



What makes an effective One Health clinical practitioner? Opinions of Australian One Health experts

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ABSTRACT

Despite agreement that One Health practices facilitate effective management of zoonoses, the pathways to a coordinated and collaborative approach by general medical practitioners (GPs) and veterinarians are hampered by limited understanding of how this can be practically incorporated in routine clinical settings. Data collected during a Delphi survey of Australian One Health 'experts' was used to explore opinions and insights into desired knowledge, attitudes and practices of effective One Health clinical practitioners. Five categories were identified as essential for GPs and veterinarians, namely: accurate baseline knowledge of specific zoonoses; a 'big picture' understanding of zoonoses; understanding of professional roles within the One Health paradigm; understanding one's own professional limitations; and collaboration and referral improve outcomes. An outline of the roles and responsibilities of GPs and veterinarians as effective One Health clinicians was determined based on the opinions of the expert panel. Educational interventions that foster interprofessional communication and collaboration will be necessary to successfully bring about the cultural change required to achieve effective One Health practice in Australia, and thus expedite improved human, animal and environmental health outcomes.

1. Introduction

Worldwide, there is increasing concern regarding the risk of emerging infectious diseases (EIDs) and the threat of potential epidemics or pandemics, with many EIDs having an animal origin [1–3]. Maintenance of global health security requires preparedness across all sectors [4–6] and there is clear agreement that multi-sectoral, One Health collaborations involving medical, veterinary, public health and environmental health professionals will significantly improve outcomes in the case of zoonoses [5–9]. Over the last decade significant progress has been made to build or strengthen multi-sectoral relationships at the academic, government and inter-governmental levels [9–14], with considerably less activity occurring at the clinical practitioner level [15–20].

General medical practitioners (GPs) and veterinarians are positioned as 'front line' responders and may be confronted with zoonotic diseases and sentinel events. Therefore it is imperative they are equipped with knowledge and capacity to effectively respond to these threats, ideally employing a multi-disciplinary response to optimise

outcomes [14,21–25]. However, the roles for GPs and veterinarians within the context of One Health are poorly defined and pathways enabling facilitation of interprofessional cooperation and collaboration at the clinical level are unclear [8,15,22,26–28].

We previously conducted a modified Delphi survey of Australian One Health 'experts' from animal and human health backgrounds to obtain opinions on future research priorities and educational interventions for GPs and veterinarians with a focus on a cross-professional approach to zoonoses and EIDs. Findings from that study enabled identification of a number of priority topics and diseases. Alongside the quantitative findings reported previously [26], experts provided insights with depth and nuance of opinions in open responses that warrant further consideration to progress professional discussion of clinical One Health practice. In this paper we present a thematic analysis of these comments to gain a deeper understanding of the experiences and opinions of Australian One Health experts. Of particular interest was the desired knowledge, attitudes and practices of effective One Health clinical practitioners, as identified by the experts.

Abbreviations: EIDs, Emerging infectious diseases; GP, General medical practitioner

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2. Methods

The methods and objectives for the Delphi survey have been described in detail elsewhere [26]. Members of the expert panel were from a range of One Health backgrounds including veterinarians (50% and 55.3% in Phase One and Two, respectively), medical practitioners, including infectious diseases and public health medicine specialists (17.7% and 14.9%), public health practitioners (17.6% and 14.9%), epidemiologists (7.4% and 6.4%), academics (5.9% and 8.5%) and others (1% and 0%). Approximately half of all veterinarians and medical practitioners identified between one and three additional professional roles including wildlife medicine, public health, epidemiology, microbiology, pathology and academia. We further categorised the experts as being from either a veterinary (57.4% and 64.9%) or non-veterinary (42.6% and 34.1%) background based on whether they had a veterinary degree.

In Phase One of the Delphi survey, the expert panel responded to open-ended questions asking for opinion on: (1) topic areas related to knowledge of zoonoses and EIDs that they believed should be prioritized in a future survey of GPs and veterinarians; and (2) practices of GPs and veterinarians that they believed reflect a good understanding of a One Health approach to the management of a patient with a zoonotic disease ("One Health efficacy"). Approximately 1300 responses to the stimulus questions were collected in Phase One ranging from names of diseases and short responses to comprehensive extended comments. This data was analyzed and 13 topics and sub-topics, including a list of 24 diseases and agents were identified. In Phase Two, participants were asked to rank these in order of importance generating quantitative data which has been previously published [26]. Participants were also given opportunities to provide general comments in both phases.

