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Current scenario of Q fever outbreaks in Australia and counteracting strategies

Dear Editor,

Q fever was first recognized in Brisbane, Australia, amongst abattoir workers as fever of unknown etiology, hence named 'Query or Q fever' by Edward Holbrook Derrick. Intracellular bacterium (rickettsia) named Coxiella burnetii is the disease causative agent. Q fever is now a common notified occupational zoonosis worldwide. Livestock related profession, abattoir workers, agriculturists, veterinarians, skin shearers and wool sorters are at high risk to the infection [1]. Q fever is globally prevalent except in New-Zealand and Antarctica [2].

The reservoir of the pathogen includes some mammals, birds, and arthropods such as ticks. *Coxiella burnetii* in Australia is sustained by wild population such as kangaroos, bandicoots, and rodents, together with the ticks that feed on them. Both wild and domestic goats, sheep and cattle may share ticks with each other. Infected ticks that feed on livestock excrete highly concentrated organism in their feces, which can contaminate the animal hide, fleece, or hair [3]. Domestic ruminants are often chronically infected and aerosolize the bacteria during parturition ($>10^9$ bacteria/gram of the placenta are released into the environment). The organism has capacity to withstand extreme temperatures, dehydration, and sunlight that allows it to exist for over a year in a dried state at 4 °C. The organism can survive on dry wool for 7–9 months at 15–20 °C and for 12–16 months at 4–6 °C.

Dehydrated tick feces have been shown to be infectious for ~2 years [4]. In domestic herds, *C. burnetii* spreads rapidly and is maintained mostly through inhalation of infected dusts and contaminated droplets liberated from the infected animal. Within a matter of months after the organism's introduction, as much as 80% of the herd might be affected. Once a herd has been infected, it usually stays sick [5]. Nearby livestock, wild and feral animals, and even cats and dogs can catch the infection. The infecting *C. burnetii* exist as two morphologically distinct forms: a 'large-cell variant' (growing form) or a 'small-cell variant' (non-growing, 'survival' form). The latter form is highly resistant to desiccation and survives for long periods in the environment. *Coxiella burnetii* also shows virulence-correlated variation in outer surface antigens, i.e., pathogenic phase 1 expresses lipopolysaccharide, while avirulent phase 2 expresses protein antigens [6].

1. The outbreak and discussion

On 9 September 2022, Q fever cases were notified from the electoral division of Wide Bay, Queensland (Noosa, Maryborough, and Gympie); then, a high alert has been kept on the symptomatic case detection. Eleven residents were found to have infections, which doubled the average of 5–7 cases over the previous 5 years. Public Health Physician of Wide Bay Public Health Unit believed that the case increment was possibly associated with greater numbers of wildlife like kangaroos and wallabies living in close association with human dwellings [7]. In Australia, majority of Q fever cases have been reported from northern New South Wales and southern Queensland. In 1999, the disease was first declared as a notifiable disease in the USA. Since then, 168 cases were observed in 2008; the prevalence was 3.1% in a national serosurvey. During 2008–2013, cases declined but upsurged in 2014. In 2019, 178 Q fever cases were notified [8]. Since 1977, Q fever has been a notifiable disease in Australia. One in every 20 Australian residents had antibodies against the bacterium. Queensland alone accounts for 43.1% of nationally notified diseases. After a rigorous study to identify clusters of *C. burnetii* infections during 2002–2017, 82% of the notifications belonged to 44 household clusters [9]. The overall prevalence was approximately 2 cases/100,000 population. However, there were Q fever 'hot spots' in central Queensland and New South Wales, where the incidence was much higher (13 cases/100,000 population) [10].

Q fever outbreaks with nearly 4000 human cases were reported in the Netherlands from 2007 to 2010 [11]. Large outbreaks were reported in Switzerland, Great Britain, Germany, and southern France [12]. Few outbreaks were reported from Asia (underreported as the disease is not notifiable). Q fever symptoms were non-specific flu-like, leading to a risk of the disease being undiagnosed. Still, many cases were reported from Japan and China [13]. This zoonosis is grossly neglected in the Indian subcontinent where farming and animal husbandry-related activities are occupations by majority of the population [14].

Q fever is transmitted to humans from infected/sick animals, e.g., cattle, sheep, goats, primarily from inhalation of aerosolized bacteria from the animal excreta and parturition products. Less predominant modes of transmission include tick bites, ingestion of milk/unpasteurized dairy products, and rarely person-to-person via sexual contact, blood transfusion, transplantation, and through placenta. As few as 10 bacteria may cause disease in a susceptible person [15,16]. Sporadic infections were reported in healthcare professionals doing autopsies, contact with an infected parturient woman and via intradermal inoculation The interval between inhalation of the organism (exposure) and illness onset may range from 14 to 60 days, depending on the exposure dose. The usual incubation period is 19–21 days [17,18] Individuals exposed to the highly infective products of conception had the shortest incubation period and the most severe illness.

