All the patients showed emotional symptoms reactive to stress. Intermittent delirious or subdelirious reactions were seen and the patients often showed evidence of increased cerebral dysfunction during or just after dialysis. Assessment of mental status and previous personality was of value in understanding the responses to the illness and its treatment.

The role of the nursing staff is crucial, team approach in management is needed, the services of a medical social worker are valuable, and the psychiatrist has a role in treatment.

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REFERENCES

Cramond, W. A., Knight, P. R., and Lawrence, J. R. (1967). *Brit. J. Psychiat.*, **113**, 1201.
Gombos, E. A., Lee, T. H., Harton, M. R., and Cummings, J. W. (1964). *Ann. intern. Med.*, **61**, 462.
Goodey, J., and Kelly, J. (1967). *Lancet*, **2**, 147.
Johnson, W. J., Wagoner, R. D., Hunt, J. C., Mueller, G. J., and Hallenbeck, G. A. (1966). *Mayo Clin. Proc.*, **41**, 73.
Kennedy, A. C., Linton, A. L., Luke, R. G., and Renfrew, S. (1963). *Lancet*, **1**, 408.
Kennedy, A. C., Linton, A. L., Luke, R. G., Renfrew, S., and Dinwoodie, A. (1964). *Lancet*, **1**, 790.
Sand, P., Livingston, G., and Wright, R. G. (1966). *Ann. intern. Med.*, **64**, 602.
Schreiner, G. E., and Maher, J. F. (1965). *Ann. intern. Med.*, **62**, 551.
Shea, E. J., Bogdan, D. F., Freeman, R. B., and Schreiner, G. E. (1965). *Ann. intern. Med.*, **62**, 558.
Wright, R. G., Sand, P., and Livingstone, G. (1966). *Ann. intern. Med.*, **64**, 611.

Q Fever in Northern Ireland

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Q fever has a world-wide distribution, but Ireland, Norway, Sweden, Denmark, Finland, Iceland, Belgium, and New Zealand are said to be free of the disease (Ormsbee, 1965).

A serological survey carried out during 1950–1 and 1953 on human and cattle sera in the Republic of Ireland showed the absence of Q fever infection (Kaplan and Bertagna, 1955), while in Northern Ireland a serological survey of Belfast abattoir workers and patients in 1957 showed that there was no Q fever infection in these people (Murray, Dane, and Dick, 1958). Between 1957 and December 1965 serological tests carried out on patients in Northern Ireland who had pneumonia, influenza-like illnesses, and pyrexias of unknown origin did not reveal any Q fever infections. It was not until January 1966 that Q fever was first diagnosed in Northern Ireland. This report describes the results of investigations which followed.

Materials and Methods

Serological Methods.—Complement-fixation tests were performed by the technique of Bradstreet and Taylor (1962) with overnight fixation at 4° C and 2½ MHD_{50} of fresh guinea-pig complement. The antigen used throughout was the same batch of the Nine Mile strain of *Coxiella burnetii* (phase 2). Initially some tests were carried out in parallel with the Henzerling strain of *C. burnetii*, but higher antibody titres were obtained with the Nine Mile strain. In patients suspected of having persistent Q fever infection *C. burnetii* antigen (phase 1) was used. The optimal dilution of antigen was determined from a "chessboard" titration with patients' convalescent serum. Sera were inactivated at 56° C. for 30 minutes, while animal sera and those human sera which were anticomplementary were inactivated at 60° C. for 30 minutes. The titre of a serum was taken as the highest dilution showing complete fixation of complement. A titre of 1:8 or higher in a single specimen of serum was regarded as evidence of past infection with Q fever, and a fourfold or greater rise in antibody between acute and convalescent sera as evidence of recent infection. Patients' sera showing evidence of recent infection with Q fever were also screened and titrated when necessary against the following antigens: influenza virus types A, B, and C, parainfluenza virus types 1 and 3, respiratory syncytial virus, adenoviruses, psittacosis-lymphogranuloma agents, and *Mycoplasma pneumoniae*.

Isolation of C. burnetii from Milk.—Two-millilitre samples of milk were inoculated intraperitoneally into guinea-pigs. Two guinea-pigs were used for each sample, and five uninoculated guinea-pigs were maintained in adjacent cages as controls in a room used only for these experiments. Living *C. burnetii* had not been isolated or used in the laboratory before. Daily rectal temperatures were taken. All guinea-pigs were bled before inoculation and again four and six weeks later. The sera were tested for the development of Q fever antibody.

