on the 11th and Case 7 of headache, pain in the back and feeling faint the same day. Then, on the 13th, Case 8 reported sick with pain in the right leg and headache and on the 15th, Case 9 with an ache in the back and in the left leg. None of these cases showed any signs in the central nervous system; all were admitted to Princess Alice which was now in being as a polio unit.

By this time the number of contacts among the nursing staff who were reporting for daily inspection had risen to over 100. On August 19 this system of observation netted its first case (Case 11, the sequence is out of order here) who was admitted to the sick bay because her temperature had been slightly raised on the four preceding evenings. The epidemic then petered out, the last three cases occurring in September: on the 5th Case 12 (with sore throat, shivering and headache), on the 7th Case 13 (with generalised aches and tingling in the arms) and on the 21st Case 14 (with cramps in the legs).

The striking thing about the presenting symptoms of these cases is their lack of consistency. In some instances it is clear that the symptoms are characteristic of the patient as an individual rather than of a common illness. In particular, Case 3 had symptoms which were surely a reflection of her chronic adrenocortical insufficiency. She became an epidemic case only because of a negative test for serum electrolyte disorder - a test that was never positive at any time up to her death. Similarly, Case 11 was admitted because she had a tendency to run low

grade evening pyrexias: this tendency was still present when she was declared fit for discharge. Case 8 had diarrhoea and for that matter Case 1, on admission, seems to have been a straightforward case of tonsillitis. It looks as though the whole range of illness present among the nursing population over a 10-week period was being drawn upon to supply Princess Alice Ward with its cases.

The Middlesex is a large hospital. During 1950 the number of times nurses reported sick totalled 1249, the number of nurses admitted was 151. The period covered by the 1952 epidemic is a fifth of a year, during which time one would expect (at the 1950 rate) 250 nurses to report sick and 30 of them to be sufficiently ill to require admission. This is a large enough flow to provide for an epidemic of 14 cases, if all illnesses not immediately diagnosable as something else were regarded as 'query polio'. In my view, the 'epidemic' was an artefact, due to an altered medical perception of the community.

The corollary to this view is that the syndrome which characterised the patients <u>after</u> admission was due to:

1 A rising anxiety level on the part of the patients who were under threat of paralysis

2 A concentration of medical examination on the central nervous system

The syndrome was primarily characterised by the subjective phenomenon of 'severe muscular pain, affecting the back, limbs, abdomen and chest' (Acheson p.1044, col.ii). This type of pain is not currently recognized as a usual way for anxiety to manifest but there is no reason why such pains should be considered definitely organic. Via the mechanism

of overbreathing, anxiety could certainly be responsible for another part of the clinical picture - paraesthesiae and cramps (Acheson p.1045 col ii: paraesthesiae or tingling a general feature, spasm present in 5 cases). It could also well be the underlying factor in the high incidence of difficulty with micturition (Acheson p.1045 col i: 8 out of the 14 cases). Moreover the presence of anxiety as a symptom in its own right, though not mentioned in Acheson's paper, cannot be doubted. The following extracts from the case notes are of interest in relation to these points (my brackets, original italics):

Case 1 13/7 Cannot keep still - sedate

Case 4 21/8 Complains of difficulty in breathing and a feeling of 'heaviness' in diaphragm region. Making a lot of noise with each breath but I do not think there is any real paresis of muscles of respiration. She is very agitated.

Case 5 26/8 After three days constipation had 2 glycerine suppositories this morning. Fair result but caused abdominal discomfort. Tonight had glycerine enema since when she has had colicky abdominal pain and nausea. Then began to get cramps and pins and needles in all four limbs. Vomited once. o/e Overbreathing ++ T.P.R. satisfactory. Carpopedal spasm.

Case 6 12/8 ....this girl is the (sic) most anxious; there is a psychogenic overlay in the weakness of the left leg. The weakness - 30-40% - in the foot muscles is too great compared with the mild reflex changes.

Case 7 16/8 Panicked a bit during the night....depressed. 19/8 Feels miserable due to bladder trouble. 24/8 Last night felt she couldn't move her arms and legs; they felt numb and queer. Today nil new. There is a large anxiety element in this case.

Case 10	1/9	Tenderness is inconsistent and all muscle groups acting on back move well. Most of this is functional. 3/9 (on continuous narcosis).
Case 11	21/9	It is difficult to estimate how much of this apparent (motor) loss is genuine.
Case 14	25/9	Very worried about possible respiratory paralysis in the night. 27/9 Legs: spasms have been preceded by pins and needles. Pethadine given at pins and needles stage seems to prevent the onset of spasm, particularly if given i.v. Has had 4 attacks in the past 24 hours. 30/9 Morale is getting frayed. Throat feels 'flat', 'collapsed' and is an added embarrassment to breathing.

So far as the evidence from clinical examination goes, the physical signs that were elicited were few in number and usually indefinite in quality. There is a total lack of groups of physical signs that are mutually consistent and point to a specific neurological (or other organic) dysfunction. The majority of positive clinical findings involve a response by the patient, as for example, in tests of sensation or motor weakness, or else a large subjective element on the part of the examiner ('all reflexes slightly depressed'). Acheson admits that "the estimation of the degree of paresis and of reflex changes in the affected limbs was extremely difficult in the acute stage". He adds "in 5 cases the deep reflexes in the affected limb were exaggerated; in one case they were normal; and in 3 cases were depressed". These results seem to me better interpreted as a scatter around normality rather than as a shift in any pathological direction.

With this in mind it is worth considering Acheson's account of Case 2, the most severely ill in the series and the one who initiated the epidemic.

> Case 2 Nurse A, aged 21, on July 12 complained of headache and malaise, cramps in the legs, gripping pain in the abdomen

and backache since the previous night. She had no vomiting, diarrhoea or sore throat.

Examination Temperature 100°F. She looked ill. There was pain on deviating the eyes and a fine horizontal and vertical nystagmus. Minimal neck stiffness was noted.

Course On July 13th, she had severe headache, pains down the the right side of the body, pins-and-needles in the right hand and twitching of the right leg. During the day she developed difficulty in micturition, followed by the sensation that 'things were sticking' in her throat, and respiratory distress. She became drowsy and euphoric and meningism was more marked, but her temperature became normal. She had nystagmus on looking to the right, poor movement of the soft palate, much tenderness in the muscles of the right upper and lower limbs, mild paresis of the flexors and extensors of the hand and of the dosiflexors and plantarflexors of the right foot. The left side of the chest moved extremely poorly, and although the patient was not yet usingher accessory muscles she was taking about three breaths for each sentence. All the deep reflexes were depressed, the left more than the right. The right plantar response was extensor. She was transferred to a Drinker's respirator, but was so much better next morning that at 5 pm she was put back to bed. In the next few days the deep reflexes of the right upper and lower limbs became exaggerated.

From this stage her recovery was uneventful, except that on July 17 she developed diplopia on looking downwards and to the right, and later she was found to have diminished vibration sense in the right hand and foot, with absent position sense in the right great toe. Lumbar puncture was not performed.

Sequelae She was discharged on August 7 with numbness and slight weakness of the right foot, no position and vibration sense in the right great toe, minimal weakness of eversion of the right foot, and an extensor right plantar response. These signs remained unaltered a year later.

(The case records support this account except for minor details. The highest temperatures recorded are 98.6 on the evening of the first two nights and 99 on the evening of the seventeenth day.

The right plantar response on July 13 is marked as 'flexor - just' rather than extensor and as 'equivocal' on the 14th. The first note of it being extensor is on July 16 and by the 22nd and 25th it is marked as 'equivocal' again. The discharge entry also calls the right plantar equivocal).

The tentative diagnosis of this case as poliomyelitis seems entirely reasonable; it seems equally reasonable that the failure of typical and diagnostic features to develop led the medical personnel involved to withdraw the diagnosis - and the notification made to the Medical Officer of Health. However I find the substitute diagnosis, of 'encephalomyelitis associated with poliomyelitis virus', intellectually unsatisfying. It is merely a re-labelling of the remnants of the first diagnosis after its predictions had failed. It is a difficult hypothesis to test but it is worth noting that

1 Poliomyelitis virus was found in the faeces of only one of the 14 cases

2 The cerebro-spinal fluid, white blood count and erythrocyte sedimentation rate were normal in all cases tested

3 Temperatures during the illness "rarely exceeded 100°F"

4 The proposed incubation period of 17-18 days - said to be compatible with poliomyelitis - must have been much shorter in at least one instance for Case 7 had only been at the hospital for a week when she succumbed.* In other cases it would have to be longer than 18 days for if Case 3 is taken out of the series, as in retrospect she must, a gap of 27 days opens between Cases 2 and 4.

By contrast I believe that the 14 patients became a homogeneous clinical group only after admission, and that the symptoms then produced were due to a preoccupation with poliomyelitis on the part of both doctors and patients.

* In the Los Angeles epidemic Gilliam noted that several nurses became ill within a few days of starting work at the hospital

The mechanisms involved in the hospital out-breaks

We now have two mechanisms for the production of epidemics of 'benign myalgic encephalomyelitis'. In the first there is a rapidly propagating hysterical epidemic which produces a considerable number of cases in a short period of time: the response of the medical authorities is secondary and, though it can perhaps influence the further spread of the epidemic and the rate of recovery of those already affected, it is irrelevant to the genesis and establishment of the outbreak. I believe that the Royal Free Hospital epidemic best exemplifies this category. The initial cases at the Royal Free were diagnosed as having glandular fever on the basis of the blood picture: it was soon established that the blood picture was normal and the diagnosis mistaken but it is difficult to see how the preliminary opinions of the medical staff, which were formed in response to the epidemic, can have influenced its appearance. The outbreak seems to have been an uncontaminated example of mass hysteria.

The second mechanism is illustrated by the Middlesex 'epidemic'. On the basis of two cases of suspected poliomyelitis, both of whom it was later conceded had not got the disease, it was declared that a polio epidemic was in being and that further cases were to be expected. Illness was searched for in the community and, unsurprisingly, illness was found. Among those affected it is not unlikely that there was the odd anxiety state for this is a common condition and the community was under stress (the threat of polio). However there is no evidence that anxiety propagated through the population - there was no mass hysteria. The cases collected probably represented the normal sickness rate for the community and the fact that they were collected was due to an increase in medical vigilance. It would be wrong to term this a iatrogenic epidemic for in

our view there was no epidemic at all: the basic phenomenon was an altered medical perception of the community.

