completed trials comprising 65,429 individuals, or 12% of the total fed, estimated homotypic negatives amounted to 13,959 or 21.3% for type I, 7,208 or 11% for type II, and 14,072 or 22% for type III. In addition there were, among the 65,429 persons surveyed serologically, an estimated 2,750 triple negatives. In not a single instance was a proved case of paralysis or disease attributed to the vaccine.

The intraspinal test has been discussed with regard to its reproducibility and its significance in relation to safety of the vaccine virus for man. The more consistent and more readily carried out intracerebral monkey inoculation has been proposed as the basis for criteria of residual monkey virulence to be used for release of oral vaccine.

Efforts to improve Lederle vaccine strains in every possible way are continuing. Meanwhile the utility of the present strains, in view of the obvious need for a better solution to the problem of immunization against paralytic poliomyelitis, has been demonstrated by the mounting evidence of their effectiveness and safety and the absence of significant undesirable reactions.

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The American Department of Health Education and Welfare has recently issued a bibliography of selected references in the English language during 1952–8: *Maternal Disorders Related to Fetal Stress, Perinatal Death, and Congenital Defects.* It is limited in scope to the following subjects: effects of maternal infectious diseases, diabetes, thyroid dysfunction, myasthenia gravis, lupus erythematosus, sickle-cell disease, thrombocytopenic purpura, leukaemia, drug addiction, and drug administration. A number of important statistical studies of perinatal morbidity and mortality are also included. A limited number of copies of the bibliography are available from the Library, National Institutes of Health, Bethesda, 14, Maryland, U.S.A.

Q FEVER IN THE R.A.F. IN GREAT BRITAIN IN 1958

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The epidemiology of Q fever has been fully reviewed by Marmion and Stoker (1958). The present report deals with two localized outbreaks, both of which illustrate an interesting facet of this disease, and with a general investigation into the prevalence of Q fever in Royal Air Force personnel in this country. Acute respiratory disease in the R.A.F. has been investigated in recent years in collaboration with the Central Public Health Laboratory, Colindale (Andrews *et al.*, 1956; McDonald *et al.*, 1958; Holland *et al.*, 1959). No case of Q fever has been detected in the recruit units, in which there is a very high prevalence of acute respiratory disease, and few in operational units though many pairs of sera have been tested.

The outbreaks of Q fever occurred at a large Coastal Command station in Cornwall and in a small officers' training unit in the Isle of Man in March–April, 1958. No relation between these two outbreaks could be found. Investigation of the prevalence of Q fever in other stations was limited to 20 operational stations, as the recruit and trade training centres had revealed no cases by the routine investigations of respiratory disease in the R.A.F.

Laboratory Methods

The complement-fixation tests were carried out in the cups of plastic haemagglutination plates (World Health Organization, 1953). The antigen used was prepared by the Standards Laboratory, Colindale, from the Nine Mile strain of *Rickettsia burnetii*.

Serum dilutions, complement ($2\frac{1}{2}$ H.D.$_{50}$), and antigen were mixed in 0.1-ml. volumes and allowed to fix overnight at 4° C. Next morning the plates were put in an incubator at 37° C. for half an hour, 0.1 ml. of a 2% suspension of optimally sensitized sheep red blood cells was added, and after a further 30 minutes at 37° C. the plates were transferred to a refrigerator at 4° C. to allow unlysed cells to settle. The titre recorded was the highest serum dilution showing 75% or more of the red cells unlysed.

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Attempts to isolate *R. burnetii* from samples of various materials were made by preparing extracts of the materials in 10% broth-saline containing 100 units of penicillin per ml. and injecting 1 ml. of the extract intraperitoneally into guinea-pigs. The guinea-pigs were bled by heart-puncture before inoculation and again six weeks later. The second sample from each guinea-pig was tested for complement-fixing antibodies to *R. burnetii*.

Cornwall

The station concerned was a large hutted unit situated about 3–4 miles (4.8–6.4 km.) from the nearest small town. Many of the personnel were Cornishmen, who often visited farms in the area during periods off duty. The local medical officer of health and the director of the local public health laboratory knew of no other cases of Q fever in the vicinity at that time.

The outbreak was limited entirely to station sick quarters. On March 8 Sergeant R. was admitted to sick quarters with a febrile illness which lasted for six days and was characterized by severe malaise, high fever, headache, cough, abdominal pain, vomiting, and persistent anorexia. There was little, if any, sputum. No physical signs were observed during the course of the illness.