Results

Index Patient

A 21-year-old student nurse developed pneumonia on 3 January 1966 and was in hospital for eight days. Serological tests on her sera showed a rising titre of Q fever antibody. Immediately before her illness she had worked in a general surgical ward, so that infection from a patient seemed unlikely. However, between 4 and 18 December 1965 she had been on holiday at home on a farm in eastern Co. Down, where there were Friesian cattle and crossbred and Dorset Horn sheep. At that time on several occasions the nurse washed her sheepdog, which was soiled after bringing bits of sheep placenta into the house.

Farm Staff

The patient's sister (who was also a student nurse) and her father and mother had Q fever antibody in their sera. Both her father and mother had severe "influenza" in the autumn of 1965. In addition, 8 out of 11 workers on the farm had Q fever antibody in their sera and five of them had a history of "influenza" in the previous 18 months. The last influenza outbreak in Northern Ireland before this investigation was between January and March 1963, and no further cases of influenza were detected until January, February, and March 1966. The patient, the patient's family, and all but one of the farm staff drank the unpasteurized farm-bottled milk. Two veterinary surgeons who had attended pregnant sheep and cattle on the farm, and who had had their hands in the uterus of some of these animals, also had Q fever antibody in their sera.

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Farm Animals

There were 72 Dorset Horn ewes and 126 crossbred ewes together with 281 lambs and four rams in the flock. Two Dorset Horn rams and 60 Dorset Horn ewes had been imported from the South of England to this farm on 14 June 1962. Six ewes out of 16 tested (37.5%) had Q fever antibody in their sera. There were 135 Friesian cattle in the herd, of which 84 were milking cows. Eighty-three of these cows were tested and 10 (12%) had Q fever antibody in their sera.

The nurse's sheepdog became ill during January 1966, and Q fever antibody was present in a serum obtained from it two months later.

Milk and Milk Consumers

Though the herd of cattle was of high quality and was known to be free of tuberculosis and brucellosis, it was of considerable public health interest that one-third of the milk output from the farm (about 80 gallons (360 litres) a day) was sold as unpasteurized farm-bottled milk in the surrounding districts, the remainder of the milk going for pasteurization.

Milk samples obtained from four Friesian cows and two Dorset Horn ewes on the farm during March 1966 were inoculated into guinea-pigs. None of the guinea-pigs developed Q fever antibody. However, a sample of pooled cows' milk obtained from the farm bottling-plant during March 1966 when inoculated into six guinea-pigs caused illness and pyrexia in one and the development of Q fever antibody in two. The spleens of both animals were enlarged, and spleen smears when stained by Macchiavello's procedure showed numerous bright red coccobacillary structures. These tests showed that *C. burnetii* was present in the cow's milk. All the milk from this farm was promptly pasteurized.

The effect of drinking this infected milk was investigated by testing sera obtained from consumers of the farm-bottled milk who were traced in four adjacent small towns. The index patient, her family, and the farm staff were excluded from this group because of their known contact with infected livestock. The control group consisted of consumers of pasteurized milk who lived in the same areas. Sera were also obtained from 1,018 urban blood donors who attended the Belfast centre of the Northern Ireland Blood Transfusion Service. The results are shown in Table I.

TABLE I

No. of People	Rural		Urban
	Farm-bottled milk consumers	Pasteurized-milk consumers	Blood donors
Tested	123	100	1,018
With Q fever antibody	14 (11·4%)	5 (5·0%)	26 (2·5%)

It will be seen that in rural areas 11.4% of farm-bottled milk consumers and 5% of pasteurized-milk consumers had Q fever antibody in their sera compared with only 2.5% of urban blood donors. When the two groups of rural milk consumers were compared statistically the exact probability (double tail) was 0.098. With the χ^2 test, $\chi^2=2.88$ and with D.F.$=1$ then $0.10>P>0.05$, so no significant difference was found between the two groups.

Clinical Cases of Q Fever

Between 1957 and December 1965 the sera from 385 persons, including patients with pneumonia, pyrexia of unknown origin, and "influenza-like" illnesses, had been tested for Q fever antibody and were negative. In February 1964 an 18-year-old nurse developed pneumonia. Seven months later Q fever antibody was found in her serum, which was taken for the diagnosis of another illness, and later serum samples showed a falling titre of Q fever antibody. In retrospect this suggested that her pneumonia may have been caused by Q fever. She had always lived in Belfast and drank pasteurized milk and had never been in contact with farm animals or been outside Ireland, so it raised the question of whether she had been infected from a patient in the respiratory diseases ward where she worked. An imported case of Q fever was diagnosed in March 1965, when an ill 39-year-old man arrived in Northern Ireland from Israel. These two patients have not been included in the Northern Ireland data.