Applying these mechanisms to the list of hospital epidemics it seems fair to say that at all institutions except the Middlesex anxiety must have been self-propagating and mass hysteria the major factor at work because the attack rates are so high. It is possible that the belief of the medical staff that they were dealing with a polio epidemic may have heightened the tension and encouraged this propagation. In the case of the Los Angeles and Durban outbreaks the medical staff were dealing with a polio epidemic in the outside community. In these instances the simplest explanation is surely that a bona fide polio epidemic was the initiating stress for a hysterical response by the nursing community.

But in the presence of a concurrent poliomyelitis epidemic the reaction of the medical staff also has to be taken into account. For example, in the Los Angeles epidemic "All suspects were held 10 days for observation, and known direct contacts released at the end of these periods were required to report back for muscle checks at a specified time, to avoid overlooking mild cases" (Stevens (1934)).

For this reason the Los Angeles and other hospital outbreaks associated with poliomyelitis cannot be considered such 'pure' examples of mass hysteria as the Royal Free epidemic. An altered medical perception of the community may well have been an additional factor.

Other outbreaks

We can now look at the remaining seven epidemics reviewed by Acheson: those that took place in communities as opposed to institutions. Five of the seven fit easily into the conceptual framework we have established (Table IV). There was a bona fide poliomyelitis outbreak in

p 35A.

TABLE IV

Place	No. of Cases	Incidence	Reference
Akureyri, Iceland, 1948 (pop. 6,900)	465*	Maximum incidence in young adult females	Sigurdsson *et al.* (1950)
Adelaide, Australia, 1949 (pop. 400,000)	c.800	Maximum incidence in young adults (no sex incidence figures given)	Pellew (1951)
Copenhagen, Denmark, 1952 (pop. 1 million)	No estimate given	10 selected cases reported on: all female; ages between 20 and 41	Fog (1953)
New York State, U.S.A., 1950 (pop. 15 million)	No estimate given†	19 selected cases reported on: 15 female: one patient was age 9: rest between 21 and 45	White and Burtch (1954)
Seward, Alaska, U.S.A., 1954 (pop, 3,000)	175*	"Great excess of females in the 14-45 age brackets"	Deisher (1957)

* Including cases of poliomyelitis.

† Sample was 47 cases of whom 11 were undoubted cases of poliomyelitis and 3 more were probable cases. The cases studied were selected from the remaining 33, with the addition of two cases obtained in clinical practice.

each of these communities which was accompanied by an outbreak of 'benign myalgic encephalomyelitis'. In the small communities of Akureyi (Iceland) and Seward (Alaska) the number of benign myalgic encephalomyelitis cases was so high that the anxiety must have been self-multiplying: these seem to me instances of mass hysteria in small communities stressed by the threat of poliomyelitis. In Akureyi none of the polio cases died but the three initial victims 'were heavily paralysed, and there seems to be no doubt about the correctness of the diagnosis (of poliomyelitis in these cases)'. In Seward there were two deaths from bulbar paralysis.

On the other hand, in cities the size of Adelaide and Copenhagen and a state the size of New York there would be at any moment of time enough ill or anxious people to provide a pseudo-epidemic of the Middlesex type if a small proportion of them were picked up simultaneously. The tendency of the more anxious to have any symptom checked when polio is prevalent, and the tendency of the doctors to take extra care during a polio outbreak could easily lead to the appearance of an 'outbreak' of benign myalgic encephalomyelitis simultaneous with a poliomyelitis outbreak. To decide whether or not there was an element of mass hysteria in these instances one would have to have a geographical plot of all cases. A certain degree of clustering could be the result of the activities of a particularly vigilant doctor; mass hysteria should manifest as intense geographical clustering. Pellew had no doubt that the Adelaide cases represented a genuine epidemic and White and Burtch took the same view of the cases in New York state. Fog was more cautious about the Copenhagen cases, labelling them 'Neuritis vegetativa (epidemica?)'. In these three instances, particularly the last two, an altered medical perception of the community seems as reasonable an explanation of events as a mass hysterical reaction.

Acheson's list contains two further epidemics - one in the small community of Punta Gorda, Florida U.S.A. and one in a soldiers' barracks in Berlin.

The outbreak at Punta Gorda involved both a hospital and the community the hospital served. It could be argued that it really belongs in the category of hospital outbreaks: the attack rate among the hospital staff was 42% as against 6.1% in the community. Moreover the community attack rate, as we will show, is of dubious validity. Unfortunately the report by Poskanzer et al. (1957) does not say when the hospital staff cases occurred in relation to the epidemic as a whole. It could be that the community investigation was only undertaken as a result of the hospital outbreak.

In Punta Gorda town the attack rate was ascertained by a retrospective house-to-house survey covering 1041 of the 2500 inhabitants. 62 individuals qualified as having had the illness as defined by

1 A definite change in physical and/or emotional state, indicating an onset of illness

2 Illness lasting 7 days or more

3 Presence of headache or neck pain plus any 4 of the following symptoms: fatigue, aching limb pain, anorexia, nausea, impairment of memory, depression, paresthaesia. (If the interviewee had had headache and neck pain, 3 additional symptoms sufficed).

As a result of this survey, the attack rate for the epidemic illness was estimated at 6.1% over the preceding four months.*

This type of investigation is difficult to accept at face value in the absence of a control study in an unaffected community. The closest comparison I have been able to find is the study carried out by White et al.

*The sample considered positive in this community survey was 68% female: the minority who had actually consulted a physician was 86% female. Of the 11 cases admitted to hospital 10 were female.

(1967) on three communities: one in the U.S.A., one in England and one in Yugoslavia. The questionnaire in this investigation asked after 13 complaints or groups of complaints, some specific (rupture, varicose veins) some subjective (headaches, stomach trouble, backache, nervousness). The proportion of people who had suffered from one of the 12 complaints during the preceding year was between 52% and 74%. Moreover, when asked if they had suffered 'great discomfort' in the previous fortnight the number who said 'yes' varied between 24% (in the English community) and 44% (in the Yugoslav community). Given this level of background ill health one cannot feel that the Punta Gorda attack rate of 6% proves the presence of an epidemic. The investigation seems to me an example of an altered medical perception of the community - possibly as the result of an hysterical epidemic in the local hospital.

The final epidemic in the series is an outbreak among British soldiers in a barracks in Berlin involving 7 cases within 8 days (Sumner (1956)). The initiating case was certainly organically ill with an abnormal cerebro-spinal fluid (6 lymphocytes per cu.mm.; protein 85 mgms. per 100 ml.). The remaining cases - five more soldiers in the same barracks and a medical attendant who nursed them - all had normal cerebro-spinal fluids and could represent an hysterical response to the threat of polio-myelitis (the first case had been diagnosed as such). There is no theoretical objection to the diagnosis of hysteria in a male community: the small numbers could be taken as a proof of the rule of female susceptibility for, in terms of mass reaction, an epidemic involving seven people is abortive. However I would not wish to press the diagnosis of hysteria very hard in this case - the clinical picture was not really typical of benign myalgic encephalomyelitis, being short-lived and lacking the sensory disturbances that are usually so prominent. The unusual picture could be a reflection

of the different psychic constitution of the male. There are, however, some positive points in favour of an organic explanation: there was a slight leucocytosis in all six cases (11,700 - 15,300 white blood cells per cu. mm.) and two cases had an erythematous rash.

Epidemics not tabled by Acheson

In the same year as Acheson's review was published a similar review was published by Henderson and Shelokov (1959). This lists eight more epidemics, one of them being the outbreak at Athens already noted. Six of them are reported as a result of personal communications: the data given are scanty and can be set out in toto as follows

1 An outbreak at a convent in Fond du lac, Wisconsin U.S.A. in 1936. 32 out of a population of 63 nuns were affected. The two cerebro-spinal fluids examined were normal.

2 An outbreak among student nurses at a hospital in Louisville, Kentucky U.S.A. in 1950. 37 were affected; the three cerebro-spinal fluids examined were normal.

3 An outbreak in Tallahasee, Florida U.S.A. in 1954. This was similar to the Punta Gorda outbreak in that it involved both the local hospital and the community. The attack rate among hospital staff (16 cases, 5.8%) was considerably greater than the attack rate in the community (330 cases, 1.5%). The age group 25 - 44 was the most susceptible. Cerebro-spinal fluid was examined in 101 cases: in 7 there was a pleocytosis of 'up to 15'.

The attack rates given above are for the white population only, as the rates were '60-fold lower' in the negro population.

4, 5, 6 Community outbreaks in Florida (1952), Connecticut (1955/6), Massachusetts (1956) affecting 27, 70 and 7 persons respectively.

In the absence of fuller information on these outbreaks it is difficult to make any useful comment. However the fact that one outbreak occurred

in a convent seems a point in favour of the hysterical hypothesis.

There is one outbreak in Henderson and Shelokov's list for which a published report is available (Houghton and Jones (1942)). This involved seven student nurses at Harefield Sanatorium, Middlesex, England. The illness started with what appears to have been a straightforward sore throat. One to three weeks after the sore throat had cleared up six out of the seven nurses developed the severe muscular pains that constituted the illness proper. Evening pyrexias of 100 - 101^{0}F were characteristic of this phase but every other physical investigation was negative. Associated with the myalgia were headache and depression. One girl had frequent faints, two suffered briefly from bleeding from the cuticles of their toe nails. The myalgic illness lasted on average three weeks but in one case for nine months. Final recovery was always complete.

Houghton and Jones ascribe the illness to a myotropic virus. The possibility of hysteria was obviously in their minds for they checked on the genuineness of the pyrexia by means of rectal determinations. They also go out of their way to stress the credibility of one of the nurses who reported bleeding toe nails. The whole episode seems a bit bizarre and it is a relief that the presence of a pyrexia in all cases removes it from the 'benign myalgic encephalomyelitis' group which has normal temperature as one of its defining characteristics.