In this paper we present the results of qualitative analysis of responses to open-ended questions and comments provided by the expert panel focusing on the question 'What makes an effective One Health practitioner?' Analysis was done using principles of thematic analysis as described by Braun and Clarke [29,30] who advocate an inductive approach to coding and theme development. Data analysis was conducted using both NVivo 11 qualitative data management software and manual methods, where coloured highlighters were used to identify patterns in the data. One of the researchers (SS) read and re-read responses from Phase One and Phase Two, noting similar or recurring words, phrases and concepts. Codes were then produced from the data as groupings of ideas were identified, and then related codes were combined into key categories and sub-categories using both mind-maps and manual methods. After reviewing the data again, these were further refined into five major categories which were finalised in consultation with the other members of the research team. Quotations from experts are provided for illustrative purposes. Spelling and grammatical errors have been corrected and insertions (in square brackets) have been included to improve clarity without altering the intent of the quotation. Given the small number of One Health experts in Australia, the authors elected to describe participants by number only as some may be identifiable if more comprehensive demographic information was included.

Approval for the project was granted by the University of Sydney human ethics committee (project number 2016/986).

3. Results

Analysis of the data resulted in identification of five major categories. Practitioners were seen to require:

1. An accurate baseline knowledge of specific zoonoses
2. A 'big picture' understanding of zoonoses
3. Understanding of professional roles within the One Health paradigm
4. Understanding professional limitations

Knowledge and understanding of these areas enable practitioners to

move towards cooperative One Health based practice by discerning that:

5. Collaboration and referral improve outcomes

Each category developed as an ongoing progression of ideas built on the foundation of the preceding category(s), ultimately providing a framework identifying the knowledge, attitudes and practices of effective One Health practitioners.

3.1. An accurate baseline knowledge of specific zoonoses

Experts universally agreed that an accurate baseline knowledge of specific zoonoses was a cornerstone of effective One Health practice, underpinning clinician awareness and ability to diagnose and manage zoonoses. This was summed up by one expert who stated, '*appropriate knowledge is essential for accurate diagnosis and understanding*'. (Participant 74). Most experts used strong descriptors in their responses when discussing knowledge of zoonoses, including adjectives and phrases such as '*hugely important*', '*appropriate*', '*accurate*', '*comprehensive*', '*evidence based*', '*relevant*', '*robust*' and '*current practice*'.

The following sub-categories were identified as important areas of knowledge for GPs and veterinarians:

1. Being able to recognise specific diseases
2. To understand unique risk factors
3. To understand specific diagnostic test protocols
4. To have knowledge of the route(s) of transmission
5. Knowledge of appropriate sources of information.

Knowledge of these areas was viewed as essential, with poor understanding seen to have a significant impact on the ability of GPs and veterinarians to diagnose zoonoses and manage their risks. This concern was summarised by one expert stating that '*...ignorance will lead to poor outcomes*.' (Participant 18).

The requirements for specific disease knowledge was seen to be dependent on geographical location – that is, what zoonoses are endemic in that region – and in the case of veterinarians, the type of clinical practice they are engaged in (e.g. companion animal vs mixed practice). The expert panel named twenty-five different diseases and agents. The high number of references to Q fever (*Coxiella burnetii*) was noteworthy. Over half of the panellists made one or more comments referring directly to Q fever; this disease was mentioned twice as often as any other disease or agent. While knowledge of local endemic diseases was a clear priority, a number of experts also identified exotic diseases such as rabies, specifically expressing concerns about the significant impact of a disease incursion in the light of Australia's rabies free status (albeit that Australian bat lyssa virus is carried by bats).

Veterinarians, especially those in companion animal practice, were seen by some experts to lack insight about the true level of zoonotic risk, with one commenting that '*...Some sectors of the veterinary profession believe that working with small animals means that zoonoses, apart from commonly known ones such as ringworm, are very low risk and probably do not form part of a risk assessment for clinic biosecurity (if they conduct one). Recent occurrence of Brucella suis in dogs and Q fever in breeding cats in city practices indicate that previous understanding needs to be expanded*.' (Participant 31). Experts also perceived that a lack of specific knowledge of zoonoses amongst some GPs may compromise their ability to '*...ask enough questions to determine if a zoonoses may be involved*' (Participant 51) or '*recognise illnesses of potential high transmission and how to deal with patients presenting with these potential illnesses*.' (Participant 64).

