The challenges of implementing an integrated One Health surveillance system in Australia: A qualitative study

Isabella Johnson BHlthSc

University of Adelaide

Presented in partial fulfillment for the requirement of the Bachelor of Health Science (Honours) Degree.

Supervised by Professor Peng Bi and Dr Alana Hansen

School of Public Health - Faculty of Health Science

November 2016

Table of Contents

Abstract ii
Declaration iii
List of Abbreviations iv
List of Appendices v
Acknowledgements vi
1. Introduction 1
2. Literature Review 3
2.1 Methods of the literature search 3
2.2 Results of the literature review 3
2.3 Synthesis of the literature 4
2.4 Discussion of the literature 6
3. Gap Analysis (in Australia) 8
3.1 Purpose statement 8
3.2 Central Research Question 9
3.3 Research Aim and Objective 9
4. Methodology 10
4.1 Reflexivity 10
4.2 Research Rigour 10
4.3 Theoretical perspective 11
4.4 Ethical considerations 12
5. Methods 13
5.1 Participant recruitment 13
5.2 Data Collection 14
5.3 Data analysis 14
6. Results 16
6.1 Main thematic findings 18
6.2 Inconsistent perspectives 28
7. Discussion 30
8. Recommendations 34
9. Study limitations 35
10. Conclusion 36
Appendix A: Literature Review Search Terms and Logic Grids 37
Table 1: PubMed Logic Grid 37
Table 2: Embase Logic Grid 37
Appendix B: Summary of the Yield 38
Appendix C: Summary Table 39

Appendix D: Ethics Approval 43
Appendix E: Participant Consent Form 45
Appendix F: Letter of Participation 46
Appendix G: Participant Information Sheet 47
Appendix H: Interview Topic Guide 50
Appendix I: Participant Complaints Form 52
Appendix J: Grouped Codes 53
Appendix K: Stages of Thematic Analysis 55
Appendix L: Examples of Zoonoses Relevant to Australia 56
References 57

Abstract

Background: One Health is an interdisciplinary approach to zoonotic diseases, which encourages structured collaboration and coordination between human, animal and ecological sectors. This interdisciplinary approach could be applied to zoonotic disease surveillance in Australia. Addressing zoonoses at the interface of human, animal and environmental health is considered to be the most holistic approach to zoonotic disease control. Seventy five percent of emerging infectious diseases are of animal origin, so an approach that links the health of humans, animals and the environment could provide an earlier opportunity for disease detection and therefore may help to reduce the burden of zoonotic diseases. Currently in Australia, human, animal and environmental health are managed by separate sectors with limited communication, acting as a barrier to effective and timely zoonotic responses. This study aims to explore how professionals in the field of human, animal and ecological health perceive a One Health approach to zoonotic disease surveillance, aiming to identify what the challenges are to the implementation of an integrated surveillance system in Australia.

Methods and results: Using a qualitative research method, ten semi-structured interviews were conducted with experts in the areas of human, animal and ecological health in order to gain an understanding of professional opinions regarding the challenges of implementing One Health surveillance in Australia. A thematic analysis of the data was undertaken to identify recurring themes. Findings showed that the absence of a clear definition of One Health acts as a barrier to collaboration, as well as siloed approaches by different sectors restricting the ability for professionals to work collaboratively across disciplines. Understanding disease transmission as a whole, as well as understanding the role of the environment on human and animal health were considered by participants to be vital requirements for a One Health approach to be successful. Additionally, political will was considered by participants to be an essential requirement for the integration of government systems.

Conclusions: This study demonstrates that for a One Health approach to be implemented in an Australian setting, those working in the fields of human, animal and ecological health must come together to agree on a 'One Health' definition. Restructuring of the traditional silos, which currently restrict intersectoral collaboration, could result in an improved and collective approach to zoonotic disease surveillance. This could be achieved through the establishment of a formal governance body. Regular communication may provide an avenue for interdisciplinary approaches, and could assist in overcoming the longstanding barriers of privacy and distrust between sectors. Further, developing interdisciplinary public health training in medical, environmental and veterinary degrees may encourage cross-disciplinary collaboration. Finally, illustrating the economic benefit of faster zoonotic detection will likely attract the attention of politicians, who could assist in implementing a formal and structured One Health approach in Australia.

Declaration

This thesis contains no material which has been accepted for the award of any other degree in any other university, and to the best of my knowledge, this thesis contains no materials previously published except for where due reference is made.

Isabella Johnson

November 2016

List of Abbreviations

CDCB:	Communicable Disease Control Branch
EIDs:	Emerging Infectious Diseases
Mers-CoV:	Middle East Respiratory Syndrome Coronavirus
NHMRC:	National Health and Medical Research Council
NNDSS:	National Notifiable Disease Surveillance System
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SARS:	Severe Acute Respiratory Syndrome
SARS-CoV:	Severe Acute Respiratory Syndrome–Associated Coronavirus
HREC:	Human Research Ethics Committee
WHO:	World Health Organisation

List of Appendices

Appendix A: Literature Review Search Terms and Logic Grids

Appendix B: Summary of the Yield

Appendix C: Summary Table

Appendix D: Ethics Approval

Appendix E: Participant Consent Form

Appendix F: Letter of Participation

Appendix G: Participant Information Sheet

Appendix H: Interview Topic Guide

Appendix I: Participants Complaints From

Appendix J: Grouped Codes

Appendix K: Stages of Thematic Analysis

Appendix L: Examples of Zoonoses Relevant to Australia

Acknowledgements

My utmost gratitude goes to the participants of this study, without whom this research would not have been possible. Their unwavering and continued commitment to protect health at a population level has inspired me to continue down the path of public health, in order to find a career in which I can contribute a similar level of passion and dedication.

Peng and Alana, thank you for your continued support throughout this year, and thank you for the opportunity to contribute to research in this field. Whether it be accompanying me to my first interview while I overcame my nerves, or drafting the world's worst attempt at a literature review, you have continued to encourage and guide me as I have learnt what research is all about. I appreciate the time and dedication you have both shown my project, and more so I appreciate the time and dedication you have both shown me.

Thank you Adriana for your constant encouragement, you never stopped believing in us, even through the breakdowns. Thank you also to my Honours cohort, what a year it has been! I could not have done it without you. Who knew that first ridiculous meeting in the level 7 kitchen would bring us here.

My wonderful friends, your constant encouragement and cheerful tales light up my days. Ebony, your kindness and understanding is a source of constant inspiration to me, and the value of the friendship you have shown me for many, many years is indescribable. Sarah, you bring happiness and positivity to every experience, and I admire, and aspire for your never-ending optimism and cheer. Hannah, goodness knows where I would be without you, your commitment to wine, and your dedication to friendship has made my life this far very rich and very happy. David, thank you for being my stress relief this year and always. You and your strange French sense of humour make my life a happy (albeit messy) one. Merci Cacahuète**.**

Mum and Dad, it is your fierce dedication to compassion, equity and social justice that has guided my similar values and passions. Kindness and empathy have been at the forefront of all that you have taught me, and while over the years that has caused my heart to hurt a little more, it has resulted in my desire to help people and animals, and my commitment to somehow make a difference. Joseph, your values and your ethical commitments are inspiring; I am both proud and fortunate to call you my brother. Sorry for being so painful for ~20 years.

Finally, little Harvie. Your enthusiasm for absolutely everything and anything, and your dedication to all those around you lights up my life. The pitter-patter of your paws and your ever-wagging tail never cease to make my heart skip a beat. How lucky I am to have met you.

1. Introduction

One Health, the concept of structured collaboration and coordination between human, animal and ecohealth systems, has, in recent years, become an emerging focus amongst public health, veterinary and ecological sectors. (1) The concept of One Health seeks to transition from the traditional management of individual sectors towards an interdisciplinary approach of addressing zoonotic diseases at the human-animal interface. (2, 3) The past two decades in particular have seen a shift in the understanding of how wildlife reservoirs can act as pathogenic hosts, and therefore have a significant influence on human health. (4, 5) However, it has only been in recent years that the One Health concept has gained momentum, with the Severe Acute Respiratory Syndrome (SARS) outbreak acting as an important catalyst. (6) Zoonotic diseases are defined as diseases transmissible between animals and humans, and are the focus of the One Health approach. (7) Ecosystem health, the health of organisms and their environments, as well as the environment itself, has been influenced by population growth and economic development, with changes to these intricate systems resulting in increased numbers of vectors, for example mosquitoes, carrying zoonotic diseases. (8, 9) The One Health approach is based on the understanding that human and animal health are inextricably linked, and therefore proposes the need for them to be addressed on a united front. (1) With 75% of all emerging infectious diseases (EIDs) being traced to animal origin, there are compelling grounds to focus on zoonotic diseases, and recognise them as a central factor in the battle against EIDs. (7, 9, 10)

There are many emerging and re-emerging zoonotic infectious diseases threatening human health, including West Nile Virus, Avian Influenza (H5N1, H7N9 and H1N1), Salmonella infections, MERS-CoV, Henda Virus Disease, SARS and most recently Ebola Virus Disease and Zika Virus Disease, all of which have caused significant public health challenges with significant economic burden. (8, 9) The World Health Organisation (WHO) estimates that infectious diseases, the majority of which are zoonotic, account for 43% of the overall global burden of disease. (11) In Australia, the most recent data from 2014, suggests the government spends just under two billion dollars annually dealing with the threat of zoonotic diseases. (12) From both economic and population health perspectives it is imperative to understand zoonotic epidemiology in order to focus on zoonotic surveillance with an integrated approach. (1, 7, 13)

Health surveillance in Australia operates at both state and national levels, and is the ongoing systematic collection and interpretation of health related data. (14) Currently in Australia, human diseases, animal infections and ecological diseases are monitored and managed by separate sectors with limited information and data sharing, and as such, effective and timely communication between these departments is inherently compromised. (15, 16) Under the Australian National Notifiable Disease Surveillance System (NNDSS), doctors and laboratories are required to report certain diseases, however these notifiable diseases differ between Australian states. (17, 18) Additionally, animal notifications are collected by a separate government sector and are primarily for the purposes of minimising adverse impacts on trade, so these notifiable diseases

vary significantly between human and animal health sectors. (19, 20) A One Health approach to disease surveillance in Australia could improve and strengthen the communication and collaboration between these sectors. However, there remain challenges to overcome for successful integration on a broad, national surveillance platform. (21)

If a One Health approach were to be implemented in Australia, it could aid and inform current global surveillance in a more systematic and timely manner than is currently achieved. (22, 23) Infectious disease surveillance in Australia is undertaken by these separate sectors, complying with the WHO's legal framework (International Health Regulations or IHRs) which requires international cooperation in infectious disease surveillance. (23, 24) Regulated global One Health surveillance, based on IHRs, could contribute to a strengthened, organised and structured international governance approach to global health surveillance. (22, 23) Australia's involvement in a formal, national One Health approach could result in a more timely response to emerging zoonotic threats within Australia, and encourage other nations to implement similar systems which could contribute to a global One Health surveillance approach.

It is necessary to identify how current health services (worldwide) are implementing and managing both informal and formal overarching One Health approaches, in order to understand the challenges that exist in the implementation of such systems. By evaluating current approaches and recognising their successes and limitations, it may be possible to find ways of implementing systems that represent the successes observed thus far.

The extensive morbidity and mortality associated with zoonotic diseases worldwide presents as the primary public health problem, with the limitation of structured integration between current health systems and the lack of an integrated disease intelligence system between these sectors being identified as the secondary problem. It is, however, the secondary problem, which acts as an enabler to the primary problem. For Australia's public health and medical, agricultural and environmental health sectors to come together in a coordinated approach to surveillance, better health outcomes in the area of zoonotic diseases may be observed. This integration may encourage improved global collaboration between sectors, and therefore global improvements in the prevention and control of zoonotic pathogens and their transmission.

2. Literature Review

A literature review was conducted to identify any gaps in current literature on One Health, in order to generate a research question relevant and appropriate to address those gaps. The literature review was implemented following a systematic approach modelled on the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (PRISMA) statement. Two separate databases searches were conducted, with the objectives of:

1. Identifying both successes and limitations of past or existing One Health surveillance approaches in published literature.
2. Identifying any gaps in research that could provide an avenue for encouraging and facilitating an integrated One Health surveillance system in Australia.

2.1 Methods of the literature search

In order to limit the number of results and find relevant and appropriate literature, only articles available in English and published within the past ten years were included in search results. The two databases chosen for searching were PubMed and Embase. Search terms for both databases were designed using a logic grid, and included terms such as 'One Health', 'Zoonoses', 'Epidemiology', 'Surveillance', 'Challenges' and 'Barriers' (PubMed), and 'One Health', 'Zoonotic Disease', 'Disease Surveillance', 'Challenges' and 'Efforts' (Embase). As well as the main search terms, 'Dengue', 'Malaria', 'Hendra', H1N1', 'Encephalitis', 'Salmonella' and 'Zika' were included in both databases in an attempt to capture literature over a wide range of zoonoses. The logic grids for both PubMed and Embase are presented in Appendix A.

Both forwards and backwards searching was completed in an effort to identify any literature that might have been missed in the two databases, with one article resulting from backwards searching (7). Additionally, articles provided by supervisors were reviewed, with one article resulting (19).

