Q fever in Ireland. A seroprevalence study of exposure to <i>Coxiella burnetii</i> among Department of Agriculture workers

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Objectives  
To estimate the risk of exposure to <i>Coxiella burnetii</i> among ‘at risk’ workers in Ireland.

Methods  
A cross-sectional seroprevalence study, using the complement fixation technique (CFT), was carried out among technical and support staff of the Department of Agriculture in Ireland (n = 375). Participants were divided into low- (n = 34), moderate- (n = 158) and high-risk (n = 83) groups according to the likelihood of occupational exposure. A result of <1:8 on CFT was accepted as normal, i.e. no evidence of past exposure to the causative organism, <i>C. burnetii</i>. Participants with titres of 1:16 were clinically assessed for evidence of past or present infection and interviewed regarding the possibility of non-occupational exposure.

Results  
The participation rate was 75% (n = 281). Overall, 24 of the 281 participants (8.5%, 95% confidence interval = 5.6–12.4%) tested positive (titres = 1:8). No statistically significant difference existed between the three groups (low, 8.8%; moderate, 9.5%; high, 7.2%). Of those reviewed (n = 10), no evidence of either past or present clinically significant illness was detected. Possible non-occupational exposure was identified in two cases.

Conclusion  
Laboratory evidence of past exposure to Q fever is common amongst readily identifiable ‘at risk’ occupational groups in Ireland, and appropriate preventative steps are warranted. Employees who do not have direct exposure to animals or animal products, but who work in a high risk environment appear to have a similar risk of exposure <i>C. burnetii</i>. Although clinical illness appears to be rare, health care workers should consider the possibility of Q fever in cases of unexplained illness arising in those working in ‘high risk’ environments.

Key words  
Occupational risk; prevention; Q fever; seroprevalence.

Introduction  
Q fever is a zoonotic illness of almost worldwide distribution [1], caused by the rickettsia <i>Coxiella burnetii</i>. Clinically apparent infection generally presents as an influenza-type illness, but a wide variety of conditions have been described [2,3]. Recovery is the norm. Following infection, a chronic fatigue state and a subsequent predisposition to cerebrovascular accidents and cardiac ischaemia have also been reported [4,5]. Chronic Q fever is defined as <i>C. burnetii</i> infection that persists for >6 months. Endocarditis represents 60–70% of all cases, but other cardiovascular, pulmonary, osteoarticular, hepatic and neurological manifestations have been described [1–4,6,7]. It is an uncommon but serious condition (with a reported mortality rate of up to 65%) that occurs in susceptible individuals. Q fever may adversely affect the outcome of pregnancy. Reported
complications include premature birth, spontaneous abortion and neonatal death. Foetal death has been reported in up to 60% of cases [8,9].

The primary sources of human infection are cattle, sheep and goats, but asymptomatic, chronic *C. burnettii* infection has been demonstrated in a wide variety of both domestic and wild animals, including cats, rabbits, dogs and birds. In general, infected animals remain asymptomatic, but persistently shed the organism into the environment via milk, urine and faeces. At parturition, *C. burnettii* is dispersed from the infected female in high concentrations as an aerosol, and may continue to be shed for weeks or months afterwards. Human infection most frequently follows inhalation, but also occurs via ingestion of contaminated milk and direct contact with infected material. Human-to-human transmission (following childbirth/autopsy) has been reported, as has infection following tick bites [1]. First described in 1935 among abattoir workers [10], Q fever is now recognized as an occupational hazard for people who work with animals or animal products, including veterinarians, sheep and dairy workers, meat processing plant workers, laboratory workers, hide handlers, wool spinners, taxidermists and butchers [11–14]. It occurs more commonly in agrarian communities [11,15].

Although endemic in Ireland, little is known of its incidence in this country. To assess workers’ risk of exposure to *C. burnettii* in Ireland, a cross-sectional seroprevalence survey to determine laboratory evidence of past exposure was carried out amongst a diverse group of employees of the Department of Agriculture.