Whilst an accurate baseline knowledge was deemed essential, it was considered that having a comprehensive knowledge of all potential zoonotic diseases was an unrealistic expectation. A number of experts accepted that GPs and veterinarians have competing demands due to

expectations to be competent across many areas of practice. Therefore, knowing where to find accurate information about zoonoses was seen as a major priority by some experts, with one panellist stating that “Resources are extremely important. Forcing [continuing professional development] for otherwise busy people is not so important - just my opinion - we can't be experts in everything”. (Participant 64)

3.2. A ‘big picture’ understanding of zoonoses is needed

Many experts perceived ‘both vets and GPs need to understand the bigger picture to identify emerging diseases’ (Participant 30). The ‘big picture’ involved understanding both the epidemiology and ecological drivers of zoonoses. Most experts perceived that a good awareness of epidemiology and environmental drivers gives practitioners a deeper understanding of the factors influencing transmission and risk of zoonotic diseases. Understanding the ‘big picture’ helps GPs and veterinarians comprehend how diseases ‘work’ and reinforces and builds on their baseline knowledge of specific zoonoses.

While the ‘big picture’ was seen as a priority for One Health efficacy, the expert panel identified different areas of focus within this category for GPs and veterinarians. Many experts recognised the primary focus of GPs should be how epidemiology and environmental drivers of zoonoses impact on patient risk and clinical management. One expert gave the context that GPs require: ‘Knowledge of local epidemiology of zoonoses, history taking to ascertain health of contact animals. Awareness of recent local stressors, such as drought or rain, and how they can impact on risk.’ (Participant 41). In other words, GPs should be cognizant of external factors that may increase susceptibility to zoonotic disease, but their priority is patient care.

In contrast, veterinarians’ understanding of epidemiology and environmental drivers of zoonoses should recognise the interplay between multiple factors which precipitate animal disease and the risk of human infection, with a focus on their impact on public health outcomes. This involved ‘Consideration of the ecosystem/production system/household system-level factors in addition to individual-level factors that may have led to the animal being infected and may be important for reducing the potential for transmission to humans.’ (Participant 27) While diagnosis and management of animal patients was clearly important, actively addressing the potential for zoonotic disease to impact on human health outcomes was thought to be a One Health priority.

However, a few experts thought that this ‘big picture’ understanding was less relevant to clinicians, with one concluding ‘An understanding of ecological drivers [is] clearly important, but to me this would be most relevant at the Public Health level.’ (Participant 75).

In general, there was a perception by the majority of the expert panel that an understanding of epidemiology and environmental drivers of zoonotic disease helped clinicians to be realistic about zoonotic risk as “Epidemiology [enables] understanding the relative rarity of zoonoses and the relative benefit of animal interactions” (Participant 64). A broad perspective was thought to equip GPs and veterinarians to place zoonoses within the context of a One Health framework due to an improved understanding of the factors which influence emergence, risk and transmission of zoonotic disease.

3.3. Understanding professional roles within the One Health paradigm

In general, in order to be effective One Health practitioners, experts perceived that GPs and veterinarians need to understand the “basic tenets of One Health practice, and how it relates to classical knowledge and practice in infectious diseases” (Participant 60). There was recognition that GPs and veterinarians have specific roles in the One Health arena, but acknowledgement that both professions need to understand how their roles and skills complement those of other One Health professionals in order to attain effective multi-disciplinary partnerships. “GPs and vet’s primary role in the One Health arena is to recognise, diagnose and treat potential zoonoses. They can educate about risk factors and individual

interventions, but they are less likely to have an impact on the various ecological drivers that promote zoonoses - generally this becomes the ‘very important domain’ of other members of the one health team.” (Participant 79).