Sporadic 'benign myalgic encephalomyelitis'

The diagnosis of benign myalgic encephalomyelitis can be fitted to a very fair proportion of the minor illnesses seen in the course of medical practice. At the height of the Royal Free epidemic a very wide range of the patients seen at the hospital appear to have been considered as candidates for the diagnosis. Geffen (1957) quotes the following instances

where 'Royal Free Disease' was raised as a possibility:

"2 nurses from the Royal Free Hospital	One diagnosed finally as headache and the other as inter-costal myalgia
1 radiographer	Acute exudative herpetic tonsillitis
1 casualty receptionist	Acute respiratory catarrh
1 patient from Royal Free Hospital	Opthalmoplegia. This patient had a haemorrhage from a duodenal ulcer and his ocular symptoms were finally determined as due to a very small cerebral thrombosis
1 cardiological technician	Infectious mononucleosis"

As he says, "this gives you some idea of the difficulties of differential diagnosis". Indeed it makes it almost impossible to know how to assess reports of sporadic cases. However I note that how much the diagnosis is used seems to depend on how much contact the practitioner has had with the disease in its epidemic form. Out of 52 cases in the five papers quoted by Acheson concerning sporadic benign myalgic encephalomyelitis, 49 are reported by physicians who had been previously concerned in a hospital outbreak (Hardtke, J (1955); Ramsay, A.M. and O'Sullivan, E. (1956); Jellnick, J.E. (1956); Ramsay, A.M. (1957); Galpine, J.F. and Brady, C. (1957)).

The clinical picture

To set out the clinical data for each of these epidemics would take a volume of its own. After inspecting all the available evidence I am

satisfied that, with the possible exception of the Punta Gorda and Berlin outbreaks, they do form an entity and I do not propose to recapitulate the clinical details of them here. However one objection to the hysterical hypothesis might be that the production of symptoms is too regular for it to be a manifestation of anxiety - which takes different people in different ways. To this the short answer is that the range of variation within an epidemic is large and the emphasis on the individual case often peculiar and idiosyncratic. Findings that are 'typical' are usually non-specific complaints, such as headache, malaise and muscle tenderness: the severe pareses and anaesthesias, tremors and fits, affect a minority only. Moreover it must be remarked again that the picture has characteristically emerged in hospitals or communities where the medical personnel have been alerted for poliomyelitis. To the extent that the clinical picture is more homogeneous than seems acceptable for states of anxiety and fear, I would suggest that this is because it is observed and reported on from one point of view, that of a doctor with poliomyelitis on his mind. The examination of the central nervous system is not a totally objective process but a dialogue between doctor and patient: it is a learning situation in which both sides take part. Repeated questions and examinations can easily create at least the subjective elements in a clinical picture that pre-exists in the doctor's mind. The only epidemics to which this explanation cannot be applied are those at the Royal Free Hospital, at the Royal Free Preliminary Training School and at the Midwifery School in Athens. They come at the end of the series, the earlier members of which had established the concept of 'infective encephalomyelitis with a normal cerebro-spinal fluid'. With the clinical entity already in existence, the idea of poliomyelitis had ceased to be a necessary pre-condition. In this context it is worth

mentioning that a mysterious epidemic afflicting a nurses' training school in the days before benign myalgic encephalomyelitis was an accepted concept, and which could well have been hysterical, was reported in rather different terms (McConnell (1945)).

Nomenclature

As there seems to be a total lack of objective evidence to support the view that in cases of 'benign myalgic encephalomyelitis' the brain and spinal cord are the site of an infective, inflammatory disease process, I would suggest that the name be discarded. Even if the view that the symptoms are hysterical is not accepted, it would seem prudent to shorten it to 'benign myalgia'. My own inclination is for 'myalgia nervosa' on the analogy of 'anorexia nervosa'. This could serve both for the epidemic illness and for any isolated cases of functional disorder which conform to the same clinical picture.

III

A CONTROLLED FOLLOW-UP OF THE ROYAL FREE CASES

The full administrative records kept at the Royal Free Hospital not only permitted the reconstruction of the nursing population at the time of the 1955 epidemic but also contained information on many of the nurses' subsequent careers. This made the idea of a properly controlled follow-up of the affected nurses very attractive and the administration of it relatively simple. It was decided to limit the follow-up to nurses: they formed a uniform social group and provided their own controls, they had also clearly been the nuclear population in the epidemic as well as the population with the highest attack rate.

Accordingly each of the nurses who had been affected by the epidemic illness between 16.7.55 and 31.10.55 was paired with a nurse who had been equally exposed but had not had the illness. Nurses born before 1926 (i.e. who were older than 29 at the time of the epidemic) were excluded as being atypical of the group as a whole and impossible to match exactly. The pairs were coded according to place of work at the time of the epidemic, G indicating the main hospital at Gray's Inn Road, L and H the Liverpool Road and Hampstead branches and P the Preliminary Training School. The aim was to pick a control with the same year of birth and nationality as the proband and an equivalent or greater exposure to the illness. Where the matching could not be perfect, similar exposure was given priority over age and nationality. As will be seen from the list of pairs in Appendix A the matching of age and birthplace remains adequate.

Before beginning the follow-up the list of pairs was used to compare the affected and unaffected for various factors on which data were present in the administrative files. There was no difference between the two ranks in marks on the entrance examination, in height or weight, or weight

corrected for height. There was however a difference in the amount of sick leave that the two groups had taken before the epidemic. Taking either the number of illnesses or the number of days off sick, the affected in the paired population averaged considerably more illness per month in the pre-epidemic period than the controls: 40% more illnesses and 70% more time off sick. Closer inspection showed that this effect was entirely due to the minority of nurses who had taken an unusual amount of sick leave.

	Affected	Controls
Less than one day of sick leave per month	78	85
One day of sick leave per month	12	14
Two or three days of sick leave per month	7	2
Four or more days of sick leave per month	5	1

This difference in pattern of sick leave before the epidemic just fails to reach the 5% level of significance ($X^2 = 5.8544$ as against the 5.99 needed for a p of 0.05).

Before the follow-up began two pairs were discarded from the original list. In one of these pairs (G 51) the control had been ill and away for much of the epidemic period: this pair was only created for the purpose of the pre-epidemic sick leave comparison. The control had had a long illness before the epidemic and it was felt necessary to include her record

in the comparative series even though her being off sick during much of the epidemic made her status as a control dubious. The second pair was discarded simply to reduce the total number to a round 100. The G 44 pair was chosen because it consisted of a Lebanese and an Iraqi whose social backgrounds were obviously very different from the European norm of the follow-up population.

Follow-up method

The follow-up was conducted in two stages. First a letter was sent asking permission to send a follow-up questionnaire. On the bottom of this letter was a slip which the proband was to fill in and return. A questionnaire was then sent to each proband who agreed to take part in the follow-up. There were four parts to the questionnaire

Form A	A general questionnaire on social and medical history
Form B	An Eysenck Personality Inventory
Form C	A list of probands whose current addresses were unknown (this was progressively shortened as the follow-up proceeded)
Form D	A questionnaire concerning possible recurrences of the epidemic illness, continuing symptoms and current state of health. This questionnaire, which was drawn up by Dr. Nigel Compston, Consultant Physician to the Royal Free group of hospitals, was sent only to the affected.

Examples of Forms A and D are included in Appendix B.

Of the women who did not reply to the initial letter or failed to return the questionnaire, those who lived in the Greater London area

were visited. They all filled in the questionnaire at this or (in one case) a second visit. In all the follow-up took a little over a year - roughly from September 1968 to September 1969 inclusive.

Follow-up results

98 of the 100 affected probands were located. Two of the 98 had died and 8 did not return their questionnaires despite reminders.

91 of the unaffected were located. None had died. 79 of the 91 returned completed questionnaires. One girl who was in New Zealand did not return the questionnaire but her parents filled in the objective parts of Form A on her behalf.

The number of pairs where both girls returned questionnaires was 71. As the parents were able to fill in the answers to the objective questions in Form A on behalf of the two affected who had died and the control who was in New Zealand, the number of completed pairs for these questions is 74.

Mortality among the affected

The two dead in the affected population had both committed suicide - one in 1967, one in 1968. The following biographies were completed with the help of relatives and friends.

ANN (Case P 2 A)

Ann was born in 1937 to an English country vicar and his wife. She was the third of six children, the others of whom have had reasonable health and success so far in life. The father, the proband and one sib suffered from both asthmas and eczema, one other sib from eczema. There was no psychiatric history in the family though the father was described by one of his daughters as very restless and impulsive, "when I was 15 we had lived in 15 different houses".

As a small child Ann lost the tips of two fingers in a mangle. She suffered from some interruption of her schooling because of her asthma and because of her father's frequent moves. She failed the 11-plus but a grammar school was persuaded to accept her, apparently because the other two girls in the family were both at grammar schools and doing well.

At grammar school Ann was academically and socially unsuccessful. "She did not mix with others and would not join in any games". A lot of time she was off ill, sometimes with asthma, sometimes with non-specific complaints that her sister felt were due to her dislike of school. "She could make herself ill quite easily". At 16 Ann left and for the next 18 months did a series of half a dozen jobs looking after children. She never stayed in any of these for more than a few days: she either rang up her father to fetch her or just turned up at home. She applied for a great man more jobs but either failed to get to the interview or failed to get the post.

During this period Ann's morale and health both deteriorated and she began to complain of increasingly severe back pain. She had had this since the age of 14 and even worn a brace for a year. Now, aged 17, she was admitted to hospital. X-rays were "considered to indicate osteo-chondritis" and she was treated by three months rest in bed on a cast.

At the age of 18 Ann was accepted for nursing training by the Royal Free where one of her sisters was already a student nurse. Within a fortnight of her arrival the 1955 epidemic had broken out and within a further fortnight she had become the third of the students in the Preliminary Training School to go down with the illness. She complained of malaise, dizziness, palpitations, headache, nausea, stiff neck and sore throat. There were no abnormal neurological signs, her condition gradually improved and she was discharged after an in-patient stay of three weeks. She was a mild case by the standards of the epidemic.

Ann remained at the Royal Free for a further year but was not very happy. Every time she had to change wards there was an emotional crisis and when her sister was transferred to a different hospital in the group she was so disturbed that she made a suicidal gesture and had to be sedated. After the Royal Free she tried another hospital but there too things went badly. At this time she attended a psychotherapist for three months.

At 20 Ann suddenly became very religious. She went to a church college to be trained as a moral welfare worker and, thanks to a good

relationship with the principal, completed the two-year course successfully. She was less successful in the jobs that followed, being apt to run away if she was left to face responsibility on her own. She made several suicidal attempts as a result of which she was admitted to the local hospital. According to her sister she told extraordinary lies to the doctors about her parents and to her parents about the doctors. After some months of this she relapsed into her teenage pattern of applying for jobs and not going to the interviews or, if she got to the interview, not getting the job or, if she got the job, not staying in it for more than a few days. She never really worked in the remaining 7 years of her life.

