

Q fever prevention in Australia: general practitioner and stakeholder perspectives on preparedness and the potential of a One Health approach

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Q fever caused by *Coxiella burnetii* is present in Australian livestock, wildlife and ticks,^{1,2} and is a persistent problem for high-risk occupations in Australia.³ Clinical presentation of Q fever includes flu-like symptoms. Complications such as endocarditis are uncommon; however, chronic fatigue syndrome is well-reported and may contribute to a high workforce turnover incurring substantial compensation claims in livestock and meat industries.^{4,5}

Q fever vaccine for humans is licensed in Australia.⁴ Vaccination involves pre-screening and must be provided by a trained general practitioner (GP).^{3,6} Q fever is of particular concern in regional and remote communities.⁷ Identified barriers to vaccination include costs,^{6,8} to overcome this the National Q Fever Management Program was a successful, but short-term, subsidised vaccination campaign.⁹ Evidence suggests that this type of vaccination campaign should be accompanied by sustainable system change.¹⁰ To facilitate such change, a multi-sectoral approach known as a One Health framework is advocated as a means of connecting human, animal and environmental domains in a Q fever prevention program.¹¹

A thorough understanding of Q fever burden and potential solutions from the perspective of stakeholders including

Abstract

Objective: To examine stakeholder perspectives on the factors of an effective approach to reduce Q fever risk including disease prevention, and the perceived potential benefits of a One Health framework.

Methods: Semi-structured interviews were conducted with general practitioners (GPs), veterinarians, government authorities, researchers, and representatives from the farming industry. Transcripts were thematically analysed.

Results: Six major themes were identified as key factors underpinning an effective approach to Q fever: understanding Q fever burden; effective surveillance; the role of general practitioners and other stakeholders; barriers and enablers of vaccination; an integrated approach; and increased Q fever awareness. Most participants perceived GPs to play a central role in disease detection, notification, treatment and prevention through health promotion and vaccination, despite GPs acknowledging limited awareness of Q fever. Participants suggested leadership is required from the Department of Health (DoH) to foster inter-sectoral communication and collaboration.

Conclusions: A One Health approach holds opportunities for zoonosis prevention. We recommend that medical curricula and professional development be enhanced, zoonosis working group networks strengthened, government-industry partnerships established, and relevant stakeholders included within an integrated program.

Implications for public health: Updating medical curricula, GP professional development programs and inter-sectoral collaboration led by health departments may reduce Q fever burden.

Key words: Q fever, general practitioner (GP), Department of Health (DoH), stakeholder, One Health

GPs, health officials and policymakers has rarely been sought. Bringing together cross-disciplinary stakeholders allows for examination of practical, on-the-ground concerns of those with an understanding of the pragmatics of policymaking and health system functionality. Further, it allows factors

identified by stakeholders as essential to Q fever prevention to inform policy responses. This study provides an in-depth analysis of these factors and a discussion of stakeholder perspectives on the potential of a One Health approach to Q fever prevention and control.

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Methods

Between July and October 2020, interviews were undertaken with four stakeholder groups responsible for: Q fever detection, treatment and notification; developing and implementing Q fever policy; generating evidence to inform clinical practice; and providing tailored advice to the farming industry.

Recruitment

Participants were identified using networks of the Environment and Health Research Group, Adelaide University, and were invited purposively to have representation across practitioners, policymakers, researchers and the farming industry. Additionally, GPs were recruited through newsletters of the Australian College of Rural and Remote Medicine, The Royal Australian College of General Practitioners, and the Primary Health Networks and Rural Clinical School. Participant roles and positions are outlined in Table 1.

Data collection

A semi-structured interview schedule (Supplementary File 1) was used, informed written consent obtained (Supplementary File 2), and interviews recorded with permission. Participants reflected on their understanding of Q fever, their perspectives on current

approaches to surveillance and vaccination, and the potential application of a One Health approach to Q fever prevention. Participants were also invited to reflect upon their own experience with initiatives concerning Q fever prevention and control. Additionally, GPs were asked about a standard consultation for a suspected case of Q fever, while veterinarians were asked about the potential for animal vaccination.