Sera sent to the Department of Microbiology are stored after testing and were available back to January 1958. The clinical data on 6,461 relevant virological request forms received during that period were reviewed and sera were selected from patients who had pyrexia, "influenza," or chest pain as symptoms. All these sera had previously been tested against other viruses but no diagnosis had been made. These tests were additional to those already described when only two patients with Q fever antibody were detected. The results of these tests and of other tests on sera received since the detection of the index case are shown in Table II. Two further patients had Q fever during 1967, so that 23 patients are now known to have had Q fever in Northern Ireland. Evidence of Q fever infection was not found before 1962. Ten patients had Q fever before the detection of the index case in January 1966, and the hospital case-notes of these patients were obtained and the clinical data reviewed. In most cases the final diagnosis was different from that suggested by the early clinical data given on the virology request forms. Q fever was not considered as a diagnosis in any of these patients.

TABLE II

Year	No. Patients Tested	No. with Q fever antibody	
		Titre not Rising (past infection)	Titre Rising (recent infection)
1958	36	0	0
1959	53	0	0
1960	82	0	0
1961	39*	0	0
1962	138	4	3
1963	131	6	1
1964	119	14	3
1965	171	18	3
1966	370†	31	11

* Sera from 1 January to 3 August 1961 not available.
† Sera from milk consumers, blood donors, veterinary surgeons, abattoir workers, and farm workers are excluded.

The first patient now know to have had Q fever in Northern Ireland was a 48-year-old County Down farmer who had pneumonia in February 1962.

The age and sex of the 23 clinical cases are shown in Fig. 1. Twenty patients (87%) were between 21 and 65 years old and the peak incidence was in age group 40–49 years. The youngest

FIG. 1.—Age and sex of 23 patients with Q fever.

patient was 3½ years old and the oldest 72. There were 18 males and five females.

A history of repeated contact with farm animals was established in 14 patients (61%). There were four farmers and two farmers' wives as well as a cattle dealer, a cattle grader, a livestock truck-driver, a travelling sack salesman who dealt with farms, and the nurse who lived on a farm. The water supply of one of the children with Q fever was a field well which was also used by cattle. A veterinary surgeon in general practice and a sheep-skin assessor in a hide company (who sniffed the hides to assess their quality) were also included in this group.

In six patients direct or indirect contact with farm animals was very likely. These patients included a child who was on a caravan holiday near to a farm infected with Q fever, a Post Office employee who worked beside a large abattoir, and four labourers who worked in rural areas. Three of the labourers worked in the building trade and one on the roads. No history of contact with farm animals could be established in three patients who lived in towns. These included a docker's wife, a dustman's wife, and a male clerk.

The time of year during which the cases of Q fever occurred and the milk-drinking habits of the patients are shown in Fig. 2. Seventeen patients (74%) became ill between January and May. Eleven patients (48%) regularly drank unpasteurized milk.

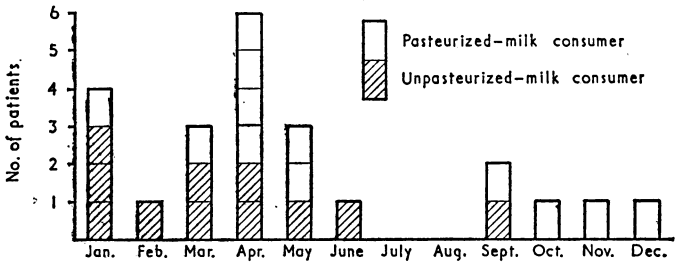

FIG. 2.—Month of illness, and type of milk consumed, in 23 patients with Q fever.

Geographically all the patients were confined to the eastern counties of Northern Ireland, as follows: Down (12), Belfast Borough (5), Antrim (4), and Armagh (2).

Twelve patients had pneumonia. In one patient the pneumonia was bilateral, while in another it was associated with meningeal symptoms and signs. Three patients with pneumonia were admitted to hospital as cases of "acute abdomen." In another patient with pneumonia there was swelling of the right parotid gland, but serological tests for mumps virus infection were negative.