During this period Ann had constant psychiatric support and, for the whole of the last year, was a resident in a psychiatric convalescent home. It was there that she formed her first relationship with a man of her own age - previously all her successful friendships had been with older women. Ann's sister considered it unlikely that the relationship had been consummated as Ann had always been very inhibited about sex, "indeed disgusted by the whole idea". Whatever the nature of the relationship, Ann was extremely upset by its ending. She took an overdose of sleeping pills in a situation where it is probably that she expected to be discovered fairly quickly: in fact she was not found for two days.

Monica (H 15 A)

Monica was born in 1935, the elder of two daughters of a German publisher. She had no memory of her mother who deserted her father in the war and was divorced by him in 1943. The father remarried (he had a son by this wife): Monica apparently always made clear her resentment of her stepmother.

By her account Monica had rheumatic chorea aged 5 (which led to her blinking a lot till the age of 10) and tuberculosis of the lungs aged 6 (as a result of which she was in a sanatorium for a year). Her father, on the contrary, wrote that up to the age of 16she was never in hospital and never away from home for more than a month.

At 18 Monica arrived in England as an au pair girl. The family she worked for found her "in some ways very satisfactory but not very stable - prone to depression". She was keen to do nursing and a year later began her training at the Royal Free. She fell victim to the epidemic at the end of August 1955 being among the

first of the cases at the Hampstead branch. She was badly affected: her summary is one of the sixteen marked 'Severe' in the series prepared for the Medical Staff Report and her total time off work was 9 months. Initially she complained of practically every symptom in the Medical Staff Report's list: sore throat, malaise, headache, depression, pain in the back and limbs, stiff neck, dizziness, vertigo, lassitude, abdominal pain, parasthesiae, nausea and vomiting. During her admission the list lengthened: blurred vision, frequency of micturition, incontinence, photophobia, subcostal pain, pain under the jaw, twitching of the limbs, paraplegia and anaesthesia. For two weeks in mid-November she ran a temperature of 101-102°F.[1] During this period she developed nystagmus, pain below the tips of both scapulae, subcostal and suprapubic tenderness, a left-sided glove and stocking anaesthesia (which gradually resolved over the next three months), a flaccid paraesis of the left arm and right leg and a rigid weakness of the left leg (the reflexes in this leg were noted to be diminished). At the end of November she had an attack of diaphragmatic spasm and breath-holding after which she was "uncommunicative and incontinent". More attacks followed: in between attacks she appeared perfectly well. By January 1956 the attacks were being diagnosed as hysterical[2].

Once recovered from the illness Monica returned successfully to her nursing and in the next two years she only had 31 days sick leave. After qualifying she worked as a staff nurse in another hospital for a year then went home to Germany for three months before emigrating to Australia.

In Australia Monica worked in two hospitals for a total of 15 months. In 1961 her hemi-paraesis reappeared and she was in hospital for six months. She was initially diagnosed as suffering from "a post-meningo-encephalitic state and anxiety-depression". Her physical disability

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1 There is no comment on this in the clinical notes but her nursing records contain a letter dating from the next year when she had reported ill with a pyrexia. In this the doctor says "She did this (i.e. ran a temperature) when she had the 'plague' and was found to be cooking it. The ward sister stood over her yesterday and it was normal so I think she is doing the same thing again here".

2 Monica is No. 10 in the series of 16 severe cases discussed in the section on the Royal Free epidemic: three charts reproduced as part of Fig. 2 give the picture of her sensory disturbance.

was finally considered to be hysterical. During the next year she worked as a laboratory assistant. There were two more admissions during this period, this time to psychiatric units. In 1963 she met and became engaged to an Englishman who lived in the Solomon Islands. She flew there, married him and left him all within six weeks, the marriage being annulled later the same year.

By the end of 1963 Monica was working as a matron in a boys' school in Australia. She was having epileptiform fits which she said were due to cerebral malaria contracted in the Solomons. The fits became so frequent that within a month she had been discharged from her post. The next two jobs she lost in a matter of days because of slurred speech and an ataxic gait.

In early 1964 Monica was admitted to hospital after collapsing at Sydney Central Railway Station. The following abnormalities were noted on physical examination : a lurching gait, slurred speech, concentric constriction of the visual fields, intermittent weakness of the left arm and leg and hypoaesthesia of the left leg. The physician who examined her considered her co-operation poor, noted that her reflexes were sluggish but symmetrical and her plantars flexor. He considered her symptoms "almost entirely hysterical although an underlying neurological lesion or drug intoxication could not be excluded". One of her fits at this time was described as "consisting of full flexion of the trunk with purposive movements of both limbs and incessant screaming".

From the general hospital in Sydney Monica was transferred to a psychiatric unit where she stayed for the next seven months. She was diagnosed as an hysterical personality disorder and considered "extremely manipulating and dependent". She had several false starts at working before deciding to return to England and the Royal Free Hospital.

In 1965 Monica settled into the Royal Free doing first relief duty then night duty. Through 1966 she worked satisfactorily and appeared in reasonable health. In 1967 she was in Sick Bay for a week with aching limbs and general malaise. The diagnosis was Bornholm's Disease but an episode of facial spasm was considered hysterical by the three doctors who observed it. At the end of this year Monica was sent on a sister tutor course. She moved into a flat with two other nursing sisters who were also taking the course. It was clear from the start that she was so anxious and confused that she could not cope either with the course or with her share of the household chores. The

amount of Tuinal she was taking each night went steadily up. At the end of the term she sat an examination: the paper she wrote was completely off the point and she failed. At this she developed abdominal pain and was referred by her general practitioner to a physician who admitted her for ten days. The diagnosis was anxiety state and erythrocyte auto-sensitisation, the latter in explanation of the bruises that appeared mysteriously on her face and body. No cause was found for her various aches and pains.

Monica was now very depressed and talking of suicide. She managed to start her second term in January 1968 but by the beginning of February she was obviously intoxicated with barbiturates nearly all the time. Her flatmates had to dress her in the morning - she would put her clothes on back to front if she had to dress herself. She started having fits at night and a series of fits at the end of February led to her admission to a local hospital. One of the girls in the flat moved out because Monica had become too much, the other looked after her for a few days while her admission to a psychiatric unit was arranged. This flatmate visited Monica a fortnight after her admission. She was quite composed and made a point of paying all her bills. A few days later she killed herself by taking an overdose of a drug whose exact nature was never determined.

Analysis of Form D

Of the 96 living probands who were located 88 completed and returned the questionnaires. Ignoring relapses in the year following the epidemic (which were mentioned by three) only six cases said they had had recurrences of the epidemic illness. Two had become chronic invalids (G3 and G12), the other four reported isolated relapses in 1958 (two), 1961 and 1962.

All but ten said they had, in general, felt well. Three of these ten said they had become fit in the last few years. Fourteen felt their current level

of activity was below the level of 'positive health' in the sense of playing physically demanding games.[1] So the majority of cases in the group - something between 80% and 90% according to definition - have not suffered any impairment of function either from the illness or from its recurrence or from any other illness.[2]

On the other hand a very high incidence of individual symptoms was reported:

Giddiness, vertigo or loss of balance	34 (38%), persisting in 20 (23%)
Blurred or double vision	23 (26%), persisting in 14 (16%)
Weakness in the limbs: cramp or muscular spasm in the limbs, pins and needles (more than momentary) in the limbs	63 (71%), persisting in 51 (58%)
Headache (in contrast to before the illness)	44 (50%), persisting in 37 (42%)
One of the above symptoms in persistent form	64 (73%)

Comment on Form D analysis

There is a paradox here: the illness rarely recurs or impairs health, but some of its symptoms persist in the majority of cases. The paradox can be resolved if the symptoms are not regarded as indicators of the

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1 Two probands did not fill in the back of the form (which concerned current health). Neither had had a recurrence of the illness nor other ill health.

2 One of the cases reporting a limitation of activity specifically stated that this was mostly due to asthma and bronchitis.

epidemic illness but as a collection of the minor ills that the flesh is heir to. The incidences do not seem too high for this explanation: the very high figure for manifestations of one sort or another in the limbs probably reflects the fact that three questions were devoted to this topic as against one to each of the others. Judging by the instances where the questionnaire was annotated the threshold for answering 'yes' was low: the question on giddiness was answered 'yes' by a woman who wrote alongside "very occasionally when getting up from bending down". The question on defective vision affirmatively by another who added "no control over eyes if tired or run down". Several wrote "yes, when tired" in answer to the query about pain, cramp or spasm in the limbs. Other women attached diagnoses to their positive responses which suggest that they did not connect their symptoms with the 1955 illness e.g. "Slipped disc this year", "varicosity of the right leg".*

So if the responses to the questions on symptoms are allowed to be non-specific and the long-term correlates judged to be best indicated by the replies to questions on relapse and general health, it seems fair to say that the illness was, in the great majority of cases, without significant sequelae.

The permanently affected

The two cases who had become chronic invalids wrote at length on the back of their questionnaires A and D, giving their views on their condition. The first (G 3 A) did not consider her ill health as entirely due to 'Royal

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*Farley et al. (1968) found that 33 in a sample of 100 normal women of child-bearing age had "clinically unexplanable neurological symptoms".

Free Disease'. She wrote as follows:

> 'I was born 6 months premature and weighed $2\frac{1}{2}$ lbs. My mother's health was very poor at this time. It was the district nurse's visiting that led to my hospital admissions and treatment as I could not walk. I have always had difficulty with muscular co-ordination and the teachers at school used to try and draw my mother's attention to this but it was accepted that I was weak and sickly and I knew I had to make the best of it. I am certain I am spastic and have been so from birth. I am also glad my mother was sensible enough to ignore it but Royal Free Disease on top has made my life such a hard one. My mother has been very disturbed by my illness and is inclined to blame me for it. Perhaps we are a 'sensitive' family. Mother - migraine, hay fever, nervous allergy reactions. ((Younger)) sister - sensitive to dyes etc. I have had migraine from age nine (untreated) and am inclined to have allergic rashes, now hay fever (gross). My brother developed mild migraine in the last ten years. My ((older)) sister emigrated to Canada but she had migraine and was considered delicate when young but outgrew it. This was why my mother quite naturally ignored mine.
>
> If I ever dare to live a 'normal life' I have a deep fatigue that rapidly develops into a full blown attack. It has prevented me from marrying as boy friends didn't like it and I couldn't cause distress to people I cared for deeply unless they chose to share it with me. Now I am disabled and permanently unemployed. I am better than I have ever been the last few months because I can go to bed when I need to and ((have)) learnt to make the best of it but I would wish ((sic)) my life on my worst enemy if I had one. Two hours shopping is my limit. The pain isn't bad because I rest before it has a chance to develop: still have headaches with vomiting etc. despite this"
>
> ((Double brackets are mine. C.M.E.))