2.2 Results of the literature review

There were 145 articles obtained from PubMed and Embase searches before any title or abstract screening was undertaken. One duplicate was identified and removed. Title screening identified 67 articles not directly relevant to the topic, or too specific in a particular area that was not appropriate to the research topic, for example, 'Fifty years of tsetse control in Tanzania: challenges and prospects for the future'. (25) Abstracts provided a more comprehensive understanding of the theme of the articles, with abstract screening excluding a further 22 articles. The remaining 55 full texts were reviewed and all considered relevant to the research topic, however 12 were identified as particularly relevant to the research objectives, together providing a

wide scope of knowledge, and an inclusive and comprehensive discussion and analysis. As well as the 12 remaining articles, two articles identified from both backwards searching and supervisor recommendations resulted in a total of 14 articles, with the summary of the yield presented in Appendix B. A summary of the articles is presented in Appendix C.

2.3 Synthesis of the literature

Professional divisions and definitions of One Health (seven articles)

One of the most common themes identified within the literature was the difficulty of merging and collaborating cross-sectorally, with each sector having different definitions and approaches to surveillance and One Health. While One Health is widely accepted as requiring a multidisciplinary approach to zoonotic disease surveillance and prevention, the issue of collaboration and communication between different sectors remains an area of ongoing concern. (26) While the overarching goal of One Health is ultimately to reduce and better control zoonosis transmission, thereby protecting both human and veterinary health, the different sectors, by their very nature, have differing goals and objectives. (26-28) When sectors which ultimately have different interests and aims are asked to collaborate and work together, there can be difficulties in ensuring that any approach is in fact multipronged and meets the need of all stakeholders. (26, 27) While both the human and animal health sectors seek to achieve the best outcomes, there can be widely varying perspectives between the sectors on how to best achieve their 'shared' goal. (27) For example, public health practitioners may criticise the 'downstream' approach of veterinarians and physicians while the veterinary and medical world tend to think the 'upstream' approach of public health practitioners can be limited. (26) Additionally, different names and terminologies between human and veterinary sectors can create difficulty for both reporting and surveillance systems, impeding the sharing of data and exchanging of information. (21) Without consistent terminology being employed by all relevant sectors, timely and effective reporting and communication is difficult to achieve. (2) In addition to differences in overarching goals and language used between sectors, there remains the issue of alternate definitions of One Health among professionals. (8, 29) While for the most part One Health is recognised to reflect a particular focus including human, animal and ecohealth, different definitions create ambiguity regarding what any particular term specifically encompasses, and therefore what specific responsibilities fall under the One Health approach. (27, 29)

Companion animals and livestock – 'high risk' human populations (four articles)

In the reviewed literature, it is widely recognised that while zoonoses do not discriminate in their targets, certain human populations have an increased probability of contracting these diseases. (3) Some occupations and lifestyles can put certain people at an increased risk. (2) Abattoir workers, veterinarians and farmers are identified as being at increased risk of zoonotic contraction due to their increased animal contact, while lifestyle choices and certain circumstances (such as the specific area in which someone is born or the occupation of their parents) also increase the dependence and interrelationships between humans and animals. (2, 3) Keeping companion animals can increase one's likelihood of contracting a zoonotic disease,

especially in developing countries where, in places, veterinary care can be scarce (30). Furthermore, people living around livestock, both in developing countries where farming and slaughtering is undertaken simultaneously, or persons living on, or in close proximity to farms, are again at an increased risk of zoonotic infection. (2, 3)

Dysfunction of global One Health governance, and funding issues (three articles)

The literature identifies that dysfunctional attempts at global health governance (in the governance itself), as well as under resourced global health bodies, act as a barrier to the successful implementation of global health initiatives, including One Health. (21) The absence of coordination or a 'One Health' governance body indicates that further investigation is needed to identify barriers restricting successful global One Health coordination and governance. Despite this, the literature provides recommendations to increase the successes of global health approaches, and addresses the necessity for ideas and approaches to flow in all directions, as well as sharing ideas and approaches between developed and developing nations rather than assuming those countries with greater access to funding inherently have better ideas and better understandings of surveillance. (2) Further to the lack of structured coordination, without an overarching One Health governance body, the availability and allocation of funding can create significant issues. (29) Better contribution to One Health funding from international agencies and governments as well as increased funding for existing international global health agencies such as the WHO, could strengthen and improve existing global zoonotic surveillance. (26)

Reporting of zoonoses (two articles)

Zoonoses are often underreported, for a variety of reasons, including inability or unwillingness to report diseases. (27) Clinical diagnosis of some zoonoses, for example Leptospirosis, can be difficult and can result in delayed or retrospective diagnoses, which can open avenues for contraction of the disease in this interim period. (3) Oftentimes, the responsibility for zoonoses is considered to lie somewhere between animal and human health sectors, and as such, there can be difficulty in ascertaining who has the ultimate responsibility for reporting, prevention and management of zoonotic diseases. (27) In developing countries, resources can be scarce and often reporting systems are not in place to respond properly to zoonoses. (27) Placing trust in other sectors and stakeholders who share responsibility is also recognised as a barrier to integrated surveillance. This involves trusting other people to do their job to the best of their abilities, trusting them with sensitive data, and again comes back to the issue of trusting their overarching approach and goals. (26, 27)

Climate change and disease emergence (two articles)

As the threat of climate change becomes more significant, and temperatures continue to increase, arthropod-borne zoonoses such as Yellow Fever, Malaria, Dengue and West Nile Virus are likely to become more widespread. (8, 9) Increasing temperatures result in an increased geographical spread of mosquito vectors. (9) Flooding can lead to a greater risk of vector-borne zoonosis transmission, as water, particularly stagnant

water, provides vector habitats for mosquitoes and their larvae. (8) Due to this increased risk, moving forward, surveillance systems will provide an important channel in early detection and therefore management of zoonotic diseases. (1, 9) An integrated approach to surveillance is therefore considered preferable for earlier zoonotic disease detection and management. (1)

2.4 Discussion of the literature

While the literature outlines a number of key issues that have hindered the success of widespread One Health approaches, other parts of the literature discuss successes and implementations that have led to better reporting and better management of zoonoses in recent years. An example of better zoonotic control is the improved collaborative management of the NSW health service, which resulted in the implementation of enhanced infection control, as well as improved biosecurity procedures through the use of a single reporting system. (19, 26) The reviewed literature provides an understanding of some of the challenges to the implementation of One Health surveillance, and recommendations based on past or existing systems, however that literature is limited, particularly in an Australian context. While tangible recommendations are provided broadly, these suggestions are not overwhelmingly innovative, or particularly relevant to an Australian context. It is clear there is a widely acknowledged and accepted understanding that One Health approaches to zoonotic diseases will likely reduce both the incidence and prevalence of emerging zoonoses, yet in both a global and national sense, the field remains largely unsynchronised. Despite barriers and challenges being widely acknowledged, they are not being refined and addressed to improve current systems and surveillance in zoonotic disease control.

Program evaluation, bridging programs or interdisciplinary One Health programs, as well as an agreed upon definition of One Health are recognised to be important next steps in the control of zoonotic diseases. (9, 13, 21) Program evaluation is lacking in the field of One Health, and as such there is little to no data available from which to draw conclusions and identify what has, and has not, worked. (21) Evaluations of the separate sectors do not provide an appropriate tool from which to measure One Health initiatives, and in the absence of this, the successes and challenges of One Health are currently based on little more than guesswork. (13, 21) Improved bridging programs or interdisciplinary One Health programs are identified as a vital part of improving One Health surveillance approaches. (9, 21) Bringing together current training areas of public health and human and veterinary medicine would enable graduates and professionals to have a broader understanding of One Health overall, rather than just the parts of One Health that align with their specific fields. (21) This would promote a body of interdisciplinary ‘One Health professionals’, rather than just professionals from separate sectors working together in One Health. (9, 21) Lastly, as already acknowledged, an internationally agreed upon definition of One Health is recommended in order to provide clarity of specific responsibilities and roles, where they are held, and by whom, providing individual nations with the opportunity to implement their own One Health approaches, consistent within a global approach. (9)

Finally, ecosystem health is consistently acknowledged as being under the One Health umbrella. However apart from limited discussions of climate change and mosquito vectors, there is little more than a mention of ecosystem health in the reviewed literature. If ecosystem health is considered an equally important aspect of One Health, it should be better considered, discussed and understood in this context.

This literature review was conducted to identify challenges surrounding the implementation of integrated One Health surveillance, with the objective being to identify any gaps in current available literature in order to understand how a One Health approach could be achieved in Australia. From the 55 articles identified in the literature search, many suggestions were made to strengthen and improve One Health surveillance, but not in an Australian specific context. Current barriers were addressed, and much of the literature provided suggestions to overcome these. Despite these suggestions, integrated surveillance has not been widely implemented, and the incidence of zoonotic diseases continues to rise. (11, 22, 31)

3. Gap Analysis (in Australia)

Despite an understanding of the limitations contributing to the lack of coordination seen by One Health approaches, currently, little has been done at a national level in Australia to eliminate these issues and enhance existing surveillance systems. The current available literature demonstrates some understanding of the challenges and barriers of implementing One Health surveillance systems, however zoonotic diseases are continuing to rise, resulting in extensive morbidity and mortality. (11, 22) This suggests that despite recognition of those barriers and challenges, even in consideration of recommendations, necessary changes are not being implemented to facilitate improved systems. As such, the current gaps in literature, relevant to Australia, are as follows:

- There is limited literature outlining the challenges of implementing One Health approaches, specific to an Australian context.
- Previous research attempts have not engaged a range of Australian stakeholders over the areas in which One Health is relevant.
- The challenges that have so far been identified have not contributed to restructuring health sectors towards a One Health approach. Therefore, they have not adequately addressed or identified 'true' barriers or recommendations, or implemented these recommendations.
- There are likely to be more (perceived) barriers to implementing One Health surveillance, further than those identified in previous research.

To address these gaps, further qualitative research is necessary to identify what is currently inhibiting the success of a One Health surveillance approach in an Australian context. Key informants such as health, veterinary and ecology professionals need to be included in any discourse. Such research will provide direction for those areas where attention can best be focused to achieve improved control of emerging, and re-emerging zoonoses in Australia.

3.1 Purpose statement

After reviewing the literature, the purpose of the research is to identify the perceived challenges (of those working in the relevant fields) that are currently hindering the success of One Health surveillance implementation in Australia. With a better understanding of these issues, future systems will be able to recognise the wide range of challenges that have tested previous systems, and use that understanding to inform future surveillance in the area of One Health. The research will seek to explore the perceived barriers among human, animal and ecological health professionals, to the effective implementation of an integrated One Health surveillance system in Australia.

3.2 Central Research Question

Based on the gaps in knowledge identified, the research question is:

'What are the perceived barriers among human, animal and ecological health professionals, to the effective implementation of an integrated One Health surveillance system in Australia?'

3.3 Research Aim and Objective

A research aim and objective were formulated based on the gaps identified in the literature review.

Aim: To seek perceptions from key informants on how to facilitate an improved integrated approach to zoonotic disease surveillance in Australia.

Objective: To use a qualitative approach to determine the perceived challenges of implementing an integrated One Health surveillance system in Australia.

4. Methodology

This study adopted a qualitative research approach, to assist in discovering and understanding the perspectives of those people relevant to the research itself. (32) Qualitative research allows for an understanding of the perceptions of individual people, and for their meaning to be properly interpreted and analysed. (33, 34) Interviewing health professionals through a semi-structured interview, followed by an inductive thematic analysis of the collected data was considered the best approach to answer the research question, in order to provide resulting data which are easily interpretable, simple and clear, but still remain true to their original context. (35)

4.1 Reflexivity

Researcher reflexivity refers to the understanding and reflection by the researcher of the risk of bias, resulting from their own values or beliefs, which threaten to incorrectly influence or shape the research process, as well as the researcher's interpretation of the data. (36)

Reflexivity was considered in all stages throughout this research. The researcher had no initial biases entering into the researcher role, and had no preconceptions about what the research would result. It is acknowledged, however, that our backgrounds shape our interpretations and understandings. (37) In an effort to minimise any misinterpretations that could occur between participant answers and the researchers understanding, throughout the study, the researcher reviewed the data frequently in order to become familiar and confident that it was the perspective of the participant being represented, not the researcher's own initial interpretation of the message.