Data analysis

Participant interviews were audio-recorded and transcribed verbatim, with identifying information removed. Thematic analysis was undertaken following the framework outlined by Braun and Clarke.¹² Data coding involved five phases to identify pervasive subthemes and themes. Two researchers (MRR and KH) read the transcripts to ensure familiarisation with the data (Phase I). Phase II involved a more thorough reading of the transcripts and theoretical coding of relevant concepts, ideas and arguments. Subthemes and themes were identified via an iterative process in which transcripts were re-read and codes incrementally refined (Phase III). Phases II and III were repeated to revisit codes, subthemes and themes and were refined to develop an initial thematic map (Supplementary File 3; Phase IV).¹³ In Phase V, themes and subthemes were finalised, illustrated with quotes and presented in a thematic map (Figure 1).

The study was approved by the SA Department for Health and Wellbeing Human Research Ethics Committee (HREC/20/SAH/8).

Results

Sixteen participants across four stakeholder groups including practitioners, policymakers, researchers and industry representatives were interviewed. Six major themes were identified: understanding the Q fever burden; effective surveillance; the role of general practitioners and other stakeholders; barriers and enablers of vaccination; an integrated approach; and increased Q fever awareness (Figure 1; Table 2). Each theme had three to six subthemes. In the sections that follow, each theme is discussed, and interconnections between themes are considered (Figure 1). Illustrative quotes are presented in Table 2.

Understanding Q fever burden

Participants agreed that the clinical presentation of Q fever is variable, yet strongly acknowledged its seriousness, particularly in terms of chronic sequelae. A few participants highlighted the mental health consequences including depression associated with the chronic stage. Participants indicated that Q fever has a significant impact on the workforce, particularly for casual workers in livestock and meat industries whose compensation claims can be substantial. The majority of participants indicated that the enduring burden of Q fever is related to the organism's existence in different hosts including livestock, wildlife and ticks. However, GPs self-identified their knowledge about Q fever transmission to be suboptimal, which may cause underestimation of the true burden (Table 2, Quote Q1–4).