The second case (G 12 A) wrote:

> "I have many comments but am too tired to make them now. Since the illness I think that I have been in hospital more times than I have stated overlead but cannot now remember when it was. Mainly it has been for investigation of various symptoms. All symptoms are due to the original illness but it was thought best to make tests to eliminate other causes"

Her symptoms she detailed as:

> "Increased sensitivity to pain
> Poor circulation and great difficulty trying to keep warm
> Increased risk of infections. If I meet someone with a mild cold that in them might last only 2 or 3 days, I am likely to catch it and be very ill for up to 6 weeks or more with very bad sore throat
> Difficulty of concentration
> Difficulty with sleeping due to cold and pain"

She added"I have moved to the south coast for the winter in hopes that I might have less pain if I was warmer but it is not any better, at times it is even colder here".

Both these cases had been admitted to psychiatric units. The first had been admitted twice: "(once) for diagnosis: second time no treatment given, no mental illness present". The second case had had psychiatric in-patient care "on several occasions over about two years. (No diagnosis) was made as far as I am aware. Treatment was pointless because all symptoms were due to Royal Free Disease and wrong treatment given with disastrous effects". This patient had finally had a "brain operation for relief of symptoms from Royal Free Disease".

The five other cases who felt that their health had been and remained impaired also wrote extensively in the 'Any Comments' section (the great majority of those taking part in the follow-up did not offer any comment at all).

> G 47 A "Since having the Royal Free Hospital illness I tire easily" "In 1966 (Sept) I had a mental breakdown (due to personal problems). I have just returned to the nursing profession after a two-year break".
>
> G 32 A "Since the 'Royal Free Disease' whether coincidental or not, I have had a continuous health problem, resulting in the inability to carry on with active bedside nursing. I have therefore had to return

to University.

In 1966 it was diagnosed in Canada that I had Thrombocytopenic Purpura and I was referred to Dr. X. At the time of examination he was interested in any virus infection that I may have had - at this time the 'Royal Free Disease'was mentioned.

In 1962 following a Spinal Fusion with Hip Graft, as a result of an accident whist on duty, the Canadian Workmen's Compensation Board decided to close their file on my case, as there was evidence of muscle damage and weakness that had occurred prior to the accident.

For my own interest I am anxious to know whether there could be a link in the two above problems and the 'Royal Free Disease'.

G 26 A "Once my husband remarked that he had 'married an invalid' and that I think is a fair judgement of my state of health. In order to 'hide' this I try to have my home organized in such a way that I can cope with social engagements and the entertaining that is part of my husband's way of life. It's the wretched tiredness which is difficult to cope with, especially as it comes on so suddenly. Also I have become rather too introspective, I don't know if that's just a question of age. I worry about the fact that I have 'slowed down' so quickly, I never discuss this with my husband, or anybody else for that matter, but I am worried about it and I often fear that I shall really become an invalid."

and also

"I get tired very quickly, not in the usual way, which is gradual, but quite suddenly. If I become over-tired I seem to take much longer than is normal to recover. I also become irritable".

L 16 A "I can do anything but I tire and lose breath quickly when running, playing games or rushing with housework. I get fits of feeling generally off colour, tired, headachy and depressed.

I don't recall headaches prior to the 'bug' but now am very prone to them. I have a really bad head with vomiting 1 to 2 times a month and several ordinary headaches in between. They seem to be brought on a) by pre-menstrual tension and b) I'm a chronic 'worry guts' and this brings them on also any unusual excitement i.e. an evening out.

My legs ache and go weak a) if I'm very tired
b) if I'm very cold.

As a teenager I remember always enjoying my life and work and having plenty of energy.

Now I get occasional fits of going 'mad' and working like a slave

in the house for a few hours but most of the time everything is 'too much trouble' and I am inclined to sit down and read or knit when I should be doing housework. I worry a lot, am sensitive to neighbours' remarks and often 'yell' at my children for next to nothing. I realize all the above is probably a matter of 'pulling myself together' and periodically try and do so but my 'good will' usually only lasts a week or so. I am usually better all round in the summer.

My breakdown I think was a result of everything getting on top of me. I missed my family in the south and can't'settle' in the midlands. I worried about 'making ends meet' and not being able 'to keep up with the Jones'. I also had ideas the neighbours were gossiping about me. I don't know if the 'bug' had anything to do with it but mentioned I had had it to Dr. X at X. Hospital when I was a patient there two years ago. I still get fits of depression also periods of feeling 'All right with the world'".

H 3 A "In August 1967 I entered Lawn Rd Branch of the Royal Free Hospital for investigations for increased weakness of the right leg and pain in left hip and lower back. This was an unfortunate experience as I was told I was suffering from hysteria and I do not want the experience repeated.

I am quite unable to take part in any sport now."

Analysis of Form A

1. Parents (Questions 1 - 3)

There is no difference in parental data between the two groups when they are examined for:

Date of birth of father
Date of birth of mother
Difference between ages of father and mother
Nationality of father
Social class of father
Health of surviving parents
Whether mother worked after marriage or not

The figures for social class are worth giving in full as they could, if

different, have affected such factors as fertility.

Social class (as in MRC Occupation Code)	Affected	Controls
1	7	5
2	26	24
3	32	34
4, 5	7	8
	(2 with no fathers)	(3 did not answer the question on father's occupation)

There is a difference (though not a statistically significant one) in the number of parents in the two groups who died prior to the 1955 epidemic. The affected group had lost 12 fathers and 5 mothers by the beginning of 1955, the controls only 6 fathers and 2 mothers. This compares with 16 fathers lost since then in each group and with 7 mothers by the affected, 5 mothers by the controls. If the groups are examined as to adequacy of parental background in general there are small differences in the same direction. Two in each group were adopted but one of the affected had been adopted not into a family but by a single woman. One of the affected was illegitimate and had no father in the home. The figures for pre-1955 parental insufficiency could be totalled as follows:

	Affected	Controls
Deaths up to 1955		
Fathers	12	6
Mothers	5	2
No father	2	0
'Score'	19	8

The number of parents considered to be in less than good health is the same in the two groups. Both groups reported ill health in mothers at a higher rate than in fathers:

	Affected	Controls	Together
Father in less than good health	29%	27%	28%
Mother in less than good health	40%	35%	37%

2. Other factors in early life (Questions 4 - 7)

The affected had fewer sibs than the controls, 145 against 170. The difference is not statistically significant. Only children are equally frequent in the two groups (12 in each).

Separations from parents before the age of 16 were also equally distributed between the two groups:

	Affected	Controls
Never separated from parents for as much as 1 month	34	36
Separated for a month or more but less than a year	25	24
Separated for a year or more	13	13

In the last category there were 6 affected (as against 2 controls) who had been separated from their parents for more than 5 years, a difference that might be thought of interest.

Data were also obtained on parental separations and divorces (Questions 6 and 7):

	Affected	Controls
Parents separated	7	3
Parents divorced	8	8

These figures refer to the 1968/69 parental situation. There is no information as to the situation in 1955.

3. Health up to the age of 16 (Questions 12 - 22)

The answers to these questions are best tabled.

	Affected	Controls
Answering 'no' to the question "Were you healthy as a small child (up to 6)?"	12	8
Answering 'yes' to the question "Were you nervous as a small child (up to 6)?"	14	15
Answering 'yes' to the question "Have you ever walked in your sleep?"	14	13
Answering 'yes' to the question "Did you ever go off your food for a day or two?"	24	16
Answering 'yes' to the question "Were you ever taken to a Child Guidance Clinic?"	2*	0
Average number of times in hospital to the age of 16	1.2	1.1

*Two of the affected did not answer this question

Also asked in this section were a series of questions (Questions 15 - 19) about the frequency of headaches, fainting, stomach ache, nausea and vomiting around the age of 16. The answer to each of these questions was made by ringing one of the following

Never - Occasionally - Sometimes - Often.

The idea was to see if there was a tendency for the affected to ring the 'Often' response more frequently than the controls. In fact the 'Often' column was rarely used and was used equally by both affected and controls (a total of 14 responses by each group). Scoring the responses as 1 for

'Never', 2 for 'Occasionally', 3 for 'Sometimes' and 4 for 'Often' there was equally no difference between affected and controls, the means for the two groups being 8.7 and 8.5 respectively.

4. Marriage and children (Questions 24 - 25)

More of the controls are married and they have produced a considerably greater number of children. The higher fertility is a matter of not only the group as a whole but of the individual marriage. The difference in the total number of live births is significant at the 5% level.

	Affected	Controls
Number ever married	50	57
Number now separated	1	2
Number now divorced	5	3
Legitimate children	82	129
Illegitimate children	4	0
Children born alive but no longer surviving	3	2
All live births	89	131
Mean number of children per marriage	1.8	2.3
Mean age of probands at marriage	25.8	24.8
Mean number of children per 10 years of marriage	1.9	2.3

The affected have adopted 4 children as against 3 adopted by the controls. They are not fostering any children whereas the controls are fostering three.

Both groups have improved their social status by marriage(cf. Table of Parental Social Class on p. 58):

Social Class of husband	Affected	Controls
1	15	18
2	13	20
3	19	15
4	0	2
(Question not answered	3	2)

5. Medical and psychiatric history since the epidemic (Questions 26 - 31)

Five of the affected said they were not completely fit now (as against one control). Five more said they were fit but qualified the answer (as did 3 controls).

Subtracting the admission for the 1955 epidemic illness the affected had still been in hospital more times since the age of 16 than the controls. They had stayed in longer on each occasion.

	Affected	Controls
Average number of hospital admissions	2.14	1.32
Average total period in hospital in weeks	5.25	2.89
Average stay in hospital per admission in weeks	2.45	2.18

The difference in hospital admissions is statistically significant at the 1% level.

Question 28 "Would you describe yourself as nervous?" was answered 'yes' by 16 in each group. However 13 of the affected as against 7 of the

controls had at one time or another consulted a psychiatrist professionally. Six of them (as against 2 controls) had been in-patients in psychiatric units.

Additional data on the 1955 epidemic

One of the affected wrote on the back of Form A as follows:

"I feel I must be honest. Though the illness apparently lasted for over three months in my case, I had actually recovered quickly but prolonged my stay in hospital by 'cooking' a pyrexia with cigarettes and hot-water bottles. I can only explain it as a love of the attention I was receiving and a slight apprehension at going back into the outside world after such a long period of security.