Q fever manifests as acute disease (more common) or chronic entity with persistent focalized infection, which occurs in only 4–5% [19]. In acute cases, Q fever manifests as mild flu-like illness with severe headaches. Rarely, atypical pneumonia, hepatitis, central nervous system manifestations may occur late in the course of illness. Chronic Q fever manifests as endocarditis, cardiac valvular abnormalities, and heart failure; fewer common manifestations are chronic fatigue syndrome, vascular infections, osteoarticular infections, chronic hepatitis, and pulmonary fibrosis. Chronic Q fever in antenatal women can lead to premature births, intra-uterine death, and spontaneous abortion.

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Immune complexes deposited in vessels particularly in placenta may cause vasculitis, vascular thrombosis, and consequently placental insufficiency. The clinical presentations depend on both the virulence of the infecting bacterial strain and specific risks factors in the infected subject.

Even in the absence of direct animal exposure, people with risk factors for chronic Q fever who experienced a prolonged fever of unclear cause, osteomyelitis, abscess, or endocarditis with a negative blood culture should be screened for *C. burnetii* infection [19]. Serological, microbiological and DNA methods are typically used for the diagnosis. Normal treatment entails antibiotic administration initiated shortly after the symptom onset. Doxycycline is used to treat the acute form in both children and adults, whereas a combination of antibiotics, such as doxycycline and hydroxychloroquine, is required to treat persistent focalized illness [20].

The Australian government launched the vaccination program for prevention in high-risk contacts. Before vaccination, screening was done to rule out workers who had been vaccinated earlier or had any prior Q fever, as they are at an escalated risk for a severe reaction. The 'Q fever register' database records the screening and vaccination status of vaccinees. A highly effective whole-cell vaccine is available in Australia to prevent infection in workers at high-risk. In a cohort study carried out between 1985 and 1990, Q fever was diagnosed in 0.08% (n = 2555) and 4% (n = 1365) of vaccinated and unvaccinated employees, respectively. An acellular vaccine is also available in the USA but sufficient data from human trials is not available.

The Workplace Health and Safety Department and the Electrical safety office recommends three levels of control measures. First level incorporates avoiding *C. burnetti* infection-associated risks, such as restricting non-immune/unvaccinated person entry into high-risk areas, ensuring pasteurization of the dairy milk. Second level includes adopting safe practices like replacing a high-pressure water cleaning method with a low-pressure one to prevent aerosolization of dust. Utilizing engineering and environmental controls to mount ventilation systems to minimize the aerosol generation, locating high movement places like parking, to less risky areas, and installing dust suppression systems like water sprinkler to minimize airborne dust. Level 3 includes stringent control measures, such as making workers aware of the risk of acquiring Q fever, training to create awareness of the disease/complications, developing safe work procedures to minimize the risk. Vaccination certificates are to be recorded at the start of the work and a pool of immune workers is to be maintained to carry out at-risk work. It is recommended to wear a suitable mask with a P2 filter/N-95 to avoid inhalation of aerosolized bacteria [20]. The workplace is to be kept tidy to minimize the dispersal of dust, and donning/doffing instructions for PPE to be displayed at multiple places. Animal products, excreta, placenta, and aborted fetuses to be handled with precaution and animals should be prevented from having contact with the placenta after birthing. There should be a provision of apt washing area for workers and strict measures should be taken to prevent the spread of infection among animals/herds [20].

Q fever is still a neglected zoonosis in many parts of the world. Surveillance, strict monitoring and suitable prevention and control strategies are obligatory to trim down outbreaks in a region. The first step should be from farm animals, through identifying the infection's seroprevalence, bacterial source, and testing its eradication. Species (e.g., greater in cattle than in water buffalo), age, and coexistence with other ruminant species, were positively correlated with increased seroprevalence [20]. Livestock vaccinations could stop the extensive outbreak and lower the risk of human infection. The main vaccination, i.e., two doses of a commercial *C. burnetii* whole cell vaccine given three weeks apart, was successful in long-term control of coxiellosis in sheep [20]. By using qPCR assay to test air samples collected near likely sources of infection (such as farms, abattoirs, and livestock saleyards), it will be possible to predict the risk of Q fever more accurately. The AirPort MD8 sampler was simpler to use and clean in the field than the BioSampler and Coriolis Micro [20]. Also, it is importance to foster awareness in communities, so that people at high-risk take necessary infection control precautions and vaccinations. One Health approach should be implemented for Q fever prevention [20].

2. Conclusions

Specialized research is necessary to precisely evaluate the risk factors for Q fever contracting. More cases around the world could be diagnosed with the help of PCR techniques that detect *C. burnetii*, in conditions like endocarditis, pneumonia, hepatitis, and pregnancy-related fever. Novel therapeutic techniques for endocarditis and vascular infections with shorter courses and better tolerance should be developed. *In vitro* assays, novel antibiotic combinations, and randomized controlled trials comparing new protocols to the therapeutic strategy of the past two decades need a special focus for counteracting Q fever.

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