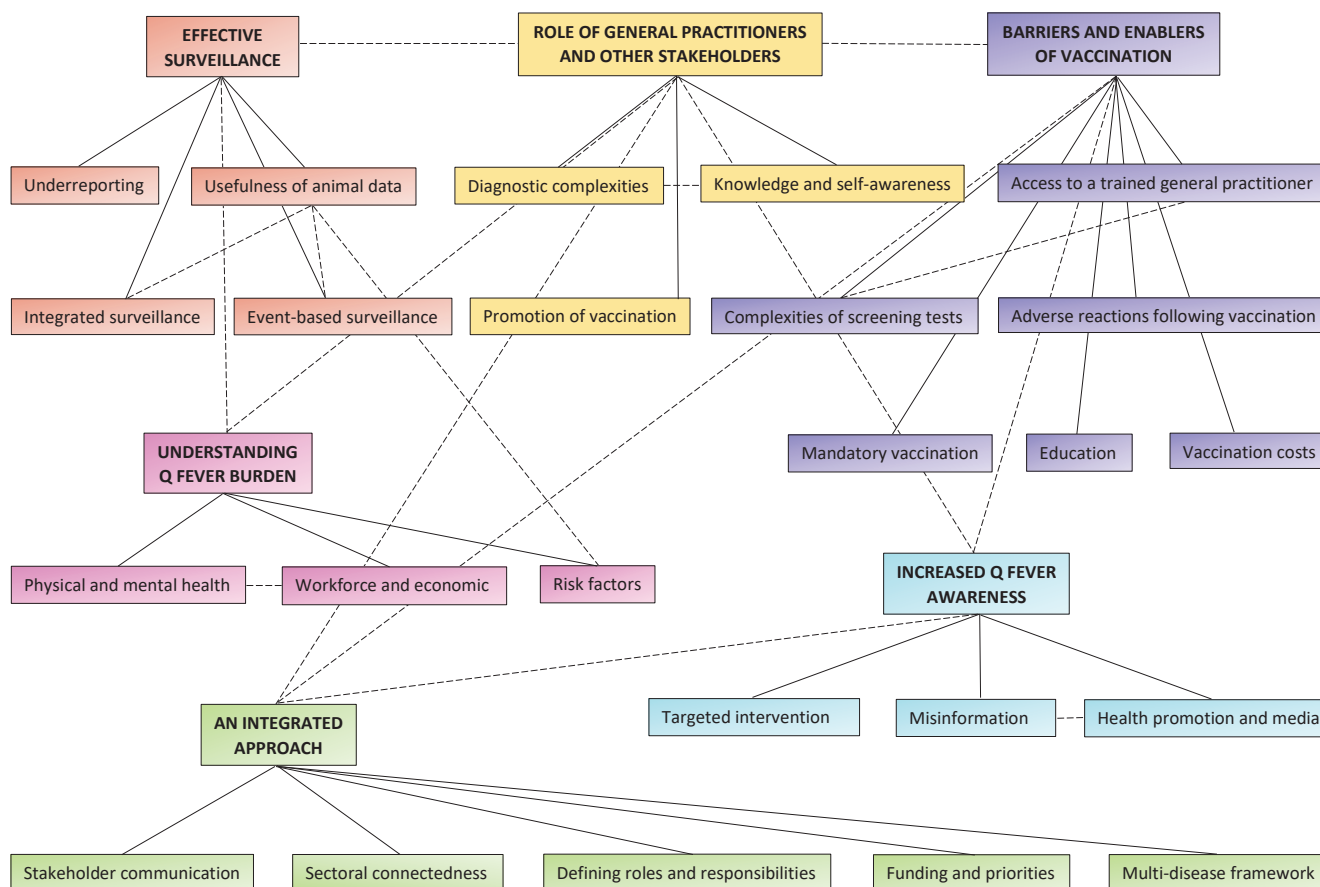
Effective surveillance

A number of stakeholders reported that human surveillance is as good as it could be, yet some policymakers and GPs suggested that underreporting remains a major issue. Participants attributed underreporting to diagnostic complexities, for example, in many instances GPs are not vigilant about zoonotic potential for humans and do not consider Q fever among differentials during a standard consultation. Some participants suggested that, unless severely ill, people may not necessarily seek medical care with mild–moderate degree of symptoms due to ignorance or apathy (Table 2, Q5).

Table 1: Participant roles and positions.

Participant (P)	Stakeholder role	Position
1	Researcher	Public health researcher One Health researcher
2	Practitioner	Veterinarian
3	Representative from farming industry	Livestock and wool producer
4	Practitioner	Veterinarian
5	Practitioner	General practitioner
6	Practitioner	Veterinarian
7	Researcher	Veterinary public health researcher
8	Policymaker	Government official
9	Researcher	Veterinary pathologist
10	Representative from farming industry	Livestock and wool producer
11	Representative from farming industry	Policy advisor
12	Researcher	Ecosystem health researcher Public health physician
13	Policymaker	Government official
14	Policymaker Practitioner	Government official General practitioner
15	Policymaker	Government official
16	Practitioner	General practitioner

Figure 1: Thematic map of major themes (bold upper case) and subthemes (sentence case). Solid lines indicate connections between themes and their corresponding subthemes (colour coded). Dashed lines indicate how themes and subthemes are interconnected.



Participants questioned the usefulness of animal surveillance given the wide range of reservoirs in which *Coxiella burnetii* prevails. Likewise, although integrated human–animal surveillance appeared to have little support, some participants suggested that event-based integrated surveillance could act as an early warning system. However, these participants argued that such integration is only useful when humans present with Q fever and an investigation is warranted for source tracing in a related animal population, or vice versa (Table 2, Q6–10).