Seven patients had an influenza-like illness or a "pyrexia of unknown origin" without lung involvement. A 3½-year-old boy had, in addition, generalized swelling of lymph nodes during his illness.

Only the heart appeared to be involved in another four patients who had Q fever infection. Three men aged 40, 40, and 46 presented with severe chest pain and pyrexia, while a woman aged 54 had a sudden onset of congestive cardiac failure after an influenza-like illness. Pericarditis developed in three, and in two of them there was gross enlargement of the heart radiologically. Two of the male patients had conduction defects. All four patients recovered, though the female patient was ill for one year. Antibody to *C. burnetii* (phase 1) was not raised in these patients. The patients' sera had previously been titrated for neutralizing antibody against Coxsackie B 1–6 viruses, but a rise in antibody titre had not been found.

Adenovirus antibody was present in both the acute and the convalescent serum of 7 out of the 23 patients with Q fever, but the titres did not rise.

Sera obtained from 61 patients who had symptoms and signs of infectious mononucleosis but who had a negative Paul-Bunnell test were tested during 1966, but none had a rising titre of Q fever antibody.

In order to discover the extent of Q fever infection in Northern Ireland, sera from veterinary surgeons, abattoir workers, and farm workers were tested, since their occupations brought them into close contact with farm livestock.

Veterinary Surgeons

There were 130 veterinary surgeons with "large animal" practices in Northern Ireland during 1966. The Ministry of Agriculture employed a further 108 veterinary surgeons for brucellosis and tuberculosis eradication in cattle and other advisory and inspection duties. Other field staff (who are not veterinary surgeons) are employed to assist the Ministry of Agriculture veterinary surgeons. The results of serological tests for Q fever in the veterinary surgeons are shown in Table III.

TABLE III

County	Veterinary Surgeons					
	In Practice			Ministry of Agriculture		
	No. Tested	No. with Q Fever Antibody	% with Q fever Antibody	No. Tested	No. with Q Fever Antibody	% with Q Fever Antibody
Belfast Borough ..	3	1	34·9	1	0	7·1
Antrim	26	7*		16	1	
Armagh	9	3		9	1	
Down	25	11		16	1	
Londonderry Borough	4	0	11·5	5	1	10·0
Fermanagh	10	3		11	1	
Londonderry ..	11	1		6	1	
Tyrone	27	2		18	1	
N. Ireland	115	28	24·4	82	7	8·5

* Includes one veterinary surgeon who had clinical Q fever.

It will be seen that 28 out of 115 veterinary surgeons in practice (24.4%) and 7 out of 82 Ministry of Agriculture veterinary surgeons (8.5%) had Q fever antibody in their sera. A 45-year-old veterinary surgeon in practice in County Antrim had pneumonia associated with Q fever infection in December 1966. Thirty-six of the Ministry of Agriculture assistant field staff were also tested, and 7 (19.4%) were positive. Of the veterinary surgeons in practice the incidence of past infection with Q fever was highest in County Down (44.0%) and lowest in County Tyrone (7.4%). The Q fever antibody present in veterinary surgeons in practice in the eastern counties of Northern Ireland (Belfast Borough, Antrim, Armagh, and Down) was 34.9%, while in the western counties of Northern Ireland (Fermanagh, Londonderry, Tyrone, and Londonderry Borough) it was only 11.5%.

Abattoir Workers

There were 1,005 workers employed in abattoirs and meat-packing plants in Northern Ireland during 1966. The results of serological tests for Q fever in the sera of 251 abattoir workers are shown in Table IV. After the detection of the index case, Belfast abattoir workers were bled in March 1966. It will be seen that 71.7% had Q fever antibody in their sera. Of the 61 abattoir workers who had been tested in April 1957 and found to be negative, 29 were still employed in the abattoir and 19 (65.6%) had Q fever antibody. There was no specialization in the slaughtering. Most operatives slaughtered cattle, a few slaughtered pigs, but all operatives slaughtered sheep. Of the 265,602 animals slaughtered during 1966 in this abattoir, 75% were sheep. A 48-year-old sheep-skin assessor in an adjacent hide company had pneumonia associated with Q fever infection in April 1966.

The proportion of abattoir workers with Q fever antibody in their sera in the eastern counties of Northern Ireland (Bel-

fast Borough, Antrim, Armagh, and Down) was 45.2%, while in the western counties (Londonderry Borough, Fermanagh, Londonderry, and Tyrone) it was only 4.7%.