GPs were seen by most experts to have a primary responsibility to appropriately manage disease or risk of zoonotic infection in their patients. However, the perceived lack of understanding of the roles of other One Health professionals was seen by many experts to result in missed opportunities for positive One Health engagement and potentially poorer clinical outcomes for their patients in the case of zoonotic diseases. A number of experts thought there was an explicit need for GPs to have greater insight into the roles of other professionals involved in One Health to enable them to become more effective in this sphere. ‘[GPs] lack understanding about roles and responsibilities of stakeholders in one health. The knowledge about who to contact for information, advice or reporting is often scant and there needs to be more work ensuring different stakeholders are well connected and understand each other roles and which areas of the public health puzzle they are responsible for.’ (Participant 67) Some experts specifically commented that GPs need greater understanding of veterinarians’ skills and the clear interface that exists in management of many of zoonotic diseases. ‘[GPs need] knowledge of the role and expertise of veterinarians - and the potential to investigate and respond to zoonotic disease in collaboration with the patient’s veterinarian (rather than in isolation).’ (Participant 15).

A significant number of experts saw that veterinarians should take a broader role in One Health practice. While their initial involvement was usually in the context of a consultation involving an animal or group of animals, veterinarians ultimately need to be cognizant of the impact of zoonoses on environmental, animal and human health and welfare outcomes and to understand the necessity for multi-disciplinary involvement in clinical management of disease(s). They need to ‘Consider not just the risk to owner and their pets but the broader risks to the community, other animals and environment - especially other exposed people. Consider reporting to [Public Health Unit] to enable tracing and investigation of others at risk.’ (Participant 15). It was seen as essential for veterinarians to be aware of the potential extent of human morbidity and mortality with some zoonoses. There was a general imperative that ‘[Veterinarians require knowledge of] management of zoonotic diseases to protect human health.’ (Participant 17) The capacity for this broader role was seen as a consequence of veterinarians’ training and experience with multiple animal species and populations, ‘... given that veterinarians would normally have more contact with and understanding of the non-human species which these diseases and parasites may use as reservoir hosts.’ (Participant 18).

3.4. Understanding professional limitations

Being an effective One Health practitioner was seen to require more than just knowledge of zoonoses and professional roles within One Health. An attitude of professional humility was identified as advantageous, including a clear recognition of the limitations of one’s own sphere of practice whilst having an accurate understanding of how one’s own unique professional skills complement and enhance those of others. One expert summarised that ‘[GPs and vets need to] recognise their own limitations in knowledge and skills and seek inputs from other discipline areas... Recognise their own limitations with respect to knowledge, diagnostic and treatment capabilities.’ (Participant 60). GPs in particular were seen by some to require ‘a willingness to accept that experts other than medical experts (vets, environmental scientists, wildlife experts etc.) can contribute to patient management on a broader, holistic scale’ (Participant 15), presumably through advising GPs of risks and management considerations. Being able to see where others fit in the ‘puzzle’ would consequently result in a willingness to seek assistance from outside of professional ‘silos’, resulting in GPs and veterinarians working collaboratively for better outcomes. Most experts perceived that poor One Health efficacy was the upshot of lacking insight in this

area, with both GPs and veterinarians seen to overstep the boundaries of their scope of practice.

As a specific example, a number of veterinary experts expressed disquiet about medical practitioner recommendations for euthanasia of animals to manage risk without consulting with a veterinarian regarding its appropriateness or effectiveness in the given context. Euthanasia of animals in the face of a real or perceived risk of zoonotic infection to humans was recognised as a complex decision, requiring consideration of multiple factors. One expert commented that ‘...*The use of euthanasia to remove risk could be considered the same as using a hammer to dispatch a snail - there are other effective measures to minimise risk than the black ops method.*’ (Participant 31). Another emphasised that consultation with a veterinarian was essential: ‘*Advising the owner to discuss investigating and managing infection and risk factors associated with the animals with their veterinarian RATHER than the Dr providing advice about what to do with the pet (Drs have unnecessarily advised owners to kill pets in the past). Recognising that it is not within their area of expertise to provide veterinary advice.*’ (Participant 15).

However, experts from both veterinary and non-veterinary backgrounds recognised that, in specific cases, a recommendation for euthanasia is appropriate: ‘*If the zoonosis is of great public health concern for other animals/humans, implement the best practice which may include euthanasia.*’ (Participant 76). Practitioners should also understand advising euthanasia can have ramifications in many areas: ‘*Determining other at-risk animals (including humans). Understanding the financial/social/psychological impact of the disease and knowing when it is inappropriate to advise euthanasia/culling.*’ (Participant 64).

Despite a perception that veterinarians may have a greater understanding of zoonotic diseases, a number of experts clearly expressed that it is never their role to give medical advice, instead they must instigate referral to appropriate medical practitioners: ‘*Vet does not provide advice to the owner about treating human illness - recognising that it is not within their area of expertise to provide medical advice* (Participant 15).