**Methodology**

The study was carried out amongst employees of the veterinary laboratory service in the Department of Agriculture. This service carries out the laboratory tests and examinations necessary for the diagnosis and regulation of various specified animal diseases. Employees of specialized laboratory facilities, meat plants and the state farm were invited to take part (n = 375). Participants were employed in 14 separate facilities in nine different counties, representing a wide geographical area covering the east, south, west, north-west and midland regions of the country. Participants included veterinary and agricultural officers, farm labourers, meat plant staff, laboratory and post-mortem room personnel, and others who did not work directly with animals or animal products, e.g. domestic, maintenance and administrative staff. The risk of exposure to *C. burnettii* varies greatly among such a diverse group. For the purposes of this study, each participant was classified according to the nature of his or her work at that time, i.e.:

- Those with direct involvement with animals or potentially infected animal tissue were classified as being at high risk of exposure, i.e. farm workers, veterinarians and meat plant workers.
- Those who work with potentially infected tissue or blood samples in controlled laboratory settings were placed in the moderate risk group, i.e. laboratory technicians and laboratory attendants.
- Those with no routine exposure to animals or animal products in the course of their work were categorized as being at low risk, i.e. office based staff.

Phlebotomy was carried out once on each participant between July 2001 and January 2003. Serological analysis was carried out in the Virus Reference Laboratory, Dublin. The complement fixation test (CFT) was used to detect the total antibody concentration, i.e. IgG and IgM to phase 2 antigen of *C. burnettii*. For the purposes of this study, samples with titre levels of 1:8 were considered significant, i.e. indicative of past exposure. All those with titres of 1:16 were reviewed and examined for evidence of past or present infection. Repeat serological testing was offered to this group. At interview, possible confounding influences were identified, e.g. animal exposure outside of work including pet ownership, primary residence on a farm. It was decided that all samples with anti-phase 2 antibody titres >1:32 would be further analysed for the presence of anti-phase 1 antibodies. This figure is below recommended diagnostic levels for both acute and chronic Q fever [16,17], and was chosen to ensure that no evidence of chronic Q fever was missed.

Within the Irish Civil Service, the ethical concerns of research projects are considered at departmental level. Local approval was received as the overall aim of the project was to improve the occupational health service to employees, participation was voluntary and the study was part of a wider screening programme that had been previously agreed between management and employees.

Data was recorded on S.P.S.S. Both the overall frequency of positive results and the frequency for each exposure group were determined. The relevant confidence interval analyses were calculated to allow comparison between the groups.

**Results**

The participation rate was 75% (n = 281). Of these, 30% (n = 83) were classified as being at high risk of *C. burnettii* exposure due to the nature of their work, 56% (n = 158) at moderate risk and 12% (n = 34) at low risk. Job descriptions were not available for the final six cases (2%).

Twenty-four participants [8.5%, 95% confidence interval (95% CI) = 5.6–12.4%] demonstrated evidence of past exposure to *C. burnettii*. No statistically significant difference was demonstrated between the three groups (low, 8.8%; moderate, 9.5%; high, 7.2%; Table 1). Two
individuals had titres of 1:32, nine of 1:16 and 13 of 1:8. No association between titre level and exposure group exists (see Table 2).

All cases with titres of 1:16 were invited to attend for a medical review. One individual could not be contacted, but all others attended (n = 10). No clinically significant illness suggestive of past or present Q fever infection could be detected on either examination or history. Possible non-occupational risk factors for exposure to C. burnettii were identified in two cases; one who resided on a farm and another who kept several pets (dogs and cats).

In order to confirm the accuracy of the results, repeat testing was offered to all those reviewed. Seven individuals underwent repeat testing and the results were unchanged in all cases.