Role of general practitioners and other stakeholders

Almost all participants indicated that GPs are integral in disease detection, notification, treatment and prevention through health promotion and vaccination. Nevertheless, participants indicated that it is common for GPs to seek testing for Q fever only when

all other possibilities are exhausted. Lack of vigilance was attributed to GPs' "limited awareness" and "limited knowledge" and acknowledged by GPs themselves. Despite these limitations, GPs, particularly in rural clinics, were considered to be well placed to promote vaccination against a background context of promotion that usually follows a "top-down" approach via the Department of Health (DoH), see Table 2, Q11–15.

The need for strong leadership was also emphasised when identifying key partners required to facilitate a One Health approach. Most participants nominated GPs and relevant medical colleges, DoH, Department of Agriculture, Water and the Environment including biosecurity, Safe Work Australia, veterinarians and the Australian Veterinary Association, and livestock producers and meat processors in their list of key stakeholders (Table 2, Q16).

Barriers and enablers of vaccination

Given that the number of GPs trained in Q fever screening and vaccination is limited, particularly in rural Australia, access to a provider was widely identified as a barrier. Complexities around screening tests including the need for two GP visits, the limited number of test centres and time constraints further compounded the issue of vaccination access. The risk of adverse effects following vaccination represented another barrier to broader provision. Furthermore, the cost of vaccination including screening cost, vaccine cost and salary loss from loss of working hours was raised as another barrier (Table 2, Q17–22).

A number of participants supported subsidies as an enabler of vaccination. While some indicated that the government should subsidise vaccination campaigns, others advocated a need for contributions from relevant industries/employers. Some

Table 2: Selected quotes (numbered 1–33) from interviewed stakeholders that illustrate the major themes and subthemes.