4.2 Research Rigour

Research rigour refers to the assurance of accuracy and integrity throughout the research process. (36) Validity and reliability are important considerations in any qualitative research, which contribute to the overall rigour of the research. (38) Validity considers whether the research methodology realistically represents the study undertaken; that is, whether the research is applicable and realistic to its context, and whether the methodology is appropriate to portray that story with accuracy and integrity. (36, 38) Sometimes referred to as the 'truthfulness of findings', reliability relates to how replicable the study is to another researcher, or rather, in its simplest form, how similar the results would be had the research been completed by a different researcher. (36)

Because of the subjectivity which inevitably exists in the world of qualitative research, and even within the consideration of validity and reliability, research rigour has been applied to this study, and is ensured by the

research design and methodology. (38, 39) A number of strategies were applied to ensure the rigour and reliability of the research, and as such, it is expected that results would remain consistent should another researcher have undertaken this study. The applied strategies included audio-recorded semi-structured interviews, researcher reflexivity, meticulous record keeping and documentation of transcripts, verbatim descriptions of participant accounts, offers of respondent validation during interviews and prior to transcription, as well as peer reviewing of coded and thematic results. These strategies aim to ensure the authenticity and integrity of data and results. (39)

Peer reviewing, by other members of the research team, was employed as a method to ensure the researcher had interpreted and represented the data in the way it was intended by the participants, striving to reduce the risk of personal bias. (36) Having the de-identified transcripts, codes and themes reviewed by people outside of the interviews provided the researcher with assurance that the codes and subsequent themes that emerged from the transcripts were data-driven, truthful, authentic representations of the participants responses, rather than results driven or construed by the researchers own theoretical interests or biases. (36, 40)

4.3 Theoretical perspective

Within qualitative research, theoretical perspectives assist in interpreting collected data and explaining influences relevant to those data. (41) The theoretical perspective applied to this research is critical realism, the influence of which helps to ensure that data are differentiated and understood in their relevant contexts, and provides a framework for the analysis of the data. (41, 42)

Critical realism argues that casual language can be used to describe the world, and ultimately seeks to understand ‘why things are the way they are’. (43) For this research, in seeking to understand the challenges of a particular system, critical realism allows for an understanding of causal mechanisms, that is, the structures and powers that influence deeper than what is observable. (44, 45) For example, in the case of this research, a critical realist approach allows for deeper observations than are immediately obvious, so it is necessary to look beyond surface appearances to answer ‘why’ and to search for underlying processes or structures that offer explanations. (44, 45) As described, despite an understanding of how and why a One Health approach could benefit disease surveillance in Australia, little has been done to implement such a system. The critical realist perspective applied to this research seeks to assist in understanding the reasons for this lack of integration and explain what structures, powers or influences have challenged or impeded the implementation thus far. Critical realism acts as a framework in which this understanding can be achieved, and the framework to guide this research.

4.4 Ethical considerations

Ethical approval in the low risk category was granted from the University of Adelaide Human Research Ethics Committee (HREC) project number H-2016-165 (Appendix D). Ethical issues identified included concerns around consent, confidentiality and data storage. Written and signed informed consent was required from participants before any interview took place (Appendix E). Participants were assured of confidentiality, and anonymity was achieved with a 'participant number' (rather than any identifying information) through all collection and analysis of data. Interview transcripts were identifiable through the participant number rather than name, and only the three active researchers (the two academic supervisors as well as student researcher) had access to the names corresponding to the participant number. The only data accessed by any computer outside of the university campus were full transcripts, not identifiable by name, only participant number. Due care was given to ensure that the research complied with the National Statement on Ethical Conduct with Human Research, by the National Health and Medical Research Council (NHMRC). (46)

5. Methods

During the initial research stages, it was decided that in order for the researcher to be able to understand the responses of the participants in the contexts in which they were intended, consideration must be given to the researcher's own understanding of health surveillance in Australia. For this reason, a joint epidemiological and agricultural surveillance meeting in the South Australian Health Department's Communicable Disease Control Branch (CDCB) was attended, to provide the researcher the opportunity to observe health surveillance in action, and gain an understanding of the practical side of surveillance, rather than relying on a theoretical understanding alone. This experience meant that questions and answers relating to infectious disease surveillance were able to be understood and conceptualised, with adequate consideration of how disease surveillance in Australia works in practice. Additionally, a detailed conversation with a member of South Australia's Primary Industries sector, PIRSA, allowed the researcher to gain further insight into how agricultural and animal health surveillance is undertaken, and better understand the current intersection of human, agricultural and environmental health.

5.1 Participant recruitment

Purposeful sampling was used to identify key informants around Australia who have an understanding of, or experience in One Health or zoonotic epidemiology. (32) This included academics from the fields of public health, veterinary science, zoology, ecology and entomology, as well as people with expertise in disease surveillance and the environment. For this study it was decided that potential participants would be academics from universities around Australia. These academics were approached based on their relevant expertise or experience in the field of zoonotic disease control, and their understanding of the necessary management for epidemiological surveillance. All potential participants were initially contacted by the academic research supervisors, provided with an outline of the study, and asked if the student researcher could contact them directly with more information if they expressed interest (Appendix F), and following this participants were provided with an information sheet (Appendix G). A total of thirteen people were contacted and invited to participate in the research, ten of whom agreed and contributed. The three people initially contacted who did not participate were away at the time of interviews and were therefore unable to contribute within the necessary time frame.

Due to the nature of the research, and the varying backgrounds of the participants who contributed, it was not considered that reliance on data saturation alone would provide the most valuable measure for establishing when the amount of data collected was sufficient. The participant sample was intentionally made up of people from varying backgrounds who would therefore hold varying understandings and perspectives to the research questions. The inconsistencies in participant responses were considered important in understanding where logistical challenges to implementation exist.

5.2 Data Collection

Semi-structured interviews were chosen as the most appropriate study design for the desired research objectives. The nature of semi-structured interviews provides guidance for the areas of research requiring consideration, and allows both the researcher and participant to pursue particular areas or ideas in further detail. (34) Questions (Appendix H) were of an open-ended design, to prompt answers that yield information relevant to the question, while also giving the participant freedom to elaborate on areas not previously considered by the researcher. This in turn provides comprehensive data to inform the research. (34)

Interviews took place between August 10th and September 20th 2016. A total of three interviews were conducted face-to-face, and seven interviews conducted over the telephone with participants who were interstate or unable to meet in person. Face-to-face interviews were conducted at the offices of participants, at times that were mutually convenient. All participants were required to provide a consent form before their interview commenced, either in person at the interview or via electronic mail. At the commencement of each interview, participants were again provided with a copy of the information sheet (first provided to them at the time of initial student contact (Appendix G)), a copy of the questions they were going to be asked (Appendix H), as well as a complaints form (Appendix I). The aim of the research and background of the student researcher was provided. Before the recording device was started, the participant was asked to confirm their consent to the audio recording of the interview.

The interview guide was based on the gaps identified in the literature review. Questions (Appendix H) were open-ended and covered a range of areas from the security of data sharing, to the benefits of integrated surveillance. Further, it was considered important to gain an understanding of the experiences of the participant that led to their interest in the One Health concept, as well as examples of where a One Health approach had, or could have been used in their work. Most questions had 'sub-questions', used as follow up prompts had the information provided not been sufficient in their original answer. The duration of interviews varied somewhat; the shortest interview took sixteen minutes and the longest interview thirty-seven minutes, with a mean time of twenty-five minutes. The transcription of recordings took place shortly after each interview. All participants were offered a copy of their interview transcript, with one participant accepting.

5.3 Data analysis

Informed by Braun and Clarke's guide to thematic analysis (40) 2006, interviews were transcribed verbatim, then read thoroughly multiple times ensuring a level of familiarisation and immersion in the data, by the researcher. (47) Initial notes were identified and recorded, before electronic coding using NVivo software (QSR International) was undertaken. Initial codes were created using a systematic approach, in which the most basic ideas were organised using general words to group phrases or sentences into relevant categories. From there, codes were reviewed and similar or comparable codes were then grouped into more specific

codes in order to begin grouping general concepts or ideas (Appendix J). Following the coding process, thematic analysis, involving the identification of any emerging themes, began. In moving from the coding process to the identification of themes, the description, or those descriptive codes, are replaced by a deeper understanding or interpretation of what was said. (47)

The identification of themes emerging from the data uncovers any patterned meaning, and allows for identification of commonalities and shared understandings between sections of participants' transcripts, as well as providing nuanced and articulate discussions of the research topic. (33, 40) The development of thematic perspectives from the participants can strengthen any proposed idea that emerges recurrently. (33) The guide to thematic analysis by Braun and Clarke (40) informed the data analysis process, and provided a systematic method of understanding and interpreting the data. The process undertaken is summarised in Appendix K.

6. Results

Of the ten academics who participated in the study, five were from South Australia, two were from Western Australia, and one participant each from New South Wales, Queensland and the ACT. The sample consisted of four veterinarians, one with particular expertise in zoonotic diseases, one with expertise in infectious diseases and one who worked as a public health practitioner. Four of the participants were public health practitioners, two of whom had expertise in disease surveillance, and another who was an expert in zoonotic diseases. Finally, one ecologist, and one entomologist who had expertise in infectious diseases participated in the research. All participants had some experience with zoonoses, and understood the concept of One Health.

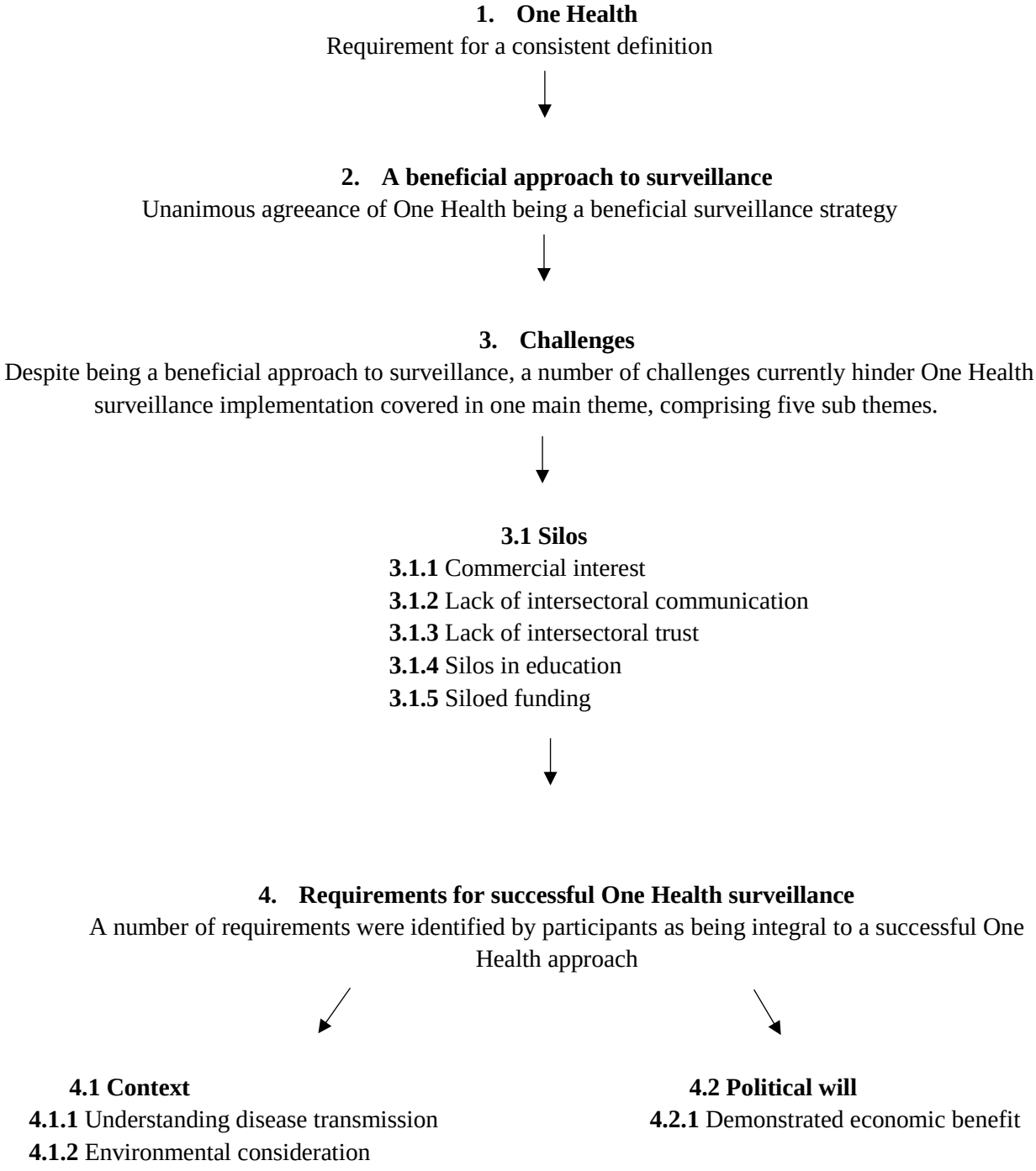
The thematic analysis of data resulted in a number of important themes relevant to the challenges of implementing an integrated One Health surveillance system in Australia, and also highlighted a few areas where differences in professional opinion or understanding resulted in inconsistent perspectives relating to the implementation of an integrated One Health surveillance system in Australia. Firstly, it was mentioned recurrently that One Health requires a clearer definition in order to be better understood and embraced, however, participants did not necessarily refer to the lack of clear definition as being a direct challenge to the implementation of One Health, rather just a barrier to the organisation and momentum.

All ten participants considered that the implementation of One Health in Australia would provide a beneficial approach to zoonotic disease surveillance, and when asked about disadvantages to One Health surveillance, all participants said that there were challenges to the implementation, but could foresee no disadvantages of such a system. Participants discussed the issues they consider to be paramount in implementing One Health surveillance systems, with a main theme of ‘silos’ being identified, containing five key concepts: commercial interest, lack of intersectoral communication, lack of intersectoral trust, silos in education and siloed funding. Additional to the challenges identified, the analysis of participant data resulted in two main requirements for successful One Health integration; ‘context’, characterised by understanding disease transmission and environmental consideration, as well as ‘political will’, characterised by demonstrated economic benefit. All participants provided recommendations on how to best proceed with a One Health surveillance strategy in Australia.