Between March 22 and 24 four members of the sick-quarters staff became ill. Their illnesses were marked by high fever, severe headache, and cough. Chest pain was present in two cases. One patient developed a mild bronchitis on the fourth day of illness and one developed signs of bilateral basal pneumonia with small haemoptyses. The latter was treated with chlortetracycline for four days; no other specific treatment was used. All patients recovered completely, and a chest *x*-ray film taken two weeks after the onset of their illnesses revealed no abnormality. A further case occurred on March 29, when Sergeant D. was admitted to sick quarters; he had a high fever, headache, anorexia, and cough with no physical signs. He had visited the first patient, Sergeant R., on March 13 in the ward. This was Sergeant D.'s only contact with sick quarters.

Evidence that the four sick-quarters personnel had suffered from Q fever was provided by a fourfold or greater rise in complement-fixing antibody titre between acute and convalescent samples of serum. Blood taken from Sergeant R. six weeks after his illness showed a titre to *R. burnetii* of 1/64 and from Sergeant D. three weeks after his illness of 1/128.

Efforts were made to assess the extent of the outbreak as follows. (1) All patients admitted to sick quarters with a febrile illness up to four weeks before the first case of Q fever and up to four weeks after the last case of Q fever had samples of blood taken. None showed titres to *R. burnetii* greater than 1/8 when bled three weeks after the onset of the last case. (2) The serum of all the other 11 members of the sick-quarters staff, none of whom had recently had any clinical illness, was tested against *R. burnetii*, but the titres of all sera taken three weeks after the onset of the last case were all less than 1/8. (3) A random sample of 60 members of the station, about 4% of the station strength, had samples of blood taken and tested for *R. burnetii* antibodies. All but one had titres of less than 1/8. One airman who had not been to sick quarters since November, 1957, and who said he had had no illness since "Asian influenza" in autumn, 1957, had a serum titre of 1/16. (4) All members of the station were questioned about contact with farm animals and undiagnosed illnesses in their families.

It can be seen, therefore, that the outbreak of Q fever was very limited, and that the levels of the single titres of 1/64 and 1/128 were probably evidence of recent infection.

Efforts to trace the source of infection began three days after the onset of illness in members of the sick-quarters staff, soon after the first serological diagnoses were available. It was found that the four members of the staff affected had nothing significant in common apart from performing their duties in sick quarters. One member lived outside the station near a farm, but denied bringing any farm products to sick quarters. There was no clinical evidence of any disease in the animals on the farm concerned.

Samples of packing material, wool, dust, and milk from various sites in sick quarters were tested as described, but no strain of *R. burnetii* was isolated. A casualty evacuation aircraft from Cyprus had landed at the station on March 2. Q fever was known to be prevalent in Cyprus at the time, but, though members of sick-quarters staff had visited the patients in the aircraft, it is unlikely that they or the contents of the aircraft were the source of infection, because tests on the serum from three members of the crew who later had respiratory illnesses after their arrival in Britain proved negative.

Various supplies had arrived in sick quarters at the end of February, and these were unpacked in small ill-ventilated rooms. Packing material from these supplies was tested and shown to be negative. As all sick-quarters supplies come from a central depot, inquiries were made there. Only one packer in the central depot had had a recent febrile illness, but no serological evidence of Q fever was found. Inquiries were made at 56 R.A.F. stations which had received materials from the central depot during the same week as the station in Cornwall. Cases of febrile illness had occurred in airmen handling these supplies in seven stations. Sera from all but one of these airmen were negative for *R. burnetii* antibodies.

Inquiries were made of British Railways, and it was found that none of the goods had been carried in cattle trucks, and therefore possibly infected with *R. burnetii* of animal origin, nor had any unexplained outbreaks of illness been reported in railwaymen along the line to Cornwall.

The only animals found in sick quarters were wild mice. Several of these were caught and examined, but no strain of *R. burnetii* was isolated. The station also had a pig farm, and there had been some diarrhoea amongst the piglets, but no strain of *R. burnetii* was isolated from scrapings of the piglets' ears or the litter in which they were kept.

It was thus concluded that no source of infection apart from the original case of Sergeant R. had been found. Furthermore, the only common experience of the four members of the sick quarters and the last patient, Sergeant D., was contact with Sergeant R. The source of infection of the original case, Sergeant R., was not discovered. He lived in married quarters some miles from the station. No evidence of Q fever was found in any members of his family; and there had been no illness in either his pet dog or budgerigar. This patient,

however, had visited several farms near his home, and it is possible that he picked up his infection at one of these.

The possibility remains of some undiscovered source of infection in sick quarters. In the last week of July, four months after the original outbreak, the senior medical officer at this station developed pneumonia with concomitant rise in antibody to *R. burnetii*. The same epidemiological procedure as before was used for investigation, but no further clues were elicited. No evidence of infection was obtained from any of the four other members of his family or from members of sick-quarters staff. No further cases of Q fever were admitted to sick quarters up to the end of October. It is therefore possible that this was a sporadic case, especially as the patient concerned was a naturalist and often wandered round the countryside.