Themes	Subthemes	Selected quotes
Understanding Q fever burden	Physical and mental health burden (P11)	[1] [T]here's acute and chronic [...] people can get out of breath really easily. They can get the Q fever fatigue syndrome, endocarditis, hepatitis all those significant health impacts. Also, mood impacts, so mental health can be impacted. I know that [senior office holder] has had depression brought on from his Q fever experience.
	Workforce and economic burden (P1)	[2] I think the compensation claims that I've seen ... relate to abattoir workers, they tend to have much more vulnerable contracts. So I think impact on casual workforce in agriculture would be quite dramatic because it's potentially a number of weeks, and for people who are casually employed that's a substantial amount of salary loss.
	Risk factors (P15)	[3] [Q] fever bacteria is excreted in large numbers in birthing products of animals. But also in feces and urine of those animals that it can, apart from coming in direct contact with the feces, birthing products and urine. That these can also be aerosolized.
	(P5)	[4] I don't actually know the details of exactly how it's transmitted from the animal to the human. I don't know whether it has to be injured by an animal or whether just contact with the infected meat, for example, of a slaughtered cow.
Effective surveillance	Underreporting (P15)	[5] I think that there's a huge underestimation of [how] many people might be affected by Q fever in a year.
	Usefulness of animal data (P9) (P13)	[6] I think I would have some doubts about the effectiveness of animal surveillance. [7] [S]etting up a surveillance system in animals just to get to find out what's happening in humans. I don't think it's warranted because we already have a surveillance system in humans that works quite well.
	(P4)	[8] If you're looking for early warning signs of an increase in environmental contamination, or incidences of Q fever in unusual animals, maybe that would be quite useful for example.
	Integrated surveillance (P4)	[9] [Y]ou'll never get rid of it because there's too many different intermediate hosts. And I would want to know what ... to what purpose would such dual surveillance be put or how could you make use of that surveillance?
	Event-based surveillance (P7)	[10] [I]f you had an outbreak, in a farm, you could then start looking into that area in the human population. On the other side, if you had a couple of people coming in with Q fever, then you could start doing something in that area and in the animal population to find out where did this Q fever actually originate from.
Role of general practitioners and other stakeholders	Diagnostic complexities (P1)	[11] The disease itself is difficult. I've had conversations with the clinical pathologists, microbiologists, and they will tell you that they often diagnose Q fever because they've ruled out other causes of illness.
	(P12)	[12] [T]here'd be very few GPs that would be capable of making the correct diagnosis. So no doubt, we will be missing a few cases of Q fever ...
	Knowledge and self-awareness (P5)	[13] I think that many people in the medical profession's awareness of Q fever would be very low [...] I wasn't taught specifically about most zoonoses at all, like infectious diseases played a very small part in the curriculum.
	(P16)	[14] So I think awareness is probably one thing is that a lot of GPs maybe just don't know about it or don't think about it.
	Promotion of vaccination (P3)	[15] [I]f you promoted it via Livestock SA and SA Health, they had little posters up in doctor's surgeries in the country. I think your healthcare providers being the doctor surgeries and so on, that's where we said about they should have posters promoting the fact that you should get checked and vaccinated.
Key partners (P14)	[16] [T]he key partner would be SA Health, health protection, Biosecurity SA, and then the big groups where you're more likely to get workers who are going to get Q fever. So Livestock SA, and probably the meat-processing corporation, sheep producers [...] unfortunately, the college of general practitioners and the college of rural and remote medicine are sort of in competition. So you probably need to involve both of those. I was going to add, SafeWork SA would be another of those high profile partners.	
Barriers and enablers of vaccination	Access to a trained general practitioner (P14)	[17] [T]he other potential barrier is access. So there are a limited number of rural GPs, and we know there's rural GP shortage and therefore there's turnover. So there's the GPs with experience in you know, screening and vaccinating for Q fever is constantly changing.
	Complexities of screening tests (P10)	[18] I think one of the big problems is that ... you've got to have a test. You don't know whether you've had it, or you could get it. And it takes some time for that test to come back. People in regional areas live a long way from doctors in a lot of cases. So there's that time-lapse between the test and getting the result back. And then if you're positive, and if you've had it, you don't have to have the vaccination. But if you come out where you should be vaccinated, then there's another time-lapse ...
	Adverse reactions following vaccination (P9)	[19] I read about the reactions to the vaccines. I've thought about it. And I'm still undecided as to whether or not I'll ever finally get vaccinated.
	P (1)	[20] I've also heard anecdotally that many GPs are not happy providing the vaccination because of the potential for the local adverse reactions that tends to put them off.
	Vaccination costs (P11)	[21] [C]ost is a main one. So people having to pay over \$500 to get vaccinated. The perception of cost is another one, people thinking that they have to pay over \$500.
	(P10)	[22] [T]he problem as I see it is that a lot of those people are casual workers. [O]f course, if people can't work, they're on social security benefits and that's a cost of the government. I believe, if there was a subsidy program that would help to eliminate those costs to the government.
	Mandatory vaccination (P2)	[23] I think people in the meat working industry for example, and perhaps veterinary students, for example, they would actually have an awareness, because it's been required as a pre requisite to have a vaccine to do your work.
	(P8)	[24] So our general guidance as a safety regulator is you try and prevent disease, so we would expect people moving stock and handling animals to all be Q fever vaccinated.
Education (P6)	[25] If [farmers] were educated, I believe that they would take [the vaccine] up. And with education then people at least can make an educated decision on it.	

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Table 2 cont.: Selected quotes (numbered 1–33) from interviewed stakeholders that illustrate the major themes and subthemes.

Themes	Subthemes	Selected quotes
An integrated approach	Stakeholder communication (P13)	[26] [W]e do have . . . meetings, regular meetings with primary industries and department of environment. So at a government level . . . there is that interaction across the departments to make sure that we are aware of what's happening.
	Sectoral connectedness (P3)	[27] Look, the potential is there to be able to bridge gaps between various organisations and link stuff together, whether you actually have to form a completely separate organisation if you like to deliver, or would you simply need to provide links between all those concerns.
	Defining roles and responsibilities (P8)	[28] [W]e only see the workplace reports or the human reports and mostly related to workplace, so I don't even know if my reports are filtered by SA health . . . but we have not had any meetings to discuss what our different roles are.
	Funding and priorities (P16)	[29] I think along with that probably comes things like funding and resourcing problems. So funding for health or funding for agriculture and they don't necessarily overlap. So that would be other . . . and sort of different sectors having different priorities . . .
	Multi-disease framework (P2)	[30] [O]bviously, there's more conditions to be focused on rather than just Q fever alone. [S]o perhaps if you've got three, four or five diseases, that we say okay, we want to take a collective approach to creating an awareness and control prevention strategies for these in the human population, you've got more strings to your bow so to speak – perhaps a multipronged approach . . .
Increased Q fever awareness	Targeted intervention (P7)	[31] [Y]ou would need to have a campaign basically to make people aware of that [. . .] so that would have to be targeted towards producers, towards doctors and probably also actually people in the risk areas. So in rural areas, you would have to target everyone there.
	Misinformation (P12)	[32] You now have idiots . . . who run the anti-vax campaigns on social media. And unfortunately many of the less educated people who work in abattoirs, for example are prone to pick up those misinformation misleading and inaccurate statements on social media and won't get the vaccinations accordingly.
	Health promotion and media (P2)	[33] There was some press last week about children of a farming family . . . contracted Q fever and the ongoing problem several years down the tracks, so it's only through that sort of media attention and publicity that there's going to be increased awareness of the risk.