In general, the ability of GPs and veterinarians to recognise their professional limitations was seen to require some insight into personal capabilities, knowledge competencies and gaps, and a degree of professional humility, recognising others may have greater knowledge in specific areas. These factors, along with a need to understand the professional skills of other One Health practitioners and a willingness to work with other professionals were seen as vital in attaining better clinical outcomes within a framework of effective One Health practice.

3.5. Collaboration and referral improve outcomes

Because of the clear interface between human and animal health in zoonotic diseases, many experts, especially those from a veterinary and public health background, perceived cross-professional collaboration and referral as the hallmark of effective One Health practice: ‘*The concept of One Health is based on collaboration, knowledge sharing and value-adding through referral and collaborative methods.*’ (Participant 74). Collaboration was seen by many experts to be an important tool in optimising both patient and One Health outcomes including effective risk management of zoonoses, with one expert summarising that ‘*Collaboration leads to sharing of knowledge and results in better prevention, diagnosis, treatment and control outcomes.*’ (Participant 18).

However, achieving effective collaboration was seen to require established channels for intra-professional communication and, as previously seen, an understanding of the roles of other One Health professionals: ‘*[There needs to be] communication between veterinarians and medical groups at local, regional and national levels. There is a need to breakdown the silo mentality that certain subjects are entirely the responsibility of one professional group when the collective knowledge would be greater. An open channel between veterinary and medical groups (which could involve seminars, conferences, regional collaborative groups) would improve information exchange and trust.*’ (Participant 31).

Many experts perceived cross-professional referral between GPs and veterinarians as the logical next step for effective One Health practice with some expressing excitement about the potential for referral. When asked about practices that would show GPs had a good understanding of a One Health approach, one expert envisioned this as ‘*[GPs] enquiring as to veterinary contacts that might be involved or directing the owner to the vet if not yet contacted to investigate animal disease +/- contacting the vet themselves or perhaps even better setting up a referral - now this could be a particularly good idea to set up a mechanism / option for doctor to vet referral! and vice versa ie. vet to doctor!*’ (Participant 21). A number of experts proposed moving towards formalisation of referrals between GPs and veterinarians using phone calls or structured referral letters, seeing this as an important step towards improving One Health efficacy.

There were differences of opinion, however, with some experts seeing collaboration and referral as unnecessary at the primary care level, being indicated more at the clinical specialist and/or governance level: ‘*It is more important that there is formal and regular contact between human and animal public health agencies, rather than between individual GPs and Vets.*’ (Participant 75).

The majority of experts saw a need to work towards encouraging and developing effective One Health practices at all levels. It was considered highly likely that veterinarians will see zoonotic diseases in everyday practice and, even though this may be a less frequent occurrence for GPs, developing appropriate referral pathways and collaborative practices at all professional levels was seen as advantageous.

Despite the identified advantages of effective One Health practice, the expert panel discerned three apparent obstacles to collaboration and referral. Some saw as a major barrier a lack of knowledge of whom to refer to. ‘*One issue regarding referrals is knowing who to contact. Vets would have little knowledge of public health structure and area health services and GPs would not know who in the vet world to contact, especially specialist vets...*’ (Participant 31).

A second obstacle identified was a lack of understanding when referral was necessary: ‘*Knowing when to refer the patient to someone else - medical specialist or veterinary specialist. Recognising which zoonoses need ongoing surveillance to avoid complications (eg Q fever, brucellosis) or ongoing transmission.*’ (Participant 64). Finally, others saw that some practitioners may feel a need to ‘defend their patch’ or were just too busy to engage: ‘*the hardest nut to crack with One Health is at the grass roots level (in the developed world) - we are hell bent on protecting our little silos or too busy that we miss the opportunities for connecting with the appropriate professionals.*’ (Participant 32).

4. Discussion

This study contributes to a limited number of studies [27,28] which aim to identify and clarify specific attributes and roles of effective One Health practitioners at the clinical level. The expert panel identified that GPs and veterinarians required a sound basic knowledge of zoonoses and an understanding of their epidemiology and environmental drivers. However, to be effective One Health practitioners clinicians need to consolidate this by being cognizant of their own and others' roles within the paradigm of One Health, including the limitations of their scope of practice. It was perceived that only then could both GPs and veterinarians fully understand the overall benefits of One Health collaboration and referral in order to facilitate better health outcomes for both human and animal patients. In essence, One Health efficacy could be summarised as comprehending and applying ‘*what One Health actually means in a practical context*’ (Participant 60).