I have always been very sorry about doing this but have never told anyone before"

Analysis of Form B - the Eysenck Personality Inventory

This personality inventory scores on three axes - neuroticism (N), introversion-extroversion (E, the more extrovert the higher the E score) and 'lies' (L). Eysenck recommends that questionnaires with an L score of 5 or more be discarded (Eysenck and Eysenck (1964)). Accordingly the 5 pairs in which one proband had an L score of 5 were left out of the analysis. The remaining 66 pairs yielded the following figures:

	Affected	Controls
Mean N score	12.2	10.3
Mean E score	13.4	13.2
Mean L score	1.74	1.77

The difference between the N scores is significant at the 5% level. (It is also significant if the high L scores are left in the analysis).

Comment on the results

The proponents of an organic explanation of the 1955 epidemic can accommodate all the results of the follow-up without much difficulty by

postulating an hysterical fringe to the epidemic. The following comments are made on the assumption that the hysterical hypothesis is the correct one: the organicist can read them as referring to a minority population of hysterics that attached itself to the true epidemic. Some of the results do not even require this concession by the organicist, they can be regarded as random or as consistent with an encephalitic illness.

1. Sick leave before the epidemic. This result suggests that a minority of the affected had had an unusually high rate of sick leave before the epidemic. The majority of both affected and controls had hardly any sick leave at all. To some extent this is a reflection of the fact that a large number had been working at the hospital for less than six months and so not had time to acquire a significant record. The result can only be said to indicate that for a few of the affected there is evidence of either a) actual ill health or b) a low threshold for reporting sick before the epidemic.

2. The two suicides. There is good evidence that Ann had a seriously disturbed personality before the epidemic and some evidence for this in the case of Monica too. The subsequent histories are consistent with a diagnosis of severe personality disorder.

3. The two chronic invalids and the five with permanently impaired health. The accounts of themselves supplied by these probands are consistent with a diagnosis of hypochondriasis i.e. with a personality disorder in which the leading feature is continuous ill health of a pattern that does not suggest any organic diagnosis.

4. Parental death or absence before 1955. Most psychiatrists believe that parental death or absence in early life has a damaging effect on personal development. This belief reflects current theories of psychological development and is inherently reasonable though the evidence for it is far from overwhelming (Birtchnell (1970)). There is inequality in the expected direction between affected and controls but it is not statistically significant.

5. The probands' perception of ill health in their parents. The probands considered that 37% of their mothers were in less than good health as against 28% of their fathers. Considering that the fathers were in fact

dying much faster than the mothers - a total of 52 fathers were dead as against 19 mothers - it seems odd that so many more of the surviving mothers were in poor health. It could be that the amount of ill health in the elderly male and female is much the same but that there is a much lower threshold for the perception of ill health in female to female communication than in male to female communication. This is of some interest in relation to the greater liability of exclusively female populations to attacks of mass hysteria.

6. Number of sibs. The fertility differential in favour of the controls' parents, though not statistically significant, suggests the possibility of a genetic factor at work in the significantly different fertility of controls and affected.

7. Separations from parents. Most psychiatrists believe that long separations , like parental deaths or permanent absences, are damaging to the developing personality. The failure to find any correlation in this study is disappointing to those who hold this view. The only crumb of comfort lies in the excess number (6 against 2) who had suffered separations of 5 years or more.

8. Questions on health round the age of 16. Most of these items are taken from a questionnaire given to school-girls involved in an epidemic of overbreathing (Moss and McEvedy (1966). Unpublished data). In that investigation it was discovered that there was a tendency for a disproportionate number of the affected to answer 'yes' to the question "Do you ever go off your food for a day or two?", but no tendency for the affected to admit to sleepwalking more frequently than the unaffected. The results in the Royal Free probands are consistent with these findings which suggest that sleepwalking is not as closely linked to other 'hysterical' traits as one might expect.

Also as expected is the finding that the two girls who attended a Child Guidance Clinic were in the affected group.

In the questions on general health which had the 'Never - Occasionally - Sometimes - Often' choice of answer the affected school-girls had shown a tendency to use the 'Often' column more frequently than the unaffected. This distinction is not found in the Royal Free population. The failure to find it could be taken as a point against the hysterical hypothesis. The defence would be that, whereas the school-girls were making a contemporary statement, the follow-up cases were trying to recall their state of health after an interval of twenty years. The situations are not really comparable. In addition there may be a

tendency such as exists in compensation neurosis to improve the assessment of health before an incident which is held to be responsible for current symptoms.

9. Marriage and children. Biological maturity in the female is reasonably assessed by reproductive behaviour. The difference of a year in age of marriage is not statistically significant but is consistent with the hypothesis that hysterical traits correlate with immaturity.

The significantly lower number of children could also be interpreted as evidence for this hypothesis.

10. Medical and psychiatric history since the epidemic. General health as measured by hospital admissions is significantly worse in the affected population. The difference in amount of psychiatric attention is also in the expected direction.

11. Pyrexias during the 1955 epidemic. Pyrexia over 100°F occurred in 4.5% of cases during the epidemic (Medical Staff Report). It is perfectly reasonable to consider this rate as due to sporadic illness unconnected with the epidemic. This is the view taken in Part I of this thesis. However the confession of 'cooking' by one of the affected in the follow-up and the similar evidence in respect of Monica (p.49, footnote) would seem to transfer this item to the hysterical side of the ledger.

12. The Eysenck Personality Inventory. The higher N score of the affected population (significant at the 5% level) is in accordance with previous findings on both hysterical patients and the populations involved in hysterical epidemics. Eysenckian theory predicts a higher E score as well but this has never been confirmed in practice. There is evidence suggesting that hysterical patients have a slightly below average E score while populations involved in hysterical epidemics have a slightly higher than average E score. There is thus a possibility that the extroversion score is related to excitability: the higher scorers being more easily excited but decaying back to normality rapidly, the lower scorers being more difficult to excite but once excited tending to become chronic. However discussion on this topic is really fruitless when the results are so clearly of no statistical significance (Ingham and Robinson (1964); Moss and McEvedy (1966); McEvedy et al. (1966)).

A study of an epidemic of vomiting in a university residential college (Cumming and McEvedy (1969)) for women showed that when the illness was equated with vomiting there was no difference in mean N score between the affected and unaffected (mean N scores of 12.2 and 12.4 respectively). The numbers involved were comparable to those in the Royal Free study: 91 affected and 74 unaffected. Within the

unaffected there was a group of girls who said that though they had not vomited, they had felt sick. This group had a mean N score of 12.9. If the nauseated group is transferred to the affected category the affected (vomited or felt nauseated) and unaffected mean N scores are 12.4 and 12.0. So even if the whole of the possible neurotic fringe is incorporated in the affected group the difference between the two scores is less than half a point. This suggests that in an illness which is basically random in respect of personality factors one is unlikely to obtain a difference in N scores of over a point, even when the neurotics are given the opportunity of defining themselves as ill.

Discussion

There is no reason to believe that young nurses are anything but normal representatives of their age group. It is therefore important to distinguish between the meaning of the word 'hysteria' in the context of an epidemic of hysterical behaviour and the word as used in ordinary medical practice.

It is reasonable to regard the threshold for hysterical behaviour as a characteristic that is distributed in a Gaussian way. The stress of everyday living cuts off the bottom few per cent of the female distribution: this small minority supplies the medical profession with its classical (pathological) hysterics. The 8 or 10 per cent just above this line may intermittently behave hysterically under stress. The remainder of the population will be able to inhibit emotional reactions so that their behaviour remains within the accepted limits of the society they live in. By definition the affected in an hysterical epidemic are not hysterics of the pathological type: the attack rates are too high. The affected group contains a majority of normal women, a number who have a tendency to behave hysterically under stress and a small minority of 'pathological hysterics'.

In respect of pathological hysterics one has fairly clear ideas what to expect: unexplained illnesses, visits to psychiatrists, failures in social and sexual life. In respect of the normal women involved in an hysterical

epidemic it is difficult to hypothesise anything other than a tendency to have the same deficiencies as the pathological minority.

The follow-up was carried out in the expectation that the pathological hysterics would occur in the affected group, an expectation that seems to have been satisfactorily met. It was also hoped that some features would be discovered to distinguish the normal women in the affected population from the controls. It would appear that there are such features: the affected population as a whole is more neurotic (as defined by the E.P.I.), has poorer health (as defined by hospital admissions) and lower fertility (as defined by the number of live births).

As already remarked the organicist can accommodate the results of the follow-up without much difficulty by postulating an hysterical fringe to the epidemic and by suggesting that the constitutionally less healthy were disproportionately attacked. There are only three real gains for the hysterical hypothesis:

1 The difference in N scores which seems too large to explain as a fringe effect

2 The fact that the objective characteristics of the affected population which suggest a neurotic element are most marked in those most severely affected <u>during</u> the epidemic i.e. the nuclear group clinically is probably the most neurotic.

3 The data on two 'pyrexial' patients indicating simulation.

The data supporting the second point are set out in Table V. The results are consistent except for the two self-assessment items.

(Table V is overleaf)

TABLE V

	Expected data. 11 controls	Expected data. 11 affected	Actual data. 11 severely affected
Parental deficiency before 1955 (1)	0 or 1	1 or 2	5
Health record before 1955.			
1. Hospital admissions to age of 16	12	13	17
2. Number of probands averaging more than 2 days sick leave a month	0 or 1	1 or 2	5
Health record as an adult			
1. Hospital admissions	15	23	34
2. Psychiatric attention	1	2	4 (2)
Marriage and children.			
1. Ever married	8 or 9	7 or 8	6
2. Mean age at marriage	24.8	25.8	27.7
3. Number of live births	19	13	10

	Expected data. 10 controls	Expected data. 10 affected	Actual data. 10 severely affected
Self-assessment.			
1. Appetite instability around the age of 16	2	3	2
2. Mean N score on the E.P.I.	10.3	12.2	12.1 (3)

(1) Scored on p. 58. The severely affected group's score includes one counted as fatherless because she was adopted by a single woman.

(2) Does not include one diagnosed as suffering from an hysterical illness while in a general medical unit.

(3) One severely affected scored 5 on the Lie scale. As her N score was 12 the mean score is the same whether she is included or not.