participants suggested that mandating vaccination may have dual benefits, in that it both enables vaccination and promotes broader community awareness. Although subsidised and mandatory vaccination was considered as an enabler, some reservations were noted around the funding, responsibilities and target populations of such programs. However, health education as an enabler was emphasised by the majority for informed decision making (Table 2, Q22–25).

An integrated approach

Participants unanimously agreed that open communication among stakeholders is an essential component of zoonosis prevention within One Health. While participants agreed this can be difficult, many suggested that lessons learned from the public health response to COVID-19 can be usefully adopted. Despite this agreement, some government officials reported that they had never been invited into discussions around a Q fever response, had received only limited statistical outputs, and felt insufficiently empowered to engage in the decision-making process. Other stakeholders, including farming industry representatives and veterinarians, reported experiencing significant power disparities and limited inclusiveness in decision making. A 'bottom-up' approach was advocated by participants to promote cross-sectoral collaboration on the issue, rather than creating a completely new unit tasked with driving change (Table 2, Q26–28).

The majority of participants indicated that having a clear definition of roles and responsibilities would be an important enabler of an inter-sectoral approach to Q fever. However, concerns were identified around funding as participants indicated that sectors may not be inclined to collaborate when their funding models and priorities do not overlap. To overcome this challenge, a novel model was suggested where infectious diseases, non-communicable diseases, nutrition and climate change could be addressed in a One Health approach. This model could be built on an existing structure such as one applied for avian influenza, bat lyssavirus or rabies (Table 2, Q28–30).

Increased Q fever awareness

Most participants reported that awareness about Q fever and other zoonotic diseases is extremely low at the community level and among clinical and industry stakeholders. The majority advocated widespread awareness-raising, although targeted interventions were thought to be more efficient. Targeted interventions included industry-led awareness campaigns, serological surveys among at-risk workers, zoonotic screening for GPs and veterinarians, a One Health summit, or a novel ecological intervention such as combating zoonotic diseases through the sustainable use of green space and boosting human immunity. Raising occupational awareness was strongly advocated as a means of countering misinformation reported to prevail among certain occupational groups with relatively low education levels,

such as abattoir workers, and even in the wider community due to the influence of those opposed to vaccination ('anti-vaxxers') on social media. Many participants also underscored the importance of promoting education about Q fever by GPs, as well as through media coverage of real-life accounts of the disease (Table 2, Q31–33).

Discussion

Our study is one of few Australian studies to investigate stakeholders' perspectives on current and potential (One Health) approaches to Q fever prevention and control. Of the themes identified, the 'role of general practitioners and other stakeholders' was most central to participants' accounts of the elements underpinning an effective approach to the disease. A majority of participants concurred that GPs and DoH represent key players while other stakeholders form the rest of the interwoven fabric in the One Health framework for Q fever prevention. However, participants suggested that GPs' current "limited awareness" of Q fever and underreporting of the disease,¹⁴ along with "limited leadership" from DoH, represent constraints on effective Q fever prevention. Many participants reported that GPs do not possess adequate knowledge and awareness of zoonoses, particularly when they see patients with occupational risk factors for such disease. Significantly, GPs themselves highlighted their limitations, linking them to inadequacies in medical curricula concerning zoonoses. This finding resonates with