TABLE IV

County	No. of Abattoirs Tested	Abattoir Workers			
		No. Tested	No. with Q Fever Antibody	% with Q Fever Antibody	
Belfast Borough	1	60	43	71·7	45·2
Antrim	2	12	5	41·7	
Armagh	3*	45	10	22·2	
Down	3	29	8	27·6	
Londonderry Borough	1	15	1	6·7	4·7
Fermanagh	1	11	0	0	
Londonderry	1	11	0	0	
Tyrone	3	68†	4	5·9	
N. Ireland	15	251	71	28·3	

* Two of these abattoirs slaughtered only pigs. Of the 30 workers employed in them only 2 (6·7%) had Q fever antibody.
† Includes 35 workers from a meat-packing factory, only 1 (2·8%) had Q fever antibody.

Farmers and Farm Workers

There were 40,265 farm owners and 35,043 farm workers in Northern Ireland during 1966. Sera from 601 farmers or farm workers had been sent to the Mycology Diagnostic Laboratory in Belfast for the diagnosis of possible farmer's lung during the 27-month period between February 1965 and June 1967. The results are shown in Table V. It will be seen that 139 persons (23.1%) had Q fever antibody in their sera, and that the distribution of those with Q fever antibody was fairly uniform over Northern Ireland.

TABLE V

County	Farmers and Farm Workers		
	No. Tested	No. with Q Fever Antibody	% with Q Fever Antibody
Belfast Borough	3	0	0
Antrim	187	44	23·5
Armagh	66	17	25·8
Down	100	21	21·0
Londonderry	71	20	28·2
Fermanagh	38	7	18·4
Tyrone	136	30	22·1
N. Ireland	601	139	23·1

Sheep and Cattle

There were 1,039,713 sheep and 1,227,453 cattle in Northern Ireland during 1966. In the eastern counties (Antrim, Armagh, and Down) there were 217,463 more sheep and 71,367 more cattle than in the western counties (Fermanagh, Londonderry, and Tyrone). The female breeding stock of ewes and dairy and beef cows, with their density per 100 acres for each county, is shown in Table VI.

TABLE VI

County	Ewes	Cows	Ewes/100 acres Crops and Grass		Cows/100 acres Crops and Grass	
Antrim	112,459	82,001	27·6	24·1	20·1	16·9
Armagh	26,385	37,253	11·3		16·0	
Down	119,757	61,920	27·7		14·3	
Fermanagh	9,649	50,648	4·0	17·3	21·1	19·2
Londonderry	79,988	50,013	27·2		17·0	
Tyrone	78,942	87,009	17·9		19·7	
N. Ireland	427,180	368,844	20·8		18·0	

It will be seen that there were 90,022 more ewes in the eastern counties, and their density per 100 acres was higher than in the western counties. On the other hand, there were 6,496 more cows in the western counties, and their density per 100 acres was higher than in the eastern counties.

Discussion

C. burnetii can multiply in the genital tract and mammary gland of cattle and sheep, and it is known that apparently healthy domestic livestock may shed enormous numbers of *C. burnetii* in the milk, urine, faeces, and particularly in the placenta (Welsh, Lennette, Abinanti, and Winn, 1958). The carrying of bits of infected sheep placenta into the house by a sheepdog and the subsequent aerosols generated when washing the dog would be a sufficient source of infection for the index case and her dog. However, other opportunities for infection existed, since cattle and sheep on the farm showed serological evidence of past infection and *C. burnetii* was isolated from the pooled cows' milk. Seventy-seven per cent. of those who worked on the farm showed evidence of past infection with Q fever. It is known that *C. burnetii* has a marked resistance to adverse physical conditions, and transmission of infection by aerosols or dust to man and probably from one animal to another can take place.

Though the index patient's family and all but one of the farm staff drank the unpasteurized farm-bottled milk, it seems more probable that infection was derived largely from contact with infected livestock. Since the two veterinary surgeons who attended the farm animals and one of the farm workers drank only pasteurized milk and all three had evidence of past infection with Q fever, some support is lent to the belief that contact with infected animals was an important means of infection.