The inconsistent responses of participants to some questions was also considered integral considerations to the challenges that exist. When asked where One Health currently stands, participants offered a wide range of responses ranging from ‘struggling’, to ‘incredibly alive and well”. These differences in perception highlight that without a consistent understanding of where One Health stands now, and therefore what needs to be done to facilitate unity, implementation is likely more challenging than some participants believe. There was also significant variation to participant responses when asked who should be involved in, and in charge of the implementation of a One Health surveillance system in Australia. These differences in belief act as a barrier in themselves, entirely separate from the range of challenges identified by participants.

The thematic findings are discussed in detail in section 6.1, with the themes being outlined in a Thematic Map, Figure 2. The inconsistent participant perspectives are discussed in section 6.2.

Figure 2: Thematic Map of Findings



6.1 Main thematic findings

1. Definition of One Health

Due to the lack of a clear One Health definition being identified in the literature review, each participant was first asked to explain their understanding of what One Health is, and who should be involved. This was to clarify to what the participant was referring specifically when they talked about One Health, and to ensure their version of 'One Health' was understood in its correct context. Responses to this initial question varied somewhat, with some participants considering One Health to be the collaboration or integration of human and veterinary health, with other participants including environmental health in their definition. A number of participants, particularly those who work in public health, reinforced what was identified in the literature, and specifically commented on the lack of definition acting as a barrier to any discussion of One Health, as without a clear definition people have different interpretations of what One Health is and who needs to be involved in any discourse.

> "I actually think we need to work a bit harder on defining what One Health actually is.."
>
> - Public health practitioner

> "…everyone you ask will have a slightly different…answer."
>
> - Expert in zoonotic diseases

> "…we can't really implement something if we don't have a shared agreement about what it is, and…I don't think we do really at the moment."
>
> - Public health practitioner

2. A beneficial approach to surveillance

Participants were unanimous in their consideration that the implementation of a formal integrated One Health approach to zoonoses in Australia would be a beneficial step in reducing the burden of zoonotic diseases. Participants identified the advantages of implementing One Health surveillance in Australia, and most commonly, they considered that One Health would enable earlier detection of zoonotic diseases, and therefore earlier reporting and opportunities for the prevention or management of zoonotic transmission from animals to humans.

"…on a theoretical basis at least we've got an opportunity for prevention at an earlier stage... so that's certainly an advantage of a One Health approach to disease surveillance."

- Public health practitioner

"We can think more broadly about 'okay, we've got a Ross River outbreak in April, but the origins of that were probably in the previous September when kangaroos were becoming infected', and so by taking a One Health approach we gain a greater understanding of disease systems, and obtain more data and more points by which we can act, so it gives us actually more opportunities to do something about disease."

- Expert in infectious diseases

Further to the improved reporting and response times that a One Health approach could achieve, many of the participants considered that a One Health approach allows for a broader and more comprehensive understanding of disease surveillance through the ability to see surveillance holistically.

"...I think more so in terms of disease surveillance, it gives much, much more depth to our surveillance procedures to understand what's happening."

- Expert in zoonotic diseases

"…a One Health approach to the study of a zoonotic disease that affect humans... gives us much richer data, much richer surveillance, and more signals…"

- Expert in infectious diseases

3. Challenges

While the participants were unanimous in their belief that a One Health approach to disease surveillance in Australia would be valuable, they all identified obstacles they perceive to be challenges to the implementation of such a system. While a number of challenges were articulated, a main theme of 'silos' emerged as the most significant, comprising five key concepts: commercial interest, lack of communication, lack of intersectoral trust, silos in education and siloed funding.

3.1 Silos

The concept of both a general 'silo effect', as well as a 'silo mentality' existing in Australia was frequently mentioned during interviews. This encompassed a range of different areas in which siloed work inevitably results in a lack of collaboration, ranging from tertiary education to siloed sectors in individual states who do not adequately communicate.

3.1.1 Commercial Interest

Commercial interest was mentioned often, mainly in the context of protection. There was a lot of discussion around the issues that exist for animal surveillance, with many participants stating that animal surveillance exists for the protection of trade, rather than protection of human health, which leads to impeded communication between health and commercial sectors. Some participants identified that the protection of one sector at the possible expense of another leads to siloed systems which show no partnership or intersectoral communication. This indicates a significant challenge for implementing One Health surveillance; a system which requires the collaboration of both the animal and human health sectors. Participants differed in their standpoints on this concept, somewhat based on their relevant fields, with participants from the animal sector speaking more sympathetically about the need for protection of surveillance so trade does not suffer, while those interested in public health showed disapproval in their reflection that animal surveillance is not designed for the purposes of human health protection. Others spoke about the protection of trade, but merely stated it and did not pass judgement. One participant's sympathetic expression of commercial protection is illustrated in this quote:

> "Many of our animal industries… they're reliant on the markets… and they're also… you're dealing with animal industries that have to look at the price of feed… there are times for example at the moment, the dairy industry… is not being paid enough money to actually cover its costs at the moment with the, with the price of milk at the moment….they very much want to be just in control of that information, um, they very much want to solve issues. You know they don't want to hide issues, but um, if control is taken away from them."
>
> - Veterinarian

Another participant spoke with disapproval of the protection of commercial interest:

> "…they get tangled up with commercial confidence as well! And then you begin to wonder 'well, who are they there for? The commercial enterprise?' Or are they there for the betterment of the state?"
>
> - Expert in disease surveillance

Others were neither approving nor disapproving in their reflection on commercial protection:

> "Animal health notifications are generally trade related diseases, so none of those appear on the notifiable conditions surveillance systems that are, that exist in public health."
>
> - Expert in zoonotic diseases

3.1.2 Lack of Intersectoral Communication

Many participants referred to the lack of communication that occurs between sectors, and the difficulty this causes to any form of integrated system. The lack of communication currently observed between sectors was considered by all participants to be counterproductive and adversely influencing health.

> "I suppose a lot of that is to do with breaking down silos… so that you have departments of government… actually talking to each other instead of just doing their thing. There have been some examples, ah Q fever, the big Q fever outbreak in goats in the Netherlands…the animal health community, the veterinary community knew that there was…an issue with abortions and Q fever outbreaks on goat farms, but they hadn't thought to consider that that was then a human health risk."
>
> - Veterinarian

> "…they may play lip service to wanting to engage and be interested in data from other sectors, they may not actually be in practice."
>
> - Public health practitioner

3.1.3 Lack of Intersectoral Trust

Trust was mentioned often in relation to siloed systems. Participants identified times where blame has led to distrust and professional tensions existing between sectors, based on their past experiences. For example the veterinary participants mentioned that their sector is often blamed for the issue of antimicrobial resistance, which has caused tensions with the medical sector. (Antibiotics have been used as growth promoters in intensive livestock production, and over-prescribed medically, with extensive use resulting in bacteria becoming resistant to treatment. (10, 48)) This is demonstrated in the below quotes:

> "…antimicrobial resistance…early on I guess where there was a lot of blame going on about who caused the problem…it's sort of the memory of that, particularly on the, I suppose the animal side that's sort of been blamed"
>
> - Veterinarian

> "…you know they want to blame livestock for the entire problem…"
>
> - Veterinarian

Participants commonly identified issues of trust that would relate to the appointment of a 'One Health' body. Many participants frequently stated that the implementation of a One Health surveillance system would have to be shared between sectors, in order to overcome the issues of trust. Many participants considered the issues of trust would be so great, the system would be unsuccessful unless the responsibility was a shared one. Others argued that the issue of trust was too big to allow responsibility to be shared, claiming that unless the governing One Health body was entirely new the issues of trust would remain unresolved. According to these participants, overcoming trust issues requires a shared, collaborative approach, and a new impartial body:

> "I don't think you can have any one sector, the other sectors wouldn't trust them."
>
> - Expert in zoonotic diseases

> …it goes back to that trust issue again…if it isn't truly new and independent it would always be…'oh I can't trust the organisation'…they're coming out of a certain area and therefore they'll have a vested interest."
>
> - Veterinarian

3.1.4 Silos in Education

Education was a theme that recurred often, and in many contexts, but was mainly referred to in terms of siloed education. The participants belief that a lack of tertiary education about One Health and zoonotic epidemiology leads to professionals thinking in a siloed way within their respective fields was common. It was considered that without across-the-board training, tertiary education is producing professionals unable to think outside the scope of their relevant silo, and therefore have trouble integrating their thoughts and work into a shared or multidimensional approach in a professional setting.

> "So we're still sort of trained either as, you know, as vets or doctors or environmental scientists…so you know we have a very sort of, again, very siloed view of the world."
>
> - Veterinarian

It was commonly considered, predominantly by those in the veterinarian field, that once people have been in the workforce for a number of years it is increasingly unlikely they can be encouraged to think in a collaborative way outside of their specific interest. Participants consider that for this reason, education regarding One Health concepts is more effective when introduced early in university degree programs. Participants considered that earlier education can result in a change to generational thinking, which would enable integrated systems like a One Health approach to be successful.

> "…even if ten or twenty years later they sort of start to get drawn into the One Health area…you know they'll be very receptive to that if they've got some, some of that early on in their undergraduate, you know they'll be thinking about it."
>
> - Veterinarian

> "…the training is, a lot of it's sort of like team re-education type training…which is fine but I think at the very sort of undergraduate and early, early professional postgraduate years is where it needs to happen to sort of embed it."
>
> - Veterinarian

3.1.5 Siloed funding

Funding was mentioned regularly as a challenge to the establishment of an integrated surveillance system in Australia. Participants considered that with all sectors having access to limited funding, particularly in environmental and agricultural fields, it is challenging to encourage collaboration and consideration of other sectors when it involves a financial cost. It was considered that political or ministerial interest in an integrated One Health approach could help in the re-allocation funding, which could help to reduce the siloed sectors that currently exist.

> "…this idea of different ministries with different budgets paying for different data acquisition can make people reluctant to share"
>
> - Expert in infectious diseases

> "…when money comes down it ends sort of allocated, for example, to human health, so it's very hard for say, a department of health, to justify their spending their health dollars on an animal issue."
>
> - Veterinarian

> "…the way the money is spent and for surveillance systems…that tend to be either top down from the government, or they're on the animal side they're sort of industry driven…they are very, sort of, siloed."
>
> - Expert in infectious diseases

4. Requirements for successful One Health surveillance

While identifying areas that hinder or challenge One Health implementation, participants offered suggestions to the integral requirements for successful One Health surveillance in Australia. Two main themes emerged: context, characterised by understanding disease transmission and environmental consideration, as well as political will, characterised by demonstrated economic benefit.

4.1 Context

The idea of understanding the 'big picture' concepts, or understanding context, was recurrent throughout interviews. Participants regularly spoke about the need to understand the contexts in order to appropriately

conceptualise them, and this consideration was identified in two key concepts: understanding disease transmission, and environmental consideration.

4.1.1 Understanding disease transmission

When participants described the importance of integrated surveillance systems such as One Health, they often referred to the importance of understanding diseases in the context of the epidemiological triad – the causative relationship between agents, hosts and their environment. It was frequently considered that without a 'big picture' understanding of where zoonoses begin and how they are transmitted, it is impossible to offer early interventions and reduce the incidence of zoonotic diseases. Further, participants often took the approach that without an appropriate understanding of disease transmission in its particular context, the health of professionals and the public can be at risk.

> "…we've had several cases of emerging infectious diseases such as Hendra virus, that have been incredibly significant and have caused deaths…maybe at the time a little bit more One Health focus…might have saved the lives of some of our veterinarians that weren't as uh…didn't go in with the same level of precaution"
>
> - Veterinarian

> "But the real questions is, 'well how do they get out of there and get into humans and what can we do about it?' And so you can't come up with human interventions without a knowledge of what's happening in the animals."
>
> - Expert in disease surveillance

> "…you can sit and look at emerging infectious disease data for humans and for animals until you're blue in the face and have no one doing environmental hazard surveillance"
>
> - Ecologist

> "…so if you knew about…what was happening in the animals it gives you context, if you are running a surveillance system, this is an intelligence system, yes…it will involve having numbers, but the job of the people running that system is to put the numbers into context."
>
> - Expert in disease surveillance

4.1.2 Environmental consideration

Similar to understanding the context of disease transmission, understanding the importance of the environment in the transmission of zoonotic diseases was a recurrent theme. Those who discussed ecological health tended to reinforce the importance of the environment in the One Health discussion repeatedly throughout their interviews. The idea of implementing One Health surveillance approaches without an environmental understanding invoked a strong reaction from many participants, particularly those whose work involves an environmental consideration. While it was generally those participants from an environmental field most passionate about this point in their discussion, everyone agreed that an environmental understanding is necessary in any comprehensive zoonoses approach.

> "..people think of more as 'Oh veterinary and human medicine put together', and that's not broad enough!"
>
> - Ecologist

> "…I see it between environment and humans and animals as an ecosystem, it's the same ecosystem, so whether you're on about biodiversity conservation and planetary stewardship or human health and sustainable communities it's the same ecosystem so it makes absolutely no sense to analyse it in two different ways."
>
> - Ecologist

4.2 Political Will

Political will, or the necessity for political involvement in both canvassing and implementing a One Health surveillance approach in Australia was mentioned regularly by participants. It was considered that without political will, it is unlikely that the operational issues that exist can be overcome, and finding a way to involve the relevant ministers and policymakers in the One Health discussion provides the best opportunity for implementation.