Australian studies conducted among at-risk occupational groups.^{6,8,15,16} Although there is no quick fix, one option is to incorporate major zoonotic diseases in medical curricula in a manner similar to that recommended to Australian veterinary and animal sciences students.⁶ It is also worthwhile considering the use of available resources such as the *Q Fever – Early Diagnosis and Vaccination* online training module in supporting GPs' professional development.¹⁷

Several participants believed DoH's leadership in Q fever prevention is limited. They argued that DoH must take the lead by promoting awareness of Q fever among at-risk workers and GPs and exchanging information with relevant stakeholders to ensure an integrated response. Although participants from DoH indicated that a Q fever strategy or zoonosis working group has been recently formulated, it seems its influence is not yet established. However, it is obvious that COVID-19 has prompted some collaboration among sectors in Australia and internationally. Strengthening such collaboration may merit the adoption of the suggested model including a range of diseases/conditions that may prove practically and economically efficient and promote inclusiveness.

In line with existing literature,³ most participants argued that the substantial health and economic burden of Q fever among Australian at-risk populations is inextricably linked to the large domestic and wildlife reservoir of *Coxiella burnetii*. This highlights the natural limitations of animal vaccination in Australia and sets the benchmark for human vaccination as the mainstay of prevention.¹⁸ However, barriers to human vaccination may include costs and access to appropriately trained GPs. Prohibitive vaccination costs have been identified in other studies^{6,8} and formed the basis of many participants' views that a subsidised program¹⁵ would be the most efficient means of preventing Q fever-related direct healthcare costs.¹⁹

Nevertheless, funding and priorities were highlighted by stakeholders, particularly when sectors are considered solo and unintegrated. Although most participants favoured the government-subsidised vaccination programs, some indicated that industry must also contribute to an effective Q fever response. Given other competing priorities, our research suggests that a practical model may involve government-industry joint-ventured Q fever preventative services.⁸ Provision of such services may

require system change and include at-risk community education, GPs' awareness and training, targeted vaccinations for all at-risk workers – not just abattoir workers for whom it is an occupational requirement,²⁰ and event-based integrated surveillance. Community education could potentially support workers to challenge misinformation, and GPs' awareness and training may enhance their vigilance and promote vaccination.²¹

A limitation of this study was the inability to recruit a practising rural GP (although we interviewed a policy stakeholder with significant experience in rural general practice, this may limit the transferability of findings concerning GPs' knowledge and awareness of zoonoses), a representative from the meat industry, or a staff member from SA Pathology (owing to workload constraints in light of COVID-19). Additionally, our sample size (16) may seem to be small, as well as not having representation of rural residents other than people from the farming industry who nevertheless are also at increased risk of Q fever.²² Despite these limitations, interviewing a range of stakeholders with significant expertise on Q fever surveillance, treatment, zoonosis prevention, a One Health approach and – most importantly – policy perspectives enhanced the richness of our data and increased the transferability of findings. Our study provided novel opportunities to find solutions, in addition to identifying potential barriers to an integrated approach.

Our results highlight that although the perceived barriers to a One Health approach are substantial, the opportunities are significant. In order to deal with the most concerning themes, we recommend updating medical curricula with dedicated inclusions on infectious diseases including major zoonosis. We also recommend that DoH provides proactive leadership and that the zoonosis working group and Q fever strategy be streamlined to empower stakeholders and ensure inclusiveness with clear definitions of roles. The zoonosis working group could include multiple zoonotic diseases. We suggest government agencies exchange information and intelligence including data sharing,²³ and institute targeted interventions including awareness-raising and human vaccination. Although Q fever is a predominant concern for human health, technical and financial support from all stakeholders will be required to establish effective, sustainable government and industry partnerships.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary File 1: Interview schedule.

Supplementary File 2: Participant information sheet/consent form.

Supplementary File 3: Initial thematic map.