Isle of Man

The outbreak at this station was very much less clearly defined than the one in Cornwall because it occurred over the Easter holiday, so that most of the personnel involved were away on leave, and thus not under medical supervision. Only 10 patients required admission to sick quarters. The illnesses were all mild with no pneumonic complications. All were marked by fever, headache, and malaise, and several of the patients had a mild cough.

At the time of the outbreak two squadrons, each of about 50 officer-cadets, were under training at the station. Only one of these squadrons was involved in the outbreak, together with members of the permanent staff.

Four cadets from the squadron affected were admitted to station sick quarters with an influenza-like illness between April 9 and 12, 1958. The illness in each of them had started some days before, during leave. Paired specimens of serum from three of these cadets showed a fourfold or greater rise of antibody to *R. burnetii*. By the time the diagnosis was made serologically the training course had ended, so that investigation of other cadets on the course was limited to single specimens of serum obtained four to eight weeks after the original illness.

The squadron in question had consisted of 45 cadets, and serum was tested from 36 (80%) of these. Nine had antibody titres to *R. burnetii* of 1/64, 6 of 1/32, 2 of 1/16, and 19 of less than 1/8. All those with titres of 1/16 or more revealed on retrospective questioning that they had had some symptoms during the period around Easter; several admitted to an episode of malaise at home or in the train. Only one cadet with a titre of less than 1/8 claimed to have had an illness at the same time.

The sick-quarters staff at this station consisted of nine men, who were questioned and examined serologically. None of them had had any illness in the previous few months, nor was any serological evidence of Q fever found among them. No patients admitted to sick quarters up to four weeks before or four weeks after April 10 showed any evidence of infection with *R. burnetii*. Twenty-six members of the permanent staff of the station (approximately 12% of the strength), excluding the equipment section, the regiment, the accounts department, and O.C.T.U. H.Q., had samples of blood taken. One of these who had a titre of 1/32 had had a cough at the end of March. The 34 members of various permanent staff sections in which evidence of Q fever had occurred were also tested. Three were found to have a titre of 1/64, four of 1/32, and two of 1/16. The rest had titres of less than 1/8. All those with titres of 1/16 or more had had a febrile illness, which was mild in most instances.

Blood samples from the families of six patients ill at home were examined. In one family of five, one daughter had a titre of 1/16 six weeks after her father's illness. She had had no illness. No other sample proved to be positive.

The wife of the station chaplain was ill soon after Easter, and her serum had an antibody titre of 1/32.

The investigation of this outbreak proved particularly difficult because the airmen exposed were widely scattered, and most of them could be questioned only by letter. Furthermore, three months had elapsed by the time all samples had been collected and tested.

The outbreak in the squadron occurred in the first week of April, and apparently caused an illness in almost 50%. Illness in members of the permanent staff began to occur in the last week in March and continued up to April 12. With an incubation period of 14–25 days, case-to-case infection is very unlikely to have caused this outbreak, and it is much more likely to have been caused by exposure to a common infective agent. No proof of the nature of this was found.

Rats and ticks, which are possible vectors of *R. burnetii*, abound in the vicinity of the station concerned. Several were caught and tested, but no positive results obtained. Though the milk on the Isle of Man is not pasteurized, it is unlikely that this caused the outbreak, as only one squadron was mainly affected, and, furthermore, the samples tested proved negative. At the time of the outbreak of Q fever members of the local population were suffering from an illness which was said to be infective hepatitis, but not all cases were icteric. No samples for testing were obtained.

It seems most probable that the R.A.F. personnel had become infected with *R. burnetii* in the locality. Part of their training involved long cross-country marches, and shooting practice near farmland. Apart from the squadron affected, members of the accounts department, equipment, O.C.T.U. H.Q., and the regiment who were infected were all closely concerned with the training of this squadron, and were often in close contact with them. One excursion 17 days before Easter was concerned with the preparation of a shooting-range near a farm at the eastern side of the island. All the persons infected were present on this expedition, or handled stores from members of the squadron on their return. The work included the cleaning out of sheds into which sheep had at times strayed. It is quite possible that lambing had occurred in the sheds. No evidence, however, could be obtained of Q fever in the farmer or his labourer.

Prevalence of Q Fever in Operational Stations

In order to assess the prevalence of Q fever in the R.A.F., personnel in 20 stations who had been ill during March and April, 1958, were examined serologically. Ten of the stations selected were situated far from a town, where the personnel would have close contact with the rural community, and in parts of the country where sheep-farming was common. Ten other stations were

chosen by their proximity to towns, and were in areas where sheep-farming was not prevalent.

The medical officers at these stations were asked in June, 1958, to notify one of us (W. W. H.) of the total numbers of cases of acute respiratory disease, and of febrile illness for which no cause had been found, during the period March to April, 1958. They were also asked to obtain samples of blood from as many of these patients as possible.