Within the five categories determined in the analysis, the expert panel identified the desired knowledge, attitudes and practices of effective One Health clinical practitioners. Despite their common roles as healthcare providers it was clear the experts did not see GPs and veterinarians as professional ‘clones’, one with a human health and the other with an animal health focus. Rather, they identified both common and different roles and responsibilities with respect to patient

Table 1
Roles and responsibilities of effective One Health clinicians as identified by experts.

GPs	Veterinarians
Diagnose and treat human patient(s)	Diagnose and treat animal patient(s) while prioritising human and public health outcomes
Initiate referral and collaboration where appropriate to optimise overall health outcomes	Initiate referral and collaboration where appropriate to optimise overall health outcomes
Communicate about and implement risk management strategies for human patient	Communicate about and implement risk management strategies to optimise public health and animal health outcomes
Report notifiable conditions to Public Health Unit as required and communicate with animal biosecurity authority where indicated.	Report notifiable conditions to animal biosecurity authority as required and communicate with Public health Uni organisation where indicated.
Be aware of environmental factors impacting zoonoses transmission and risk	Consider environmental factors impacting zoonoses transmission and risk when making clinical decisions
Be aware of the impact of zoonoses on the community and animal(s)	Consider the impact of zoonoses on economic outcomes and animal welfare when making clinical decisions.

management which are outlined in Table 1.

An accurate baseline knowledge of specific zoonoses was recognised as essential for One Health practice at the clinical level. Knowledge of Q fever was frequently identified as a priority for both GPs and veterinarians. This is consistent with our original quantitative analysis [26] where Q fever was seen as the highest priority disease for GPs and the third most important for veterinarians. Q fever is the most common direct zoonosis in Australia and has been the subject of much recent research and discussion. [31–34] However, its degree of importance may not be as marked as the data suggest, with a number of other common zoonoses such as *Salmonella*, *Campylobacter* and *E. coli* causing more frequent illness and morbidity in humans in this country [35]. Indeed, the potential for direct zoonotic transmission of these gastrointestinal pathogens is sometimes overlooked, even by clinicians [26,36,37].

Many experts from both veterinary and non-veterinary backgrounds expressed concern regarding the poor knowledge of zoonoses by GPs, an area also identified in previous studies [38,39]. Concerns encompassed the lack of knowledge of specific diseases, lack of understanding about the relevance and interpretation of diagnostics, and lack of insight into the roles of other One Health practitioners. A number of experts specifically thought that GPs would improve clinical outcomes for their patients if they had a deeper knowledge of the epidemiology of disease, that is, a ‘big picture’ view instead of a ‘single outcome/disease centric’ mindset. This has been previously identified as a crucial area of knowledge, enabling clinicians to better understand infectious diseases [11,40,41], and, in the context of zoonoses, assisting practitioners to comprehend the need for One Health collaboration. The veracity of these concerns cannot as yet be quantified, as the level of knowledge of GPs in Australia regarding zoonoses has not been evaluated. We are currently addressing some of these areas in a project investigating knowledge, attitudes and practices of GPs (and veterinarians) with respect to zoonoses management and confidence therein.

Collaboration and referral was seen by many experts, especially those from veterinary and public health backgrounds, as the epitome of One Health efficacy. Collaboration is at the heart of much of the One Health literature, beginning with Calvin Schwabe's early writings on ‘One Medicine’ in 1964 [42] and followed by many examples up to the present day. The One Health paradigm involves multidisciplinary collaboration at ‘local, regional, national and global levels’ [43] in order to maximise human, animal and environmental health and welfare outcomes using a common strategy [6,25,43]. All disciplines within One Health have unique roles which are defined by their training and experience. While there may be some areas of overlap, the multi-disciplinary nature of One Health practice requires cooperation and collaboration by employing the distinctive and defined skills of the co-contributors [15]. As stated by Zinsstag et al. ‘One Health’ must become mainstream rather than a new discipline or new association; it should just become normal that practitioners and professionals in the health, animal and environment sectors work together as closely as possible.’ [16]