4.2.1 Demonstrated economic benefit

It was considered necessary, by many participants, to demonstrate the economic benefit of integrated surveillance in order to get the attention of the relevant ministers. Participants considered that if politicians were convinced of the economic benefit to a One Health approach they would be supportive of, and encourage the implementation of an integrated approach in Australia.

"…get down to the real nitty gritty part of it, and say alright 'this has saved the country 89 billion dollars over the past 4 years'…so you get some kind of value put on it."

- Expert in zoonotic diseases

"…health economists, or several working together, can demonstrate the monetary value of what we're doing, then the political impetus…would follow quite rapidly, because it would be significant."

- Ecologist

6.2 Inconsistent perspectives

1. Where One Health currently stands

Participants gave inconsistent perspectives of the current status of One Health in Australia, often with consistency in perspective aligning to their relevant field. Some considered that a One Health approach is already in the early stages of integration in Australia, while others claimed that integration is not possible without further consideration of how surveillance looks currently. Differing perceptions of how possible the implementation of a One Health approach is in Australia indicates a barrier, as without consistent understanding and therefore approaches, any One Health implementations are likely to be disjointed between sectors, leading to further segregation.

> "Oh look, I think…it's incredibly alive and well"
>
> - Veterinarian

> "…currently there's, there's quite a bit of activity…I think it's more…at an institutional level. More agreements and, you know, frameworks and proposals…it's sort of integration at that higher level, I think is where it's at, at the moment."
>
> - Expert in zoonotic diseases

> "We have human surveillance, we have some animal surveillance in Australia, we have no environmental surveillance, so basically integration…it doesn't, there's not enough information to make anything integrated properly at this stage."
>
> - Expert in zoonotic diseases

2. Who should govern a One Health approach

Participant responses about who should govern a One Health approach varied significantly. Most participants were strong in their view of the direction a One Health approach needs to to come from, however that direction was not consistent. Some participants believe that if One Health seeks to benefit public health, it requires responsibility from the public health or medical sector. Others, particularly veterinarians, thought that the responsibility lies with a formal, yet impartial agency, sitting between sectors. If those people who are most supportive of a One Health approach, and who all consider a One Health approach to be beneficial,

have such differing opinions on who needs to take control, implementation itself is likely a bigger challenge than participants realise.

> "I think by definition One Health lies, the responsibility lies with the public health sector…because it's ultimately about the health of people…if it's only about animal health then it's not a One Health issue."
>
> - Expert in zoonotic diseases

> "Oh it's got to be shared…it has to be that, that level of respect for what people do in their…own sectors…you know you can't have…a medical doctor infectious disease specialist speaking on behalf of an animal industry that they have no knowledge of…"
>
> - Veterinarian

> "…the medical fraternity is one of the most powerful lobby groups, and if they take the lead and say…'we're the doctors that save lives, and we need veterinary surveillance in our systems to help us do that', people will listen…"
>
> - Ecologist

> "I think the only way to sort of progress One Health surveillance is to have a group or an agency that's responsible…that sits between animal health and human health and also environmental health…that's seen as independent, and you know, nonpartisan."
>
> - Veterinarian

7. Discussion

Zoonotic diseases have the potential to cause a major threat to public health in Australia, for example Severe Acute Respiratory Syndrome–Associated Coronavirus (SARS-CoV), Henipaviruses (Hendra and Nipah), as well as Avian Influenza (H7N9) (for examples see Appendix L). (49, 50) Additionally, climate change is considered a threat to the incidence of vector-borne diseases in Australia (which are classed as zoonotic), including Dengue Fever, Japanese Encephalitis, and Ross River Virus. (51-53) While Australia's biosecurity, in part due to Australia's geographical isolation, has prevented many diseases from entering the borders to date, there remains an increasing threat, particularly with EIDs and climate change. (54, 55) While many zoonoses are legally notifiable under human health surveillance regulations, there is no integrated human, animal disease surveillance aiding in early recognition of diseases. (18, 20) With infectious diseases regularly crossing the boundaries of human, animal and ecological health, it has been proposed that an interdisciplinary approach to surveillance, providing early recognition of diseases that risk animal and human health, would be valuable in Australia. (49, 56, 57)

This study aimed to identify the perceptions of academic experts in relevant areas on the perceived barriers to the implementation of a One Health surveillance system. The findings highlight the challenges of implementing One Health surveillance in an Australian context. At its most fundamental level, this study reveals there is a lack of communication restricting intersectoral collaboration, leading to a silo mentality and siloed approaches by different sectors. The study identified some requirements necessary for successful One Health implementation, which are relevant in the future planning of such a strategy. Lack of political will, the absence of a shared definition to One Health as well as limited cross-disciplinary funding were also identified as likely barriers to the successful implementation of an integrated disease surveillance system in Australia.

The concept of silos existing in the world of public health, and health more broadly, has been specifically addressed in the wider literature. (27, 58-61) As described by Yang (62), "As emerging diseases and health priorities evolve into global and multi-sectoral issues, public health professionals – from interventionists to advocates to researchers – must step outside of their silos". Participants identified that restructuring traditional siloed education into a multi-disciplinary educational approach is an important avenue in training professionals, in order to engage people in cross-disciplinary collaboration and communication. This concept resonates with the wider literature, with Lee and Brumme (21) advocating for the creation of 'interdisciplinary One Health degree programs' in order to integrate knowledge across the three sectors, while Halliday et al. (27) discuss the poor communication that currently exists between health and animal sectors. It was considered by participants that interdisciplinary education is best instituted in the early stages of tertiary training in the areas of medicine, public health, veterinary science and ecohealth. Jeggo and Mackenzie (10) reinforce this view, and argue that education facilitates generational changes to thinking and approaches, which is likely to increase and improve the willingness of intersectoral cooperation over time.

While it was considered beneficial to have training in the tertiary years of education, Gibbs (29) discusses the importance of ongoing education through regular conferences, describing how conferences provide an educational avenue for people already working in the field, as well as an avenue for encouraging and promoting cross-disciplinary communication. Furthermore, ongoing in-house training, contributing to professional development, is considered important. (29) The majority of the literature on One Health surveillance, at some point, acknowledges the need for education that is not siloed from other relevant disciplines. (6, 55, 56, 60) Additionally, the need for regular, professional communication was reinforced in this study. Further, the consideration that an understanding of both the environment and disease transmission are necessary in understanding the interconnectedness of zoonotic diseases between human, animal and ecohealth, is relevant, and without this understanding, there may be resistance to cross-sectoral collaboration. (28) The results of this study, as well as the observations identified in relevant literature, reinforce the need for an early, educational approach to zoonoses in order to improve intersectoral collaboration, break down traditional silos and provide both students and professionals with a holistic understanding of the epidemiological triad and disease transmission. (2, 59, 63)

Participant considerations that a lack of an agreed definition and shared goal for One Health surveillance, as well as lack of intersectoral trust, are relevant and have been highlighted in other studies. As described by Conrad et al. (2), a common language for One Health, as well as an agreeance of a core set of goals or values to guide practice would be beneficial in addressing zoonoses. Runin et al. (64) states "A successful One Health approach will require that representatives from both animal and human health identify common mission and goals…" This concept is prominent in the literature. (2, 6, 21, 65, 66) As well as a shared definition and goal assisting in reducing the siloed approaches of sectors, Lee and Brumme (21) discuss the necessity for an agreed definition in order to also engage the relevant stakeholders.

The impact of zoonotic diseases on commercial interests and animal trade was mentioned often by participants of this research, although this is not well documented in the reviewed literature. Perhaps this disjuncture that exists between human health and animal trade is particularly relevant in an Australian context providing an Australian specific challenge. Australia's agriculture sector is a significant contributor to Australia's economy, estimated to be worth around 40 billion dollars annually, so restructuring these systems could have implications on Australia's economy, and therefore mitigation would best be managed at a government level. (67) As described by Zinsstag et al. (59), successful implementation of One Health systems requires ministerial involvement, as funding must be restructured to support collaboration, communication and new surveillance. This reinforces the participants' views that politicians are necessary in the discourse about zoonoses. Additionally, looking to other countries engaging in successful collaboration could assist. For example, in Europe, the agency responsible for animal health and food safety produces an annual zoonoses report, jointly with the agency responsible for public health. (56) For animal trade to be more understanding of the necessity for cross-sectoral data sharing, intersectoral communication and collaboration is first required. (68)

There have been a number of zoonotic disease outbreaks in Australia and overseas which illustrate the need for an integrated One Health approach to address these challenges. With improved interdisciplinary surveillance and earlier detection and reporting of disease outbreaks in animals, human infections may have been identified earlier and better managed, thereby reducing morbidity and mortality. (27, 69-73) Q Fever outbreaks in both Australia in the Netherlands, West Nile Virus in the USA, and the Australian Hendra outbreak, which took the lives of 4 veterinarians, could have been better managed had a One Health surveillance system existed. More timely detection and reporting of animal diseases, recognition of potential implications on human health, and increased protective measures could have led to better outcomes for both animals and humans involved. (74, 75) A more holistic understanding of the epidemiological triad, and a more comprehensive understanding of zoonoses, would likely have resulted in a more cautious approach to the Australian Hendra outbreaks by veterinarians. (72, 75) Similarly, linking Q Fever in infected goat farms in the Netherlands to infected humans was time-consuming, relying on an epidemiological investigation identifying the common exposures of patients before the association with infected goats was recognised. (69, 70) Early detection and reporting of identified zoonoses is crucial in preventing localised cases from becoming epidemic. (27)

The Australian Prime Minister's Science, Engineering and Innovation council (PMSEIC) reported in 2009 that "it is a matter of when, not if, a lethally catastrophic epidemic will happen". (76) It could be beneficial for the Australian government to consider the economic value of the agricultural industry in relation to, and not separate from zoonoses, in adopting an approach that accommodates industry while also enhancing zoonotic surveillance. Participants of this study considered that a demonstrated economic benefit is the way to engage the attention of the government, which could lead to policy or legislative change, as well as a less siloed approach to the funding of individual sectors. The results of this study suggest that a cross-disciplinary approach to funding will reduce some of the tensions that currently limit collaboration. The wider literature reinforces that collaboration between relevant ministers could result in improved government approaches to funding, education, communication and trust. (68, 77)

The WHO, in collaboration with the sixty-eighth World Health Assembly, recently released the 'Draft Global Action Plan on Antimicrobial Resistance', which specifically advocates for a One Health approach, including both combined surveillance and improved information sharing, due to demanding public health and animal health need. (78) Restructuring Australia's organisational systems to enable and enhance collaboration, cooperation and trust would likely be beneficial steps in zoonotic disease control. For the findings of this research to be translated into policy and practice, government involvement is necessary.

Commonly identified by participants of this study, and reinforced by similar views expressed in the wider literature, is that a new, independent, impartial overarching body be established to address EIDs and zoonoses in Australia. Considering the siloed approaches of current sectors and the lack of trust that exist, a new nonpartisan organisation, with representatives from each of the fields is recommended. This governance

body could provide the essential cross-disciplinary communication, with representatives from each of the fields providing their particular expertise in the discussion, bringing together a shared understanding of, and surveillance approach to zoonoses. Additionally, where possible, relevant ministers, policymakers or government representatives should be involved in that governance. A shared governance body, with both professional and ministerial involvement, is likely to provide the most effective management of such a system. Professionals involved in this governance body should equally represent human, animal and ecohealth, and the ministers of these areas should be kept informed, in order to provide an avenue for policy and legislative change where required.

While further research could provide a more comprehensive interpretation from those involved in the relevant fields, there is already extensive literature outlining challenges to the implementation of global One Health surveillance approaches, and compelling arguments for their importance. Further research should be undertaken in an Australian specific context, aiming to identify ways in which these systems could conceivably operate. Looking to individual Australian states and identifying any successes in their approaches would likely be beneficial, and provide an opportunity to understand what has worked for them. NSW provides a good example of disease surveillance integration, which, with further research, could inform and guide a national approach. (19) Research areas should address how to achieve confidential and controlled intersectoral data sharing, how to enable the merge of human and animal surveillance into a system allowing for direct comparisons, and improving national environmental surveillance to provide data which can be included in any One Health approach. Additionally, future research should aim to identify how integrated data can best be used to prevent and control zoonotic diseases. In order for a global approach to be possible, successful and collaborative national systems are first necessary.

8. Recommendations

In consideration of participant perspectives and the relevant literature, recommendations for overcoming the challenges associated with implementing an integrated One Health surveillance system in Australia are as follows:

- Establish a formal governance body with representatives from human, animal and ecohealth sectors.
    - Develop a consistent One Health definition.
    - Establish environmental surveillance to monitor the presence of vectors and pathogens.
    - Develop a plan to engage intersectoral communication.
    - Consult with the agricultural industry to develop policy enabling notification and data sharing of animal health.
    - Engage policymakers in discussions around One Health.

- Tertiary education institutions should consider the development of interdisciplinary public health training in areas of medical and veterinary public health and environmental studies.

- Conduct further research to establish the economic and health benefits of One Health surveillance in Australia.

9. Study limitations

Due to the nature of this research, and its objective to establish the professional opinion of experts, it is acknowledged that participants' own biases may act as a limitation. While the question design (Appendix H) intended to reduce the risk of personal bias and mitigate these limitations, inevitably, when opinions are sought, the likelihood of subjectivity is significant. As Connelly (42) states, "Neutrality in social science and particularly public health is not possible, even if it is considered desirable".