Marmion and Stoker (1958), in their survey of Q fever in Kent and East Anglia, pointed out that unpasteurized cows' milk was an important vehicle of infection for *C. burnetii*. In the County Down survey the comparison of the incidence of Q fever antibody in people who drank milk infected with *C. burnetii* with those who drank pasteurized milk showed that there was no significant difference between the two groups. Since the population under study in both groups had lived in rural areas for a long time the evidence of past infection with Q fever in the pasteurized-milk drinkers suggested that infection was occurring in other ways than by ingestion of infected milk. The association of this group with infected livestock need not have to be a direct one, since the organism can be carried long distances on clothes, straw, vehicles, and other infected "micro-environments" (Clark, Lennette, and Romer, 1951).

Ninety-six per cent. of all milk sold in Northern Ireland in 1966–7 was pasteurized, compared with 91% in 1956–7. Many farms in Northern Ireland are small, with a few cattle to supply milk for the farmer's family and his livestock. A history of drinking only pasteurized milk in those people who live and work in rural areas is often unreliable, since they may consume unpasteurized milk from time to time at farms when working or visiting socially. Undisclosed amounts of unpasteurized milk are sold privately by farmers, who may also supply their farm workers with milk. The very low incidence of past infection with Q fever (2.5%) in urban blood donors probably reflects the lack of contact with infected animals and the high percentage of pasteurized milk consumed.

It is of interest that Q fever was not considered as a diagnosis in 14 out of the 23 clinical cases, probably because Northern Ireland was thought to be free of the disease. With the dissemination of information about the index case, a further nine cases were confirmed by the laboratory during 1966–7. Clinical Q fever in Northern Ireland was predominantly a disease of males of working age engaged in occupations where contact with farm animals occurred. The occurrence of 74% of clinical cases between January and April may reflect the increased infection of a farm environment which takes place at parturition in livestock infected with Q fever. Lambing takes place between late December and April, and many farmers with smallholdings endeavour to have their cows calving during January and February so that they obtain maximum advantage from their grassland and optimal summer milk production.

Clinical Illnesses

The most common clinical illness was pneumonia, followed by pyrexial and influenza-like illnesses. The involvement of the heart in four patients was unusual in that the pericardium and myocardium were involved. There was no clinical evidence of endocarditis in these patients, and all recovered. Involvement of the pericardium in Q fever has been described by Ludwig (1956) and Stephan and Saliba (1963), and of the myocardium by Tapie, Delaude, Cassagneau, and Le Tallec (1960) and Gsell (1962).

Van der Veen and Heyen (1966) reported some children with adenovirus infections who developed antibody to Q fever antigen as well as to adenovirus antigen. All of the clinical cases in this survey had a rising titre of antibody to Q fever antigen and none developed a rising titre of adenovirus antibody.

A clinical picture suggestive of infectious mononucleosis but with a negative Paul–Bunnell test was described by Eshchar, Waron, and Alkan (1966) in two patients with Q fever, but none of the 61 patients with this syndrome who were tested in this survey had serological evidence of infection with Q fever.

The difference in incidence of past infection with Q fever between the veterinary surgeons in practice (24.4%) and the Ministry of Agriculture veterinary surgeons (8.5%) requires explanation, since both groups handled cattle and sheep in the same areas. Veterinary surgeons in practice do obstetrics, and it is a common procedure to evacuate the uterus of sheep and cattle manually. The Ministry of Agriculture veterinary surgeons, on the other hand, have no obstetric duties. This offers further evidence that infected parturient animals are potent sources of Q fever infection. The higher incidence of past infection with Q fever (19.4%) in the other Ministry of Agriculture assistant field staff may be because many of them were recruited from a farming background.

It is remarkable that in the eastern counties of Northern Ireland (Belfast Borough, Antrim, Armagh, and Down) the veterinary surgeons in practice had three times the infection rate and the abattoir workers nine times the infection rate of those in the western counties (Londonderry Borough, Fermanagh, Londonderry, and Tyrone), and also that all the clinical cases of Q fever were in the eastern counties. This may be related to the excess of sheep in the eastern counties.