Although there was some disagreement, most experts thought that engaging GPs and veterinarians in One Health collaboration had clear advantages. Involving graduate veterinarians and medical practitioners will however require behavioural and cultural change. [11] Some authors have seen positive moves towards collaborative practices [44], however it was clear from our analysis that most Australian One Health experts did not think that collaboration was happening effectively at the clinical level. Much of the One Health literature focusing on multi-disciplinary collaboration has an expectation that veterinarians will take the lead in this area as they are more likely to grasp the benefits of One Health practice due to a broader understanding of zoonotic diseases. [11,12,15,18,27,45,46] However, successful implementation of One Health collaboration was seen both by our expert panel and others [11,15,47] to be dependent on GPs being cognizant of the benefits of a One Health approach to zoonoses and being willing to engage in collaborative care.

Many have also proposed the need for cultural change at the training level [11,46,48–50], with some suggesting the current lack of engagement in collaborative, multi-disciplinary practice is a consequence of current medical educational curricula [50]. Cooperation between veterinary and medical training institutions is seen as essential in bringing in a change of attitudes amongst students and clinicians in the future, with the knowledge, attitudes and practices of practitioners being seen to be primarily influenced by their clinical education [7,14,50]. Involvement by students in One Health clinics have been found to have a positive impact on their long term engagement [15], with further research and evaluation into this type of intervention being clearly indicated.

Effective One Health collaboration between GPs and veterinarians is seen to be dependent on building pathways for interprofessional communication [18,47,51]. A number of experts in our study suggested practical ways of facilitating this such as seminars, conferences and regional collaborative groups in order to provide a platform for developing relationships between GPs and veterinarians and increasing the comprehension of each other's professional skills and capabilities. Others have suggested that the goal of these endeavours should be to build trust [12,52], with some suggesting this as a critical turning point in breaking down medical practitioner's ‘anthropocentric viewpoint’ [53] and professional isolation. The lack of clearly defined competencies and agreed role for One Health has been identified previously as an impediment to collaboration in Australia [54]. By focussing our analysis on ‘what makes an effective One Health practitioner?’ we have provided additional insights into perceived One Health roles and responsibilities of medical practitioners and veterinarians to those published previously [27,28]. These may help guide competency-based, interprofessional education programs in support of more effective One Health practice in the country.

The viewpoints determined in our analysis have enabled us to progress our broader research agenda, namely to identify priority areas for future surveys and educational interventions with the aim of

building knowledge and capacity of GPs and veterinarians, as well as exploring pathways for collaboration and referral between sectors. There are however several limitations to this study. Firstly, approximately 60% of experts were from a veterinary background, with this group being more inclined to give extensive commentary than those without such a background. However, the opinion generated was largely consistent with the results of the original quantitative analysis [26] where there was general agreement between these groups except in the areas of collaboration and referral, which was rated as more important by participants with a veterinary background. It is therefore thought unlikely that this has created any significant bias in the qualitative analysis. A broader understanding may have been gained by more active recruitment of non-veterinary experts.

While overall there was an adequate number of participants and responses, the data did not provide enough depth to do a complete thematic analysis. However, it did warrant exploration and produced a representative overview of the opinions of experts by applying the principles of thematic analysis to determine defined categories. Data quality could have been improved by modifying the Delphi process to ask more open-ended questions or conducting targeted interviews with participants, but the original study design was selected being mindful of the time constraints of participants as well as geographical distribution of the target group.

5. Conclusion

In order to be effective One Health clinical practitioners, GPs and veterinarians require accurate knowledge of specific zoonoses, a 'big picture' understanding, insight into professional roles, acceptance of their professional limitations and a willingness to engage in cross professional collaboration. Integration of One Health concepts into medical and veterinary clinical training and continuing professional education, using interventions designed to facilitate interprofessional communication, co-operation and collaboration, will strengthen relationships and trust between clinicians. This will normalise One Health practice and equip GPs and veterinarians to be effective in their roles as 'front-line' responders in the face of current and emerging zoonotic disease threats.

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Authors' contributions

SS designed the study, coordinated the surveys, performed the data analysis and drafted the manuscript. SM co-designed the study and provided feedback on the analysis and drafts. JAT provided feedback on the analysis and drafts. RB provided feedback on study design and reviewed the final draft. All authors approved the final manuscript.

Declaration of Competing interest

The authors declare they have no competing interests.

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