I personally would like to base the argument for the hysterical hypothesis on the data set out in Section I and accept that the follow-up is only of interest to those who find the hysterical hypothesis credible. For those who do accept this premise the follow-up provides evidence that the population involved in an hysterical epidemic is less healthy, less fertile and more neurotic than the uninvolved population. These conclusions may seem banal but at least they represent a beginning to a subject that deserves more study than it has so far received.

SUMMARY

I The uneven sex incidence (more than 10 females for every male) suggests that mass hysteria is a reasonable explanation of the Royal Free Epidemic of 1955.

The 'prodromal symptoms' were all complaints of a subjective type similar to those seen in an epidemic of overbreathing among schoolgirls.

The sensory dysfunction in the severe cases was of the 'glove and stocking' type classically associated with hysteria.

The motor disturbances included cases of flaccid paralysis with normal reflexes and of spastic paralysis with diminished reflexes, associations normally considered to indicate hysterical loss of function.

The 'action potential bunching' seen in the electromyograms of some cases is a physiological finding, indicating tremor.

The laboratory investigations were normal.

There was no mortality and, in the two cases that died of other causes, no evidence of any pathological process at post-mortem.

The spread of the epidemic was social, not geographical. Social groups not consisting of young adult females were effectively immune.

These facts would appear to make mass hysteria a much more likely explanation of the epidemic than the virus infection of the central nervous system postulated at the time.

II Outbreaks similar to the Royal Free epidemic have always been reported on as probably due to viral infections of the central nervous system.

One of these epidemics (in Los Angeles) was probably an hysterical reaction to an influx of poliomyelitis cases by the nursing staff of a fever hospital.

A second (in London) was probably an artefact created by the over-examination of a nursing community under threat of poliomyelitis.

It is suggested that ten other outbreaks are best explained by one or both of these mechanisms.

It is suggested that the criteria for diagnosing the postulated viral infection are so vague that reports of sporadic cases are more likely to be a reflection of the physician's experience of the illness in epidemic form than true observations of illness.

Myalgia nervosa, on the analogy of anorexia nervosa, would appear a better term for the syndrome than 'benign myalgic encephalomyelitis'.

III Using the administrative records of the Royal Free Hospital a list of 100 pairs of nurses was drawn up. Each pair consisted of one nurse affected in the 1955 epidemic and one nurse of the same age who was equally exposed but unaffected.

During 1968/69 ninety-eight of the affected pair members were traced. Two of them had committed suicide. Eighty-eight completed questionnaires on their state of health, all but ten stating they had been generally well since the epidemic.

The biographies of the two suicides and the complaints of those who have had chronically poor health since the epidemic suggest personality difficulties and hypochondriasis rather than organic illness.

Analysis of the 74 pairs in which both affected and control completed questionnaires indicates that the affected population is significantly more neurotic (as measured on the Eysenck Personality Inventory), less healthy (as measured by hospital admissions) and less fertile (as measured by the number of live births).

Analysis of these 74 pairs also yields differences that are not statistically significant but which suggest that vulnerability to hysterical contagion may be associated with lack of a parent in early life, appetite instability, delayed psychosexual maturation, and psychoneurotic difficulties in both early and middle life.

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APPENDIX A

Pair number	Year of birth Affected/Control	Country of origin if not U.K.	Both members of pair answering questionnaire
G1	1932		+
2	1933	UK/Danish	+
3	1933/34		+
4	1936		+
5	1936		+
6	1935		+
7	1937		+
8	1937		(1)
9	1930/32		+
10	1933/34	Jamaican/West Indian	0
11	1934		+
12	1930		+
13	1933		+
14	1935		+
15	1929		+
16	1929	German/UK	+
17	1932		+
18	1934		+
19	1931/33	Irish/Irish	+
20	1932/31	French/German	0
21	1933		+
22	1935		+
23	1936/35		+
24	1936/35		+
25	1931	Swiss/UK	0
26	1933/32	Irish/Irish	+
27	1936/35		+
28	1936/35		0
29	1935		+
30	1935		+
31	1935		0
32	1935/34		+
33	1936		+
34	1933/32		+
35	1934		+
36	1933/32		0
37	1935		+
38	1936		0
39	1933		+
40	1934		+

Pair number	Year of birth Affected/Control	Country of origin if not UK	Both members of pair answering questionnaire
G41	1933/32		0
42	1929/28		+
43	1930/31		+
45	1935	Indian/Indian	0
46	1936/35		+
47	1932		+
48	1935		+
49	1937/36		+
50	1937/36		+
L1	1932		0
2	1936		0
3	1936		0
4	1934		+
5	1930/32		+
6	1937/34		0
7	1932		0
8	1934/33		0
9	1933/34		+
10	1935		+
11	1935		+
12	1935		0
13	1936/35		0
14	1935		+
15	1931	Irish/German	+
16	1936/35		+
17	1936/35		+
18	1928/27		0
19	1928/26		+
20	1936/35		+
21	1934		+
22	1934		+
23	1934		+
24	1935/34		0
25	1935/34		+
H1	1933		+
2	1931		+
3	1933		+
4	1933/34		+
5	1935/33	Ceylonese/Ceylonese	+
6	1936		0

Pair number	Year of birth Affected/Control	Country of origin if not UK	Both members of pair answering questionnaire
H 7	1936		0
8	1936		+
9	1935		+
10	1935		0
11	1935		+
12	1936		+
13	1933		+
14	1935		+
15	1935	German/Swiss	(2)
16	1935		+
17	1935		0
18	1937		+
19	1935		0
P 1	1937		+
2	1937		(2)
3	1937		+
4	1936		0
5	1937		0
6	1937	UK/Irish	+
7	1935	Irish/UK	+

(1) Control member abroad: answers to objective questions obtained from parents.

(2) Affected member dead: answers to objective questions obtained from relatives etc.

APPENDIX B

FORM A

Please answer all the questions. Don't worry too much about details and don't leave any questions blank because you're not sure of the exact answers. It doesn't matter whether your father was born in 1890 or 1891 or 1892, but we would like to know whether it was about 1890 or about 1910. Similarly if you can't remember whether you were four months or eight months in a job put six months; if you leave it blank we have no way of knowing whether it was ten days or ten years.

Where there is a dotted line we want you to write in the answer. Where there are no dots ring one of the given answers; these are always printed in capitals.

If you feel that some of the questions need answering more fully to be properly understood by us, use the blank sheet of paper at the end headed "Any Comments".

CODE NUMBER

FAMILY HISTORY:

1. Father Born (year)..... Nationality at Birth.....Occupation.....

   Health: GOOD FAIR INDIFFERENT BAD • ALIVE DEAD Year of death.....

2. Mother Born (year)..... Nationality at Birth.....

   DIDN'T WORK AFTER MARRIAGE. WORKED AFTER MARRIAGE Occupation.....

   Health: GOOD FAIR INDIFFERENT BAD • ALIVE DEAD Year of death.....

3. If you were adopted tick this box ☐ and state age of adoption.....
   The questions above will then be taken to apply to your adopted parents.

4. Brothers and Sisters Please give in order of birth and include all who lived a year or more after birth.

	Year of birth	Year of death	
1.....ALIVE	.....	.....	MARRIED UNMARRIED
2.....ALIVE	.....	.....	MARRIED UNMARRIED
3.....ALIVE	.....	.....	MARRIED UNMARRIED
4.....ALIVE	.....	.....	MARRIED UNMARRIED
5.....ALIVE	.....	.....	MARRIED UNMARRIED
6.....ALIVE	.....	.....	MARRIED UNMARRIED

5. Before the age of 16 were you ever separated from your parents for:

   a month at a time YES NO
   6 months at a time YES NO
   a year at a time YES NO
   5 years at a time YES NO

   If one of your parents died or left home before you were 16, do not count this as a separation. What we are after is whether you were away from home, even if this only contained one parent.

   If you lost both parents before 16 tick this box ☐ and take the questions as applying up to the time of the second parent's death

6. Did your parents separate? YES NO

7. Did your parents divorce? YES NO

8. Were you born a British Citizen? YES NO

9. If not, state nationality at birth .....

10. Have you changed your nationality?... YES NO

11. If Yes state which nationality you have taken.....

PERSONAL HISTORY

12. Were you healthy as a small child (up to 6)? YES NO

13. Were you nervous as a small child (up to 6)? YES NO

14. Have you ever walked in your sleep? YES NO

As a young girl (around the age of 16):

15. Did you get headaches? NEVER OCCASIONALLY SOMETIMES OFTEN

16. Did you feel faint? NEVER OCCASIONALLY SOMETIMES OFTEN

17. Did you get stomach ache? NEVER OCCASIONALLY SOMETIMES OFTEN

18. Did you feel sick? NEVER OCCASIONALLY SOMETIMES OFTEN

19. Did you actually vomit? NEVER OCCASIONALLY SOMETIMES OFTEN

20. Did you ever go off your food for a day or two? YES NO

21. To the age of 16, how many times were you in hospital?.....

22. Were you ever taken to a Child Guidance Clinic? YES NO

23. CAREER: Please write a list of all the jobs you have done for a month or more. If you held different posts in one place, count them as one job: for example: 1) Royal Free Group (student nurse, S.R.N. sister)- 7 yrs. 2) Welwyn Garden City Hospital (sister)- 3 yrs. Working for an agency would count as one job. Put "part-time" in where necessary.

1.....

2.....

3.....

4.....

5.....

6.....

7.....

8.....

9.....

10.....

24. MARRIAGE: Please ring one of the following (two if you've remarried)

SINGLE MARRIED MARRIED & SEPARATED MARRIED & DIVORCED WIDOWED REMARRIED

Nationality of husband.....

Date of marriage:

Occupation of husband at time of marriage .....

Month.....

Occupation of husband now.....

Year.....

Age of husband now.....

Nationality of 2nd husband.....

Date of remarriage

Occupation of 2nd husband at time of marriage .....

Month.....

Occupation of 2nd husband now.....

Year.....

Age of 2nd husband now.....

25. Names and ages of children (in birth order)
(All births please. If you have adopted any children enter adopted in brackets).

1..... Age.....
2..... Age.....
3..... Age.....
4..... Age.....
5..... Age.....
6..... Age.....

26. MEDICAL HISTORY Please write a list of all your hospital admissions since the age of 16 - in order if you can. Give the diagnosis if you can. <u>Do not include admissions for childbirth even if the birth was complicated.</u>

1. Age..... for .....weeks. Diagnosis.....
2. Age..... for .....weeks. Diagnosis.....
3. Age..... for .....weeks. Diagnosis.....
4. Age..... for .....weeks. Diagnosis.....
5. Age..... for .....weeks. Diagnosis.....
6. Age..... for .....weeks. Diagnosis.....