The small sample size of this study, and the different interviewing techniques used (a mix of face-to-face and telephone interviews) act as further limitations to this research. Additionally, due to time constraints, it was not possible to interview government or industry representatives, and as such, the study group consisted of academics only. Additionally, the perspectives of participants included in this research are not necessarily representative of those of their peers. As such, these views cannot be generalised to represent the fields in which the participants experience lies. Further larger-scale studies involving interviews and surveys of stakeholders including representatives from a range of organisations would be beneficial.

Despite these limitations, the strengths of this study include its unique approach, with a national focus and input from prominent experts around Australia, influential in their respective fields including veterinary health, public health, ecohealth, zoonoses, vector-borne diseases and disease surveillance systems. The rich and insightful data provided by participants has enabled a comprehensive understanding of the challenges of implementing an integrated One Health surveillance system in Australia, and resulted in a study that could provide guidance for overcoming challenges in the implementation of such a system.

10. Conclusion

A formal, integrated One Health surveillance system is likely to provide an effective approach to reducing both the prevalence, and economic burden of zoonoses in Australia. The results of this study, in collaboration with relevant literature suggest that for a One Health approach to be successfully implemented in Australia, a number of priorities should be addressed. A clear definition of One Health should be agreed upon, and a formal governance body should be established with representatives from the fields of human, animal and ecohealth. This committee should involve relevant policymakers where possible, and engage them in discussions regarding zoonoses. Environmental surveillance, monitoring both pathogens and vectors, as well as cross-disciplinary tertiary training would allow for the implementation of integrated surveillance. Broadly, this study illustrates how a lack of collaboration results in siloed approaches and mentalities across Australian sectors, and the importance of interdisciplinary communication and collaboration in the field of zoonotic disease control.

Appendix A: Literature Review Search Terms and Logic Grids

Table 1: PubMed Logic Grid

One Health OR Zoonoses **(Dengue Fever OR** **Malaria OR** **Hendra OR** **H1N1 OR** **Encephalitis OR** **Salmonella OR** **Zika)**	**Surveillance System**	**Challenges OR Barriers**
(((“One Health”[tiab] OR "Zoonoses/Epidemiology"[Mesh] OR "Zoonoses/Prevention and Control"[Mesh] OR "Zoonoses/Transmission"[Mesh] OR (“One Health”[TIAB] AND (Dengue[tiab] OR Malaria[tiab] OR Hendra[tiab] OR H1N1[tiab] OR Encephalitis[tiab] OR Zika[tiab]))	(“Surveillance”[ti] OR“Health Surveillance”[MH] OR "Population Surveillance"[MH] OR "Epidemiological Monitoring"[MH])	(“Challenges”[ti] OR “Barriers”[ti] OR "Efforts"[ti] OR "Optimization"[ti] OR “Optimisation”[ti] "Implement*"[ti]) OR “Guides”[ti] OR “Guidelines”[ti])

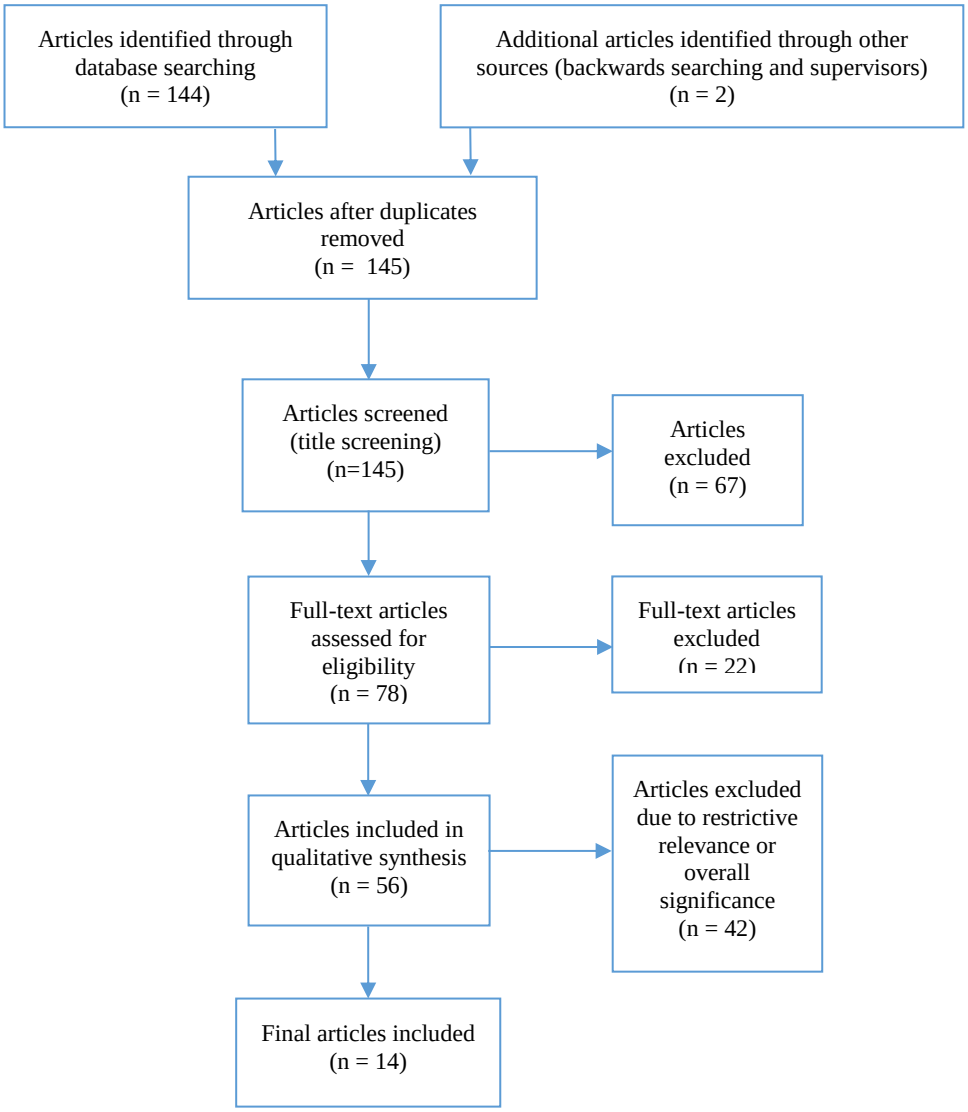
(((“One Health”[ti] OR "Zoonoses/Epidemiology"[Mesh] OR "Zoonoses/Prevention and Control"[Mesh] OR "Zoonoses/Transmission"[Mesh] OR ("One Health"[tiab] AND Dengue[tiab] OR Malaria[tiab] OR Hendra[tiab] OR H1N1[tiab] OR Encephalitis[tiab] OR Zika[tiab] AND (("Surveillance"[ti] OR “Health Surveillance”[MH] OR "Population Surveillance"[MH] OR "Epidemiological Monitoring"[MH])) AND ((“Challenges”[ti] OR “Barriers”[ti] OR "Efforts"[ti] OR "Implement*"[ti]) OR “Guides”[ti] OR “Guidelines”[ti])) – 31/03/16 77 results (1 duplicate)

Table 2: Embase Logic Grid

One Health OR Zoonoses **(Dengue Fever OR** **Malaria OR** **Hendra OR** **H1N1 OR** **Encephalitis OR** **Salmonella OR** **Zika)**	**Surveillance System**	**Challenges OR Barriers**
‘One Health’:ti OR ('animal health'/exp AND 'public health'/exp) OR 'zoonosis':ti OR 'zoonotic disease':ti	“Health survey”/exp OR “disease surveillance”/exp OR “Surveillance”:ti	“Health care planning”/exp OR “Challenges” OR (“Barriers” OR "Efforts" OR "Optimization" OR “Optimisation” "Implement” OR “Guides” OR “Guidelines”)

'one health':ab,ti OR ('animal health'/exp AND 'public health'/exp) OR 'zoonosis':ti OR 'zoonotic disease':ti AND ('health survey'/exp OR 'disease surveillance'/exp OR 'surveillance':ti) AND ('health care planning'/exp OR 'challenges':ab,ti OR 'barriers':ab,ti OR 'efforts':ab,ti OR 'optimization':ab,ti OR 'optimisation':ab,ti OR 'implement':ab,ti OR 'guides':ab,ti OR 'guidelines':ab,ti) – 31/03/16 68 results

Appendix B: Summary of the Yield



Appendix C: Summary Table

Country and article title	Journal	Author	Year	Summary
GERMANY Zoonotic disease surveillance - Inventory of systems integrating human and animal disease information	Zoonoses and Public Health	Wendt et. al.	2015	Article addresses the lack of interdisciplinary approaches to zoonoses, and provides a study of current surveillance systems for zoonotic diseases. Addresses the issue that there is a higher focus placed on emerging zoonoses, rather than endemic zoonoses with a higher burden. Challenges, as well as recommendations are addressed.
USA A Review of Zoonotic Disease Surveillance Supported by the Armed Forces Health Surveillance Center	Zoonoses and Public Health	Burke et. al.	2011	Article addresses prevalence of zoonoses, the difficulty of clinical diagnoses of zoonoses and the difficulty of controlling zoonoses in 'high risk' human populations. Article addresses challenges associated with One Health and provides recommendations for the future.
CANADA Surveillance of zoonotic infectious disease transmitted by small companion animals	Emerging Infectious Disease Journal	Day et. al.	2012	Article acknowledges the closeness in environment between domestic animals and humans, and addresses the lack of coordinated systems to monitor disease in companion animals. Identifies a challenge with regard to companion animals, and provides both recommendations and addresses challenges.

UNITED KINGDOM Bringing together emerging and endemic zoonoses surveillance: shared challenges and a common solution	Philosophical Transactions of the Royal Society	Halliday et. al.	2012	Article addresses regulations and barriers to disease reporting as well as a lack of enforcement of reporting in some areas. Addresses the idea of incentives for reporting, eg. surveillance reporting should benefit involved communities. Both challenges and recommendations are addressed.
USA Barriers to, Efforts in, and Optimization of Integrated One Health Surveillance: A Review and Synthesis	EcoHealth	Uchtmann et. al.	2015	Article focusses on the barriers that currently hinder the implementation or successes of One Health approaches. Describes examples of US based systems, and the ways in which these systems are designed to strengthen collaboration of sectors to achieve a shared One Health goal.
UNITED KINGDOM More than one world, more than one health: Re-configuring interspecies health	Social Science and Medicine	S. Hinchliffe	2015	Article addresses the need to tackle emerging zoonoses, and addresses the increasing interdependence of humans and animals. Specific diseases and their current and surveillance systems are addressed. Both challenges of One Health and recommendations are discussed.
CANADA Operationalizing the One Health approach: the global governance challenges	Health Policy and Planning	K. Lee & Z. Brumme	2013	Article addresses the challenges that have so far prevented or hindered the success of the One Health approach. Addresses the issue that there are various interpretations of One Health and how far the 'net' should be cast. Article provides suggestions and

				recommendations for implementing and strengthening One Health approaches.
AUSTRALIA One Health in NSW: coordination of human and animal health sector management of zoonoses of public health significance **- article provided by supervisor**	NSW Public Health Bulletin	Adamson et. al.	2011	Article talks about the coordination of sectors in NSW to create a One Health approach. Addresses the individual sectors involved in zoonoses control and talks about the successes seen with the integrated approach in NSW. Addresses recommendations to improve current or emerging systems.
USA One World – One Medicine – One Health: emerging veterinary challenges and opportunities	Scientific and Technical Review	Osburn et. al.	2009	Article addresses global issues that require veterinary attention and would benefit from a One Health approach. Focuses on vital components of One Health that are needed moving forward. Recommendations are provided.
USA The evolution of One Health: a decade of progress and challenges for the future	Veterinary Record	P. Gibbs	2014	Article addresses the evolution of the One Health concept over the past ten years, outlining achievements over the past decade as well as the challenges associated with bettering current or new One Health approaches. Recommendations are provided.
UNITED KINGDOM Emerging zoonoses: tackling the challenges	Epidemiology and Infection	K. Stark & D. Morgan	2015	An editorial which addresses the challenges of controlling the emergence of infectious diseases. Describes recommendations as well as challenges.

USA Operationalizing a One Health approach to global health challenges	Comparative Immunology, Microbiology and Infectious Diseases	Conrad et. al.	2013	Article focusses on collaboration and interdisciplinary approaches. Looks at conceptual differences between sectors and the challenges faced by researchers. Encourages the engagement of community stakeholders moving forwards. Recommendations are provided.
UNITED KINGDOM Risk Factors for Human Disease Emergence **- article found through backwards searching**	Philosophical Transactions: Biological Sciences	Taylor et. al.	2001	A study providing a discussion of their hypothesis that zoonotic pathogens are more likely to be associated with emerging diseases, rather than non emerging diseases. Article provides conformation that the majority of emerging infectious diseases are of zoonotic origin.
USA The historical, present, and future role of veterinarians in one health	US Fish and Wildlife Publications	S. Gibbs & P. Gibbs	2012	Article discusses the role of veterinarians in zoonoses control, as well as their specific role in One Health. Addresses the 'rebranding' of One Health and discusses the past attempts of integrating sectors. Argues that the veterinary world is more integral in One Health approaches. Neither challenges nor recommendations are addressed.