Possible Bird and Insect Vectors

The even distribution of past infection with Q fever in the farmers and farm workers throughout Northern Ireland is of interest. Contact with infected livestock at markets distant from their own farms could be occurring or they could be infected in other ways. Possible bird and insect vectors must be considered. *C. burnetii* has been isolated from pigeons and migrating birds such as swallows, while serological evidence of Q fever infection has been found in domestic poultry and wild birds in endemic areas (Babudieri and Moscovici, 1952; Syrůček and Raška, 1956; Marmion and Stoker, 1958). Birds have often been seen feeding on placentas in the fields in Northern Ireland, and it is possible that *C. burnetii* is spread by them. Perhaps of greater interest has been the arrival of the collared dove (*Streptopelia decaocto*) in Northern Ireland (Ennis, 1965). *S. decaocto* was formerly an Asian species; over the past 60 years it has spread slowly westwards through Europe and has a decided preference to stay near man. The first immigrant birds appeared in the eastern part of County Down in 1959, and by 1963 they were breeding in several localities there. It is of interest that some patients with Q fever also lived in the same areas. Since 1963 the collared dove has appeared in Belfast and also further westwards in Armagh, Fermanagh, and Londonderry.

Ticks of the species *Ixodes ricinus* are abundant on animals in all areas of Northern Ireland, and are more plentiful as one moves westwards. They have not, however, been found on the Ards peninsula, in eastern County Down. While the ticks are more plentiful during spring and summer they have been found on sheep and cattle from March to December (Dr. J. B. McFerran, personal communication). However, a history of tick bites in man was uncommon.

The origin and method of spread of Q fever in Northern Ireland is not known with certainty. The serological conversion of 65.5% of the Belfast abattoir workers from negative to positive between April 1957 and March 1966 suggests that Q fever may have entered Northern Ireland during this period. From the retrospective investigation of patients we now know that clinical Q fever existed in February 1962, so that Q fever probably entered Northern Ireland some time between then and 1957. The importation of Dorset Horn ewes from the South of England in June 1962 to the farm in County Down where the index case lived was a possible source of infection which later spread to the cattle on the farm. Other breeds of sheep have been imported into Northern Ireland from Great Britain for many years, and this may explain the occurrence of clinical cases of Q fever in other places before the detection of the index case. There are considerable movements of livestock, particularly of sheep, to markets, abattoirs, and for export, which could account for the spread of infection to other animals and to man. The turnover of sheep on farms is about double that of cattle, which would increase the chance of infection even further.

During the past decade only male cattle have been imported into Northern Ireland, so that Q fever infection is more likely to have originated from the importation of infected ewes.

Summary

Investigation of a patient with Q fever associated with a farm in County Down in January 1966 showed that infection was probably transmitted by sheep placenta brought into the house by a dog. The farm staff, the dog, and the sheep and cattle had been infected with Q fever in the past, and *C. burnetii* was present in the cows' milk. The consumers of this milk did not have a significantly higher infection rate when compared with a control group of pasteurized-milk drinkers in the same areas.

Retrospective and prospective serological tests showed that 23 patients in Northern Ireland had Q fever. Q fever was predominantly a disease of males of working age who were occupationally exposed to livestock at the time of year when calving or lambing was taking place. The most common illness was pneumonia followed by influenza-like or pyrexial illnesses. Pericarditis or myocarditis was present in four patients.

Investigation of veterinary surgeons, abattoir workers, and farm workers showed that past infection with Q fever was widespread in Northern Ireland, but all of the patients and the majority of abattoir workers and veterinary surgeons in practice showing evidence of past infection were in the eastern counties of Northern Ireland. Healthy urban blood donors had a low incidence of past infection.

Abattoir workers showed no evidence of Q fever infection in April 1957, and the first known patient with Q fever was in February 1962, so Q fever is thought to have entered Northern Ireland between these dates, probably by the importation of infected ewes from Great Britain.

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REFERENCES

Babudieri, B., and Moscovici, C. (1952). *Nature (Lond.)*, **169**, 195.
Bradstreet, C. M. P., and Taylor, C. E. D. (1962). *Mth. Bull. Minist. Hlth Lab. Serv.*, **21**, 96.
Clark, W. H., Lennette, E. H., and Romer, M. S. (1951). *Amer. J. Hyg.*, **54**, 319.
Ennis, T. (1965). *Irish Nat. J.*, **15**, 63.
Eshchar, J., Waron, M., and Alkan, W. J. (1966). *J. Amer. med. Ass.*, **195**, 390.
Gsell, O. (1962). *Schweiz. med. Wschr.*, **92**, 1219.
Kaplan, M. M., and Bertagna, P. (1955). *Bull. Wld Hlth Org.*, **13**, 829.
Ludwig, H. (1956). *Schweiz. med. Wschr.*, **86**, 490.
Marmion, B. P., and Stoker, M. G. P. (1958). *Brit. med. J.*, **2**, 809.
Murray, H. G. S., Dane, D. S., and Dick, G. W. A. (1958). *Ulster med. J.*, **27**, 53.
Ormsbee, R. A. (1965). In *Viral and Rickettsial Infections of Man*, 4th ed., edited by F. L. Horsfall and I. Tamm. London.
Stephan, E., and Saliba, E. (1963). *Arch. Mal. Cœur*, **56**, 1161.
Syrůček, L., and Raška, K. (1956). *Bull. Wld Hlth Org.*, **15**, 329.
Tapie, J., Delaude, A., Cassagnesu, J., and Le Tallec, Fermond (1960). *Bull. Soc. méd. Hôp. Paris*, **76**, 65.
Van der Veen, J., and Heyen, C. F. A. (1966). *Amer. J. Epidem.*, **84**, 396.
Welsh, H. H., Lennette, E. H., Abinanti, F. R., and Winn, J. F. (1958). *Ann. N.Y. Acad. Sci.*, **70**, 528.