27. **Are you physically fit now?** YES NO

28. **Would you describe yourself as nervous?** YES NO

29. **Have you ever seen a Psychiatrist?** YES NO

30. **Have you ever been treated as an inpatient in a Psychiatric Unit?** YES NO

31. If yes, fill in this list of admissions as you did the one above on physical illness.

1. Age..... for.....weeks. Diagnosis.....
2. Age..... for.....weeks. Diagnosis.....
3. Age..... for.....weeks. Diagnosis.....
4. Age..... for.....weeks. Diagnosis.....
5. Age..... for.....weeks. Diagnosis.....
6. Age..... for.....weeks. Diagnosis.....

32. Have you been abroad (outside the United Kingdom or Eire) for more than three months? YES NO
If so, please give a list of the periods you have spent abroad.

1. Country..... for.....years .....months
2. Country..... for.....years .....months
3. Country..... for.....years .....months
4. Country..... for.....years .....months
5. Country..... for.....years .....months
6. Country..... for.....years .....months

33. If you live in England, Wales or Scotland - would you be willing to come to an interview at the Royal Free Hospital? (We would, of course, pay your travelling expenses).
YES NO

34. Any Comments ?

FORM D

CODE NUMBER.....

Since your original illness at the Royal Free Hospital

1. Have you had a recurrence of the whole illness(not just an individual symptom. ?) YES/NO

   If so approximately when .....

2. Have you suffered from "giddiness", vertigo or loss of balance ? YES/NO

   If so do such symptoms persist ? YES/NO
   If No when did they cease ? .....

3. Have you suffered from any defect of vision ? YES/NO
   a) Blurred vision YES/NO
   b) Double vision YES/NO

   If so do such symptoms persist ? YES/NO
   If NO when did they cease ? .....
   c) Do you wear glasses ? YES/NO

4. Have you experienced weakness of the limbs ? YES/NO
   a) permanent YES/NO
   b) intermittent YES/NO

   If so do such symptoms persist ? YES/NO
   If NO when did they cease ? .....

5. Have you experienced pain, cramp or muscular spasm in the limbs ? YES/NO

   If so do such symptoms persist ? YES/NO
   if NO when did they cease .....

6. Have you experienced more than momentary pins and needles or numbness in the limbs ? YES/NO

   If so do such symptoms persist YES/NO
   If NO when did they cease ? .....

7. Have you suffered from headache in contrast to before the illness YES/NO

   If so does the symptom persist ? YES/NO
   If No when did it cease ? .....

8. Has your capacity for physical activity been limited ? YES/NO

If so does the limitation persist ? YES/NO
If NO when did it cease ? .....

9. If your present level of activity is limited please indicate which of the categories below you are in:

a) Restricted activities in the home .....
b) Full activity in the home .....
c) Limited activity in the home .....
d) Normal activity in the home .....
e) Increased activity outside the home .....
(tennis, squash, skiing, swimming etc .....

10. Have you in general felt well ? YES/NO

If so do you continue to feel well ? YES/NO
If NO when did you feel unwell ?

APPENDIX C

1. Sick leave before the 1955 epidemic

Less than 1 day's sick leave per month	78 (81.5)	85 (81.5)	E 1 63
1 or 2 days' sick leave per month	12 (13.0)	14 (13.0)	E 2 26
3 or more days' sick leave per month	12 (7.5)	3 (7.5)	E 3 15
	E 4 102	E 5 102	EE 204

X^2 cell	1/4	.1503
	1/5	.1503
	2/4	.0769
	2/5	.0769
	3/4	2.7000
	3/5	2.7000

Total X^2 = 5.8544 Degrees of freedom = 2

X^2 required for p of 0.05 is 5.99.

2. Number of children

Pairs where both married

Win = the control having more children

Pair number	Affected. No. of children	Controls. No. of children	Win	Lose	Draw
G 1 G1	0	3	1		
2 2	0	3	2		
3 3	0	3	3		
4 4	1	2	4		
5 5	0	0			1
6 6	2	0		1	
7 7	0	2	5		
8 8	3	4	6		
9 9	0	1	7		
11 11	3	2		2	
12 12	0	0			2
13 13	1	1			3
14 14	2	4	8		
15 15	0	3	9		
16 16	0	0			4
17 17	2	2			5
18 18	3	5	10		
19 19	2	4	11		
21 21	2	2			6
22 22	0	1	12		
23 23	1	4	13		
24 24	2	3	14		
26 26	1	5	15		
27 27	0	0			7
29 29	0	0			8
30 30	0	1	16		
32 32	0	3	17		
33 33	0	0			9
34 34	1	2	18		
35 35	2	2			10
37 37	2	4	19		
39 39	0	0			11
40 40	1	4	20		
42 42	0	0			12
43 43	1	0		3	
46 46	1	2	21		
47 47	0	0			13
48 48	2	3	22		

Pair number		Affected. No. of children	Controls. No. of children	Win	Lose	Draw
G 49	G49	2	(2 adop.)		4	
50	50	4	3		5	
L4	L4	1	1			14
L5	5	0	0			15
L9	9	0	1	23		
L10	10	2	0		6	
L11	11	5	2		7	
L14	14	2	2			16
L15	15	0	4	24		
L16	16	2	0		8	
L17	17	1	4	25		
L19	19	1	2	26		
L20	20	2	3	27		
L21	21	0	2	28		
L22	22	0	2	29		
L23	23	2	0		9	
L25	25	0	2	30		
H1	H 1	0	0			17
H2	2	2	0		10	
H3	3	0	5	31		
H4	4	1	4	32		
H5	5	2	3	33		
H8	8	4	2		11	
H9	9	2	2			18
H11	11	2	0		12	
H12	12	3	0		13	
H13	13	1	0		14	
H14	14	0	3	34		
H15	15	0	2	35		
H16	16	1	2	36		
H18	18	3	0		15	
P1	P1	4	3		16	
P2	2	0	0			19
P3	3	0	2	37		
P6	6	2	0		17	
P7	7	3	0		18	
		89	131			

$\frac{(m-n)^2}{m+n} = \frac{(37-18)^2}{55} = 6{\cdot}5.$ As this exceeds 5.02 the result is significant at the 5% level.

3. Admissions to hospital since the age of 16

Pair number	Controls. No. of admissions	Affected. No. of admissions	Control win	Affected win	Draw
G1	1	1			1
2	1	2		1	
3	0	0			2
4	3	0	1		
5	1	1			3
6	1	3		2	
7	0	6		3	
9	5	0	2		
11	1	0	3		
12	1	1			4
13	1	3		4	
14	0	2		5	
15	1	0	4		
16	3	6		6	
17	1	1			5
18	0	5		7	
19	0	2		8	
21	1	0	5		
22	3	6		9	
23	1	1			6
24	2	1	6		
26	0	0			7
27	1	3		10	
29	1	2		11	
30	0	2		12	
32	0	1		13	
33	0	4		14	
34	3	2	7		
35	1	0	8		
37	1	4		15	
39	4	2		16	
40	1	1			8
42	1	1			9
43	2	0	9		
46	0	4		17	
47	1	1			10
48	3	4		18	
49	1	3		19	

Pair number	Controls. No. of admissions	Affected. No. of admissions	Control win	Affected win	Draw
G50	4	1	10		
L4	1	6		20	
5	0	2		21	
9	0	0			11
10	0	1		22	
11	3	1	11		
14	0	5		23	
15	0	5		24	
16	0	1		25	
17	0	1		26	
18	0	5		27	
20	6	1	12		
21	0	2		28	
22	1	5		29	
23	0	2		30	
25	0	6		31	
H1	0	2		32	
2	3	0	13		
3	6	2	14		
4	4	1	15		
5	1	3		33	
8	1	1			12
9	2	2			13
11	1	0	16		
12	1	1			14
13	0	5		34	
14	4	4			15
16	1	2		35	
18	1	3		36	
P1	0	1		37	
3	2	4		38	
6	3	0	17		
7	2	2			16

$\frac{(m-n)^2}{m+n} = \frac{(38-17)^2}{38+17} = 8.02.$ As this exceeds 7.88 the result is significant at the 1% level.

A win is when the affected scores higher

4. EYSENCK PERSONALITY INVENTORY - N Scores

Pair	Affected	Control	Win	Lose	Draw
G 1	15	14	1		
2	2	6		1	
4	14	11	2		
5	13	5	3		
6	13	4	4		
9	12	2	5		
11	1	8		2	
12	7	5	6		
13	9	17		3	
14	16	10	7		
15	15	14	8		
16	3	14		4	
17	6	10		5	
18	15	7	9		
19	16	20		6	
21	14	12	10		
22	12	3	11		
23	2	16		7	
24	8	15		8	
26	15	12	12		
27	10	7	13		
30	15	4	14		
32	19	6	15		
33	11	12		9	
34	8	10		10	
35	12	21		11	
37	7	19		12	
39	10	6	16		
40	16	14	17		
42	17	9	18		
43	15	9	19		
46	13	17		13	
47	9	5	20		
48	14	6	21		
49	15	11	22		
50	15	6	23		
L4	15	11	24		
5	16	16			1
9	20	7	25		
10	1	11		14	
11	10	11		15	

Eysenck Personality Inventory - N scores

Pair	Affected	Control	Win	Lose	Draw
L15	23	5	26		
16	21	20	27		
17	9	12		16	
19	19	8	28		
20	10	17		17	
21	5	8		18	
22	12	22		19	
25	16	7	29		
H1	10	8	30		
2	12	9	31		
3	11	10	32		
4	13	6	33		
5	16	10	34		
8	16	12	35		
9	7	4	36		
11	11	9	37		
12	13	8	38		
13	13	14		20	
14	21	7	39		
16	14	11	40		
18	6	9		21	
P1	10	8	41		
3	13	19		22	
6	10	10			2
7	18	3	42		

$\frac{(m-n)^2}{m+n} = \frac{(42-22)^2}{42+22} = 6.25.$

As this exceeds 5.02 the result is significant at the 5% level.

Liars among affected					
G3	12	11	43		
G29	8	7	44		
L14	6	17		23	
Liars among controls					
G7	3	9		24	
L23	7	11		25	

$\frac{(m-n)^2}{m+n} = \frac{(44-25)^2}{44+25} = 5.25.$

As this exceeds 5.02 the result is still significant at the 5% level.