Appendix D: Ethics Approval

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

27 July 2016

Professor P Bi
School of Public Health

Dear Professor Bi

ETHICS APPROVAL No: **H-2016-165**

PROJECT TITLE: **What are the perceived barriers, among health professionals, to the effective implementation of One Health surveillance systems in (South) Australia**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Health Sciences) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **27 Jul 2016**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/rb/oreci/human/reporting/. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely,

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

Appendix D: (Continued) Ethics Approval

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelalde.edu.au

CRICOS Provider Number 00123M

Applicant:	**Professor P Bi**
School:	**School of Public Health**
Project Title:	**What are the perceived barriers, among health professionals, to the effective implementation of One Health surveillance systems in (South) Australia**

The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Health Sciences)

ETHICS APPROVAL No: **H-2016-165** **App. No.: 0000021851**

APPROVED for the period: **27 Jul 2016 to 31 Jul 2019**

Thank you for your response dated 25.06.2016 to the matters raised.

It is noted this study includes Isabella Johnson, Honours student.

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

Appendix E: Participant Consent Form

Human Research Ethics Committee (HREC)

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	**What are the perceived barriers among human, animal and ecological health professionals, to the effective implementation of an integrated One Health surveillance system in Australia**
Ethics Approval Number:	**H-2016-165**

2. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

4. Although I understand the purpose of the research project it has also been explained that involvement may not be of any benefit to me.

5. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

6. I understand that I am free to withdraw from the project at any time.

7. I agree to the interview being audio/video recorded. Yes ☐ No ☐

8. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: _____Signature: _____ Date:_____

Appendix F: Letter of Participation

Dear _____,

My name is Isabella Johnson, I am an honours student in the discipline of Public Health at the University of Adelaide. Together with Professor Peng Bi, and Dr Alana Hansen, I am conducting research in the area of One Health.

The aim of my research is to seek perceptions from key informants to facilitate an improved integrated approach to zoonotic disease surveillance in Australia, with the objective of determining any challenges that are hindering the implementation or successes of One Health surveillance approaches. To achieve this, I am approaching identified experts in the field of One Health, and inviting them to participate in this research.

I would like to invite you to contribute to this research by providing your professional opinion on a range of issues surrounding One Health in a semi-structured interview. Interviews will take between 30 to 40 minutes and can be held at a location convenient to you, or using a phone on the University of Adelaide campus. Interviews will be recorded and transcribed verbatim. Thematic analysis of the data will follow, and the resulting data will provide the basis for my thesis. All participants will be de-identified.

If you have any questions please feel free to contact me via email, or if you are interested in participating please email me with a suitable time for a phone interview. Please find attached an information sheet outlining the research, as well as a consent form.

Kind Regards,
Isabella Johnson
Isabella.johnson@student.adelaide.edu.au

Appendix G: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

PROJECT TITLE: The challenges of implementing One Health surveillance systems
HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2016-165
PRINCIPAL INVESTIGATOR: Peng Bi
STUDENT RESEARCHER: Isabella Johnson
STUDENT'S DEGREE: Bachelor of Health Science (Honours)

Dear Participant,

You are invited to participate in the research project described below.

What is the project about?
The purpose of this project is to identify the challenges that are currently faced in the area of One Health. By identifying and understanding these challenges, through interviews with experienced professionals in the field, current and future One Health surveillance systems could focus on improving the integration of human, animal and ecological surveillance with a focus on One Health.

The WHO estimates that infectious diseases, the majority of which are zoonotic, account for 43% of the overall global burden of disease. (1) From a population health perspective, it is imperative to not only understand zoonotic epidemiology, but to also focus on zoonotic surveillance with an integrated approach. (2) Currently, human diseases, animal infections and ecological diseases are dealt with by separate sectors with limited information exchange and data sharing, and as such, effective and timely communication between these departments is inherently compromised. (3)

In order to improve the way health sectors are currently implementing and managing overarching One Health approaches, if at all, it is necessary to identify and evaluate current approaches, their successes and their challenges and to look to find ways of implementing systems that represent the successes that have been identified thus far. For communicable disease health sectors and services to come together and use their time, resources and knowledge in a coordinated approach to achieve better surveillance, better global outcomes in the area of zoonotic disease control may be observed.

(1) Global Burden of Disease Geneva: The World Health Organization; 2016 [cited 2016 04 April]. Available from: http://www.who.int/trade/glossary/story036/en/.

(2) Wendt A, Kreienbrock L, Campe A. Zoonotic disease surveillance - Inventory of systems integrating human and animal disease information. Zoonoses and Public Health. 2015;62(1):61-74.

(3) Halliday J, Daborn C, Auty H, Mtema Z, Lembo T, Bronsvoort BM, et al. Bringing together emerging and endemic zoonoses surveillance: shared challenges and a common solution. Philos Trans R Soc Lond B Biol Sci. 2012;367(1604):2872-80.

The aim of the research is to:

- Seek perceptions from key informants to facilitate an improved integrated approach to zoonotic disease surveillance in Australia.

Objective:

- Determine the challenges of implementing One Health surveillance in Australia.

Who is undertaking the project?
This project is being conducted by Professor Peng Bi (supervisor), Dr Alana Hansen (supervisor) and Isabella Johnson (honours student). This research will form the basis for the degree of Bachelor of Health Science (Honours) at the University of Adelaide under the supervision of Professor Peng Bi and Dr Alana Hansen.

Why am I being invited to participate?
Your experience in the health field, and your views on One Health surveillance will provide the insight that will inform the research, and potentially public health action.

What will I be asked to do?
You will be asked to answer questions about One Health and surveillance in the style of a semi-structured interview, and provide your professional expertise on where the challenges in the surveillance currently lie, as well as provide any recommendations for future systems. The interview will be recorded, transcribed verbatim, and then coded and analysed thematically.

The interviews will take place at a location convenient to you (either the University of Adelaide or your place of work), alternatively phone interviews are possible.

How much time will the project take?
The interview will be one off, and is expected to take between 30 to 40 minutes of your time.

Are there any risks associated with participating in this project?
There are no obvious perceived risks associated with the research, however, the University of Adelaide offers a free and confidential counselling service that is available to anyone taking part in the research.

What are the benefits of the research project?
The research will endeavour to inform future One Health surveillance systems, and look to provide recommendations to strengthen existing systems. The research will not directly benefit you, but will look to enhance knowledge in your area of interest.

Can I withdraw from the project?
Participation in this project is voluntary. If you agree to participate, you can withdraw from the study at any time, and any data will be withdrawable up until the time of thesis submission in late October 2016.

What will happen to my information?
Interviews will be recorded and transcribed verbatim. Those transcripts will then be coded, thematically analysed and the resulting data will inform the research that will make up the student honours thesis. The data will be stored on a password protected university computer, and only accessible to Professor Peng Bi, Dr Alana Hansen and Isabella Johnson. Any hard copies of data will be stored in a locked fining cabinet at the University of Adelaide in the department of Public Health. All data will be de-identified through the use of a participant number, and only the two supervisory researchers and the student researcher will have access

to the names corresponding to those numbers. The data may be used in the future to form part of a pilot project.

Who do I contact if I have questions about the project?
For any questions please contact:

Supervisor Professor Peng Bi on 8313 3583 or at peng.bi@adelaide.edu.au,

Supervisor Dr Alana Hansen on 8313 1043 or at Alana.hansen@adelaide.edu.au,

Student Isabella Johnson at Isabella.johnson@student.adelaide.edu.au

What if I have a complaint or any concerns?
The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2016-165). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator Professor Peng Bi on 8313 3583 or at peng.bi@adelaide.edu.au.

If you wish to speak with an independent person regarding a concern or complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:
Phone: +61 8 8313 6028
Email: hrec@adelaide.edu.au
Post: Level 4, Rundle Mall Plaza, 50 Rundle Mall, ADELAIDE SA 5000
Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If I want to participate, what do I do?
If you are interested in contributing to this research please fill in the attached consent form and email to **Peng.bi@adelaide.edu.au, Alana.hansen@adelaide.edu.au** and **Isabella.johnson@student.adelaide.edu.au**

Following this, student Isabella Johnson will be in email contact to arrange an interview, either by phone or in person.

Yours sincerely,
Professor Peng Bi
Dr Alana Hansen
Isabella Johnson

Appendix H: Interview Topic Guide

HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2016-165

1. Introduce myself, explain the purpose of the research

   'I'm from the Adelaide University school of Public Health, and I'm looking to gain further insight into the perceptions and understandings of people working in the field of human, animal and ecological health; to get their perspectives of a One Health approach to disease surveillance.'

2. This interview will be audio recorded, can I confirm that is okay with you?

   (Explain confidentiality of data)

3. Consent forms (x2), information sheet and complaints form

This research project is being undertaken by Honours student Isabella Johnson and will be supervised by Dr Alana Hansen and Professor Peng Bi, from the School of Public Health.

PROJECT TITLE: What are the challenges of implementing One Health surveillance?

1. Because One Health is such a broad area, can you explain your understanding of One Health?

   - Who is involved, what issues should it include, how does it look (from your field)?

2. Can you tell me where you understand One Health to be at currently?

3. Can you tell me about the experiences of your career that have led to you being interested in One Health?

4. Could you give me an example of where a One Health approach has been relevant to your work?

   - Who was involved? What happened? What didn't happen?

'I would like to ask you a little bit about disease surveillance and data sharing, so essentially combing the surveillance of human, animal and ecological health for the purposes of integrated disease surveillance.'

5. What do you consider to be the advantages of integrated One Health surveillance?

- What do you consider to be the disadvantages?
- Ideally, what do you think a One Health surveillance system should look like?

6. What are the biggest challenges for the integration of human, animal and ecological disease notification systems?

'Its been acknowledged that some sectors may feel ultimately responsible for the security of sensitive data, and can therefore be hesitant to share this data with other sectors.'

7. What do you think the barriers are relating to data sharing and the security of data sharing between sectors?

-Can these be overcome? If so, how?

8. From your understanding of how One Health can best be achieved (if at all), do you think that any one sector should be ultimately responsible for One Health surveillance, or should the responsibility be shared between sectors?

- (If shared) How can we encourage collaboration between sectors to contribute to such a system?
- (If not shared) Who should hold the ultimate responsibility, and why are they best suited to that role?

9. Where to now for One Health? If Australia were to implement a One Health approach, how do you think it should proceed?

- What would be the next steps?
- What needs to be planned and considered before moving forward?
- Who would collect data?
- How would data be collected?
- How should data best be used to benefit health?

10. Finally, is there anything else that I have not asked you about that you think is important to consider?

Thank the participant for taking the time to answer the research questions, and offer them a copy of their interview transcript.

Appendix I: Participant Complaints Form

The University of Adelaide
Human Research Ethics Committee (HREC)

This document is for people who are participants in a research project.

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project Title:	**What are the perceived barriers among human, animal and ecological health professionals, to the effective implementation of an integrated One Health surveillance system in Australia**
Approval Number:	**H-2016-165**

The Human Research Ethics Committee monitors all the research projects which it has approved. The committee considers it important that people participating in approved projects have an independent and confidential reporting mechanism which they can use if they have any worries or complaints about that research.

This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (see http://www.nhmrc.gov.au/publications/synopses/e72syn.htm)

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Name:	**Professor Peng Bi**
Phone:	**08 831 33583**

2. If you wish to discuss with an independent person matters related to:
   - making a complaint, or
   - raising concerns on the conduct of the project, or
   - the University policy on research involving human participants, or
   - your rights as a participant,

   contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au

Appendix J: Grouped Codes

Advantages

Advantages\Ability

Advantages\Advocate

Advantages\Agreeance

Advantages\Communication

Advantages\Generic

Advantages\Improved

Advantages\Improved\Benefit

Advantages\Improved\Broader

Advantages\Improved\Convenient

Advantages\Improved\Depth

Advantages\Improved\Earlier

Advantages\Improved\Earlier\Detection

Advantages\Improved\Easier

Advantages\Improved\Easier\Already do it

Advantages\Improved\Faster

Advantages\Improved\Function

Advantages\Improved\Sustainable

Advantages\Improved\Valuable

Advantages\Inform

Advantages\Integration

Advantages\Intelligent

Advantages\Interaction

Advantages\Intervention

Advantages\Mistakes

Advantages\Prevention

Advantages\Reason

Advantages\Save

Challenges

Challenges\Avoidance

Challenges\Barriers

Challenges\Blame

Challenges\Clash

Challenges\Collaboration

Challenges\Common sense

Challenges\Common sense\Override

Challenges\Comparable

Challenges\Compatible

Challenges\Competing

Challenges\Definitions

Challenges\Destroyed

Challenges\Different

Challenges\Different purposes

Challenges\Disadvantages

Challenges\Disinterested

Challenges\Do not do it

Challenges\Goals

Challenges\Inappropriate

Challenges\Increasing

Challenges\Invading

Challenges\Irrational

Challenges\Legal

Challenges\Overcome

Challenges\Perspectives

Challenges\Problem

Challenges\Quarantine

Challenges\Reporting

Challenges\Reporting\Voluntary

Challenges\Resistance

Challenges\Responsibility

Challenges\Security

Challenges\Silo

Challenges\States

Confidentiality

Confidentiality\Commercial

Confidentiality\Data

Confidentiality\Privacy

Confidentiality\Protection

Confidentiality\Secrecy

Confidentiality\Tourism

Confidentiality\Trade

Context

Context\Story

Context\Understanding

Disease triad

Disease triad\Disease

Disease triad\Disease\Bluetongue

Disease triad\Disease\Death

Disease triad\Disease\Defecate

Disease triad\Disease\Diagnose

Disease triad\Disease\Ebola

Disease triad\Disease\Emerging Infectious Diseases

Disease triad\Disease\Heat Stress

Disease triad\Disease\Hendra

Disease triad\Disease\HIV

Disease triad\Disease\Microbes

Disease triad\Disease\Multi resistant

Disease triad\Disease\Notification

Disease triad\Disease\Pathogen

Disease triad\Disease\Rabies

Disease triad\Disease\Ross River

Disease triad\Disease\Sheading

Disease triad\Disease\Stressed

Disease triad\Disease\TB

Disease triad\Disease\Testing

Disease triad\Disease\Transmit

Disease triad\Disease\Vector-borne

Disease triad\Disease\Virus

Disease triad\Disease\Zika Virus

Disease triad\Disease\Zoonotic

Disease triad\Host

Disease triad\Host\Mosquitoes

Economists

Economists\Money

Education

Education\Training

Environment

Environment\Agriculture

Environment\Biodiversity

Environment\Biota

Environment\Climate Change

Environment\Conservation

Environment\Eating

Environment\Ecohealth

Environment\Ecohealth\Impossible

Environment\Ecology

Environment\Environmental change

Environment\Environmental Health

Examples

Government

Government\Minister

Government\Political will

Government\Political will\Legislation

Government\Political will\Lobby group

Government\Political will\Mandatory

Government\Political will\Required

One Health

One Health\Attempt

One Health\Australia

One Health\Holistic

One Health\Intersect

One Health\Label

One Health\Mislabel

One Health\Missing

One Health\\Nothing new

One Health\Proposal

One Health\Tool

One Health\Unifies

Progressing

Progressing\Demonstrate

Progressing\Independent

Progressing\Interest

Progressing\Momentum

Progressing\National

Progressing\Not shared

Progressing\Recommendation

Progressing\Respect

Progressing\Stakeholders

Progressing\Take charge

Public health

Public health\Communities

Public health\Human populations

Public health\Medicine

Public health\People

Surveillance

Surveillance\Environmental surveillance

Surveillance\Intelligence

Trust

Trust\Resent

Veterinary

Veterinary\Animals

Veterinary\Wildlife

Appendix K: Stages of Thematic Analysis

Adapted from Braun and Clarke 2006. (40)

Stages of thematic analysis	Description of thematic analysis
Familiarising self with data	Transcribing data, familiarising self with data and noting initial ideas.
Formulation of initial codes	Arranging features of the data in a systemised approach across the data set, ordering data into their relevant codes.
Identification of themes	Organising themes from initial codes.
Reviewing themes	Cross-checking themes in relation to original codes and data. Generating a thematic 'map' of results.
Defining and naming themes	Refining the specifics of the themes, create clear names and definitions for each theme. Finalise thematic map of findings.
Writing report	Final opportunity for analysis. Selection of compelling extracts of themes, relating back to the research question and reporting the analysis.

Appendix L: Examples of Zoonoses Relevant to Australia

Adapted from Australian Veterinary Association 2013 (79), and the WHO (80)

Disease	Agent	Susceptible animals	Means of transmission to humans
Influenza A	Highly pathogenic avian influenza virus (HPAI - H5, H7 strains) and swine influenza A viruses	Pigs, poultry, water birds	Contact, aerosol (droplet, airborne)
Hendra Virus (Previously Equine morbillivirus)	Genus Henipavirus, Family Paramyxoviridae	Flying foxes. Horses and humans are spillover hosts. Dog is possible spillover host. Ferret and cat have been infected experimentally.	Contact, aerosol (droplets, airborne). Respiratory secretions and possibly urine of the horse; placenta and birth fluids, other body fluids of flying foxes
Leptospirosis	Leptospira spp.	Rodents, pigs, cattle, sheep, goats, horses, dogs, bats	Contact, aerosol, ingestion, food and water
Lyssavirus encephalitis	Australian bat lyssavirus	Bats	Contact (bite, scratch), parenteral exposure to body fluids
Q fever	Coxiella burnetii	Goats, sheep, cattle, rodents, lagomorphs, dogs, cats, kangaroos, bandicoots, camelids	Contact, aerosol (droplet, airborne), ingestion, fomites
Salmonellosis	Salmonella spp. (non-typhoid), including strains highly resistant to antimicrobials and ESBL producing strains	Reptiles, amphibians, poultry, horses, pigs, cattle, many species of mammals and birds	Contact, ingestion (food, water)
Severe Acute Respiratory Syndrome	Severe Acute Respiratory Syndrome –Associated Coronavirus (SARS-CoV)	Unknown (suspected bats, cats)	Contact, aerosol (droplet, airborne)

References

1. Hinchliffe S. More than one world, more than one health: Re-configuring interspecies health. Social Science and Medicine. 2015;129:28-35.

2. Conrad PA, Meek LA, Dumit J. Operationalizing a One Health approach to global health challenges. Comparitive Immunololgy, Microbiology & Infectious Diseases. 2013;36(3):211-6.

3. Burke RL, Kronmann KC, Daniels CC, Meyers M, Byarugaba DK, Dueger E, et al. A Review of Zoonotic Disease Surveillance Supported by the Armed Forces Health Surveillance Center. Zoonoses and Public Health. 2012;59(3):164-75.

4. Palmer MV. Mycobacterium bovis: characteristics of wildlife reservoir hosts. Transboundary and Emerging Diseases. 2013;60 Suppl 1:1-13.

5. J Mackenzie, M Jeggo, P Daszak, Richt J. One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases: Springer Berlin Heidelberg; 2013.

6. Mackenzie JS, McKinnon M, Jeggo M. One Health: From Concept to Practice. Confronting Emerging Zoonoses: The One Health Paradigm. Tokyo: Springer Japan; 2014. p. 163-89.

7. Taylor LH, Latham SM, woolhouse MEJ. Risk factors for human disease emergence. Philosophical Transactions of the Royal Society B: Biological Sciences. 2001;356(1411):983-9.

8. Stark KD, Morgan D. Emerging zoonoses: tackling the challenges. Epidemiology & Infection. 2015;143(10):2015-7.

9. Osburn B, Scott C, Gibbs P. One world--one medicine--one health: emerging veterinary challenges and opportunities. Scientific and Technical Review. 2009;28(2):481-6.

10. Jeggo M, Mackenzie JS. Defining the Future of One Health. Microbiology spectrum. 2014;2(1):OH-0007-2012.

11. Global Burden of Disease Geneva: The World Health Organisation; 2016 [cited 2016 04 April]. Available from: http://www.who.int/trade/glossary/story036/en/.

12. Australia's Health 2014. Canberra: Australian Institute of Health and Welfare, 2014. [cited 2016 04 April] Available from: http://www.aihw.gov.au/australias-health/2014/

13. Wendt A, Kreienbrock L, Campe A. Zoonotic disease surveillance - Inventory of systems integrating human and animal disease information. Zoonoses and Public Health. 2015;62(1):61-74.

14. Australian Government Department of Health. Surveillance systems reported in Communicable Diseases Intelligence Canberra 2016 [cited 2016 8/4].

15. Australia's Health System Canberra: Australian Institute of Health and Welfare; 2016 [cited 2016]. Available from: http://www.aihw.gov.au/australias-health/2014/health-system/

16. Armstrong BK, Gillespie JA, Leeder SR, Rubin GL, Russell LM. Challenges in health and health care for Australia. Medical Journal of Australia. 2007;187(9):485-9.

17. Miller M, Roche P, Spencer J, Deeble M. Evaluation of Australia's National Notifiable Disease Surveillance System. Communicable Diseases Intelligence Quarterly Report. 2004;28(3):311-23.

18. Australia's notifiable disease status, 2013: Annual report of the National Notifiable Diseases Surveillance System. Communicable Diseases Intelligence Quarterly Report. 2015;39(3):387-478.

19. Adamson S, Marich A, Roth I. One Health in NSW: coordination of human and animal health sector management of zoonoses of public health significance. NSW Public Health Bulletin. 2011;22(6):105-12.

20. Australian Government Department of Health. National list of Notifiable Animal Diseases Canberra: Australian Government Department of Agriculture and Water Resources; 2016 [cited 2016 20/8]. Available from: http://www.agriculture.gov.au/pests-diseases-weeds/animal/notifiable

21. Lee K, Brumme ZL. Operationalizing the One Health approach: the global governance challenges. Health Policy Plan. 2013;28(7):778-85.

22. M SL. Global Health Surveillance. United States of America: Centres for Disease Control and Prevention, 2012.

23. Katz R, Fischer J. The Revised International Health Regulations: A Framework for Global Pandemic Response. Global Health Governance. 2010;3(2):1-18.

24. Plotkin BJ, Hardiman MC. Infectious disease surveillance and the International Health Regulations. Infectious Disease Surveillance: John Wiley & Sons Ltd; 2013. p. 62-80.

25. Malele, II. Fifty years of tsetse control in Tanzania: challenges and prospects for the future. Tanzania Journal of Health Research. 2011;13(5 Suppl 1):399-406.

26. Uchtmann N, Herrmann JA, Hahn EC, 3rd, Beasley VR. Barriers to, Efforts in, and Optimization of Integrated One Health Surveillance: A Review and Synthesis. Ecohealth. 2015;12(2):368-84.

27. Halliday J, Daborn C, Auty H, Mtema Z, Lembo T, Bronsvoort BM, et al. Bringing together emerging and endemic zoonoses surveillance: shared challenges and a common solution. Philosophical Transactions of the Royal Society Biological Sciences. 2012;367(1604):2872-80.

28. Gibbs SEJ. The historical, present, and future role of veterinarians in one health. Current Topics in Microbiology and Immunology. 2013;365:31-47.

29. Gibbs EP. The evolution of One Health: a decade of progress and challenges for the future. Veterinary Record. 2014;174(4):85-91.

30. Day MJ, Breitschwerdt E, Cleaveland S, Karkare U, Khanna C, Kirpensteijn J, et al. Surveillance of zoonotic infectious disease transmitted by small companion animals. Emerging Infectious Diseases. 2012;18(12).

31. Kahn LH, Kaplan B, Steele JH. Confronting zoonoses through closer collaboration between medicine and veterinary medicine (as 'one medicine'). Italian Journal of Animal Science. 2007;43(1):5-19.

32. Cooper S, Endacott R. Generic qualitative research: a design for qualitative research in emergency care? Emergency Medicine Journal : EMJ. 2007;24(12):816-9.

33. Sandelowski M, Barroso J. Classifying the findings in qualitative studies. Qualitative Health Research. 2003;13(7):905-23.

34. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. British Dental Journal. 2008;204(6):291-5.

35. Sofaer S. Qualitative methods: what are they and why use them? Health Services Research. 1999;34(5 Pt 2):1101-18.

36. Liamputtong P. Qualitative Research Methods 4ed. Victoria, Australia: Oxford University Press; 2013.

37. Cresswell J. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications. 2003.

38. Long T, Johnson M. Rigour, reliability and validity in qualitative research. Clinical Effectiveness in Nursing. 2000;4(1):30-7.

39. Noble H, Smith J. Issues of validity and reliability in qualitative research. Evidence Based Nursing. 2015;18(2):34-5.

40. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3(2):77-101.

41. Reeves S, Albert M, Kuper A, Hodges BD. Why use theories in qualitative research? British Medical Journal. 2008;337.

42. Connelly J. Critical realism and health promotion: effective practice needs an effective theory. Health Education Research. 2001;16(2):115-20.

43. Easton G. Critical realism in case study research. Industrial Marketing Management. 2010;39(1):118-28.

44. McEvoy P, Richards D. Critical realism: a way forward for evaluation research in nursing? Journal of Advanced Nursing. 2003;43(4):411-20.

45. Willig C. Constructivism and 'The Real World': Can they co-exist? Qualitative Methods in Psychology Bulletin. 2016(21).

46. National Statement on Ethical Conduct in Human Research (2007) Canberra: National Health and Medical Research Council; 2007 [14/6].

47. Green J, Willis K, Hughes E, Small R, Welch N, Gibbs L, et al. Generating best evidence from qualitative research: the role of data analysis. Australia and New Zealand Journal of Public Health. 2007;31(6):545-50.

48. Nathan C, Cars O. Antibiotic Resistance — Problems, Progress, and Prospects. New England Journal of Medicine. 2014;371(19):1761-3.

49. Fauci AS, Touchette NA, Folkers GK. Emerging infectious diseases: a 10-year perspective from the National Institute of Allergy and Infectious Diseases. Emerging Infectious Diseases. 2005;11(4):519-25.

50. Salman MD. The role of veterinary epidemiology in combating infectious animal diseases on a global scale: the impact of training and outreach programs. Preventive Veterinary Medicine. 2009;92(4):284-7.

51. Bambrick HJ, Woodruff RE, Hanigan IC. Climate change could threaten blood supply by altering the distribution of vector-borne disease: an Australian case-study. Global Health Action. 2009;2.

52. Russell RC, Currie BJ, Lindsay MD, Mackenzie JS, Ritchie SA, Whelan PI. Dengue and climate change in Australia: predictions for the future should incorporate knowledge from the past. Medical Journal of Australia. 2009;190(5):265-8.

53. Whelan PI, Jacups SP, Melville L, Broom A, Currie BJ, Krause VL, et