Small-Bowel Abnormalities in Dermatitis Herpetiformis

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The occurrence of jejunal mucosal abnormalities in dermatitis herpetiformis was first reported by Marks, Shuster, and Watson (1966) and Van Tongeren, Van der Staak, and Schillings (1967). More recently two other studies of small-bowel structure and function have been published (Fry, Keir, McMinn, Cowan, and Hoffbrand, 1967; Fraser, Murray, and Alexander, 1967). In addition, Smith (1966), in his clinical study of 149 cases of dermatitis herpetiformis seen at St. John's Hospital, found two patients who had a malabsorption syndrome.

In an investigation of the jejunal biopsy appearance of patients with rosacea it was noted that in the control series one of the two patients with dermatitis herpetiformis had subtotal villous atrophy (Marks, Beard, Clark, Kwok, and Robertson, 1967). We here report our findings in 29 patients with dermatitis herpetiformis.

Methods

The patients were admitted for investigation. The first part of the jejunum was biopsied with the Crosby capsule under radiological control. The specimens were immediately examined under a Watson dissecting microscope and photographed before being submitted for histological examination. The classification of dissecting microscope appearances is that described by Holmes, Hourihane, and Booth (1961). Fingers and leaves describe the appearance of the villi of the normal jejunum; convolutions, the mosaic pattern; and the completely flat mucosa are regarded as increasing degrees of abnormality. The histological classification used is the accepted one of normal mucosa, partial villous atrophy, and subtotal villous atrophy. Subtotal villous atrophy is the condition associated with untreated gluten enteropathy. Partial villous atrophy is the condition associated with tropical sprue and certain other conditions where the villi are short and blunt and many inflammatory cells are present, some crossing from the lamina propria into the epithelial layer.

We have also used the term "partial focal villous atrophy" to describe a condition in which the villi appear focally shortened but not to the extent seen in partial villous atrophy and where there is an excess of inflammatory cells in the lamina propria and epithelial layer. We have scored this as "normal," though it is possible that it represents early abnormality. We have not scored epithelial cytological abnormalities, as it is intended to compare the biopsies with those taken after treatment with a gluten-free diet and to report these findings later.

In most cases the following haematological investigations were performed: peripheral blood and bone-marrow examinations, serum vitamin B_{12} and folate estimations, and a Schilling test of vitamin-B_{12} absorption. Serum vitamin B_{12} and folate were estimated by bioassay with *Lactobacillus leishmanii* and *Lactobacillus casei* respectively.

Twenty-eight patients had xylose tolerance tests; a 25-g. dose was given to 25 patients and a 5-g. dose to three. The amount of xylose in a five-hour specimen of urine and in the blood was estimated by the method of Roe and Rice (1948), The lower limit of normal for urinary xylose excretion in five hours has been taken as 17% of the ingested dose (4.2 g. for a 25-g. test and 0.85 g. for a 5-g. test). A level of 26 mg./100 ml. at one to two hours after ingestion of the xylose was regarded as the lower limit of normal.

A glucose tolerance test was performed on 24 patients. Blood sugar levels were estimated by a method based on that of Haslewood and Strookman (1939). A rise in the blood sugar level of 30 mg./100 ml. or less over the fasting value has been regarded as abnormal and rises of 30 to 40 mg./100 ml. as equivocal.

Stools were collected to estimate the average daily faecal fat excretion in 25 patients. The collection was made over a five-day period on 18 occasions, over a three-day period on 10

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