The total number of illnesses that had occurred at these 20 stations was 373, and 154 specimens of serum—that is, from 41% of cases—were received for testing. The antibody titre to *R. burnetii* of 152 of these was less than 1/8, of one it was 1/8, and of one 1/16. The patient with a titre of 1/16 had had an influenza-like illness lasting 15 days at the end of March, with no pneumonic complications. At the time there had been no outbreak of respiratory disease at his station, which was located near a town.

During this investigation one further case of Q fever came to light. The sergeant in charge of the sick quarters on an operational station near York, not included in the survey, became ill on February 14. He had a severe pneumonic illness and had to be admitted to hospital. No satisfactory diagnosis was reached at the time, but serological tests were not done. When tested in May his serum gave a titre of 1/32 to *R. burnetii*. All his close contacts at work were examined, and none of the samples of blood tested showed any rise of complement-fixing antibody to *R. burnetii*. Samples of blood were also obtained from 21 out of 33 patients who had been admitted to sick quarters at this station during the period January 13 to March 18. None showed any evidence of having had Q fever. The sergeant, at that time, had been living in married quarters in South Lincolnshire, and travelled home every week-end. He regularly visited three farms near his home, but the local veterinary surgeon had no knowledge of any disease in animals on these farms, nor had any of the farmers' or the sergeant's own family any illness suggestive of Q fever.

Discussion

Marmion and Stoker (1958) have discussed the epidemiology of Q fever in detail. The source of infection was discovered in only one out of seven outbreaks investigated in Great Britain. This was at the Royal Cancer Hospital in London (Marmion and Stoker, 1950). Regarding the two R.A.F. outbreaks described in this paper no definite conclusion can be reached. The evidence obtained from the first outbreak —that in Cornwall—is suggestive of case-to-case infection, though the incubation period was shorter than usually stated. In the second outbreak, in the Isle of Man, no source was found, though case-to-case infection was virtually excluded. Case-to-case infection appears to be uncommon in Q fever and has been described with reasonable certainty on only three occasions. Siegert *et al.* (1950) described a hospital outbreak caused by a laboratory worker who had been working on "Balkan grippe" and from whose sputum a strain of *R. burnetii* was isolated. Deutsch and Peterson (1950) recorded a case of Q fever where three persons attending the patient were admitted with the same illness 14 to 23 days later. Of 26 other contacts tested, two had an antibody titre to *R. burnetii* of 1/64, but no symptoms, and one room-mate developed symptoms but no rise in titre. A nurse at the Royal Cancer Hospital was infected from a patient either during life or from the cadaver, but certainly before the post-mortem examination at which the two pathologists and a mortuary attendant were infected.

The outbreak in the Isle of Man is of particular interest in that of 30 personnel with a titre of 1/16 or more all had symptoms of disease, while, of 66 with a lower titre than this, only one had symptoms.

It is noteworthy that in both these outbreaks only one patient was seriously ill.

Summary

Two localized outbreaks of Q fever are described. In the first, four sick-quarters attendants and one visitor were probably infected from a patient 14 to 16 days after contact with the latter. No other case or any source of Q fever was found at this station. In the second outbreak, half of one squadron of 45 officer cadets were shown to have had Q fever. Serological findings agreed closely with history of illness. Nine out of 34 members of the permanent staff on this station also had a raised titre of complement-fixing antibodies to *R. burnetii*. All personnel involved were concerned in some way with a visit to a shooting-range and with cleaning out a hut in which lambing may have taken place. It is postulated that this was the source of the outbreak.

To assess the prevalence of Q fever in the R.A.F., samples of serum from 154 patients admitted with a respiratory illness to 20 different station sick quarters in March and April were tested. One was found to have a titre of 1/16. One further case of Q fever was discovered in another R.A.F. station during this investigation. These findings confirm those of Marmion and Stoker in showing that the origin of most outbreaks of Q fever in this country remains unexplained.

We are indebted to the P.M.O. Technical Training Command and Coastal Command, the Director of Hygiene and Research, R.A.F., and other medical officers for granting us facilities to conduct these studies; to many station medical officers and in particular to Wing Commander F. L. Jenkins, O.B.E., and Flight Lieutenant D. Coulterjohn for their help; and to Flight Sergeant E. G. Cawkwell for technical assistance in the laboratory. We are grateful to the Director General, Medical Services, R.A.F., for permission to publish.

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In its new booklet, *Clean Food Handling*, the Corporation of London, as the Health Authority of the Port and City of London, addresses itself with brevity and common sense to those responsible for preparing food on ships as well as in cafés, and includes illustrations of ideal galley conditions afloat. The Corporation is responsible for 1,000 cafés in the City of London, and for some 28,000 ships in the Port of London every year.