Discussion
This study demonstrates that laboratory evidence of past exposure to Q fever is common in employees working in readily identifiable ‘at risk’ work environments in Ireland. The frequency of antibody is constant, irrespective of type of occupation. This suggests that the organism is widely dispersed in such environments and that all employees in such areas are at risk of exposure. The result does not support a gradient of risk among the different occupations, which is surprising given the differences in potential exposure. The categorization system in this study has been successfully used to demonstrate a risk gradient among employees previously [11]. This result may be a chance finding or may reflect work practices among those at higher risk of exposure in Ireland. Further research is required to explore this finding. As similar prevalence rates for the general population in Ireland are not available, the extent of this increased risk cannot be accurately assessed. The possibility that these figures represent the background exposure of the general population in Ireland to C. burnettii, although unlikely, cannot be entirely discounted.

Of those with titres of 1:16, no evidence of clinically significant illness was identified. This was not wholly unexpected given that the highest titre was 1:32, which is below the recommended diagnostic levels for both acute and chronic Q fever. However, the lack of any history suggestive of Q fever confirms that the spectrum of illness is extremely wide.

The drawbacks of seroprevalence studies are well established. No distinction can be made between unimportant exposure and clinically significant illness. Furthermore, as antibodies do not persist indefinitely following infection [18], the results do not accurately reflect the incidence of a condition, and underestimate the lifelong risk of exposure. This study did not address the issue of potential previous occupational exposure and this may have resulted in some inaccuracy in assessing participants’ occupational exposure. The CFT, as used in this study, is considered to have high specificity but its sensitivity has been reported as being lower than other testing methods [19,20]. As a result of these factors, it is possible that this study may underestimate the true picture.

The incidence of Q fever in Ireland is unknown. For the four years 1999–2002 inclusive, 12 cases were reported to the Hospital In-patient Enquiry System Ireland. As <5% of Q fever cases warrant hospital admission, this result does not accurately reflect the overall incidence of the condition. The patterns of animal infection and human Q fever in Ireland are believed to be broadly similar to those in Britain [21]. In the UK, the Communicable Disease Surveillance Centre reports an average incidence of 0.15–0.35 per 100 000 population per year [1]. International prevalence rates vary greatly, and strongly endemic regions include areas as diverse as Northern Spain and Japan [22,23]. In addition to international variation, the reported rates of significant anti-phase 2 antibody titres vary considerably between workers of similar occupations in given regions [1,11]. For example, published prevalence rates for cattle workers in New South Wales, Australia vary from 11 to 28% [11,14]. Similarly, prevalence rates for farm workers in the UK range from 15 to 27% [13,15]. Such variation may reflect either geographical differences and/or variable sensitivity of the available testing techniques (e.g. CFT, ELISA, immunofluorescence assay, skin prick testing).

Despite this variation, this study confirms that

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Results presented as a percentage of each group, with the attendant 95% CI. n = the actual number that tested positive.
exposure to C. burnettii occurs frequently in certain work environments. As a result, suitable prevention is warranted. In conjunction with appropriate public health policy, e.g. pasteurization of milk and milk products, and the provision of adequate quarantine facilities for imported animals, additional preventative steps should be directed at people working in areas where animals or animal products are processed. These include educating workers as to likely sources of infection and the implementation of ‘safe work practices’, i.e. rigorous personal hygiene, appropriate handling and disposal of potentially infected material, and ensuring that adequate personal protection (gloves, aprons, masks etc.) is supplied. Potentially infected animals and high-risk activities, e.g. calving/lambing, should be restricted to separate enclosures situated away from populated areas. The identification and possible relocation of pregnant employees and individuals at high risk of chronic illness should be considered. Vaccination of domestic animals has been attempted, but has not proved successful, and may actually increase the shedding of C. burnettii by animals, thereby increasing the risk to humans. Pre-exposure vaccination of those in high-risk occupations is routinely carried out in some countries, and has been shown to be both safe and 100% effective for at least 5 years [24–26]. However, further research is required to establish whether this is indicated in Ireland. It is concluded that exposure to Coxiella burnettii is likely among readily identifiable occupational groups in Ireland. Although clinical illness appears to be rare, health care workers should consider the diagnosis of Q fever in cases of unexplained illness arising in those working in ‘at risk’ environments. Appropriate preventative steps should be directed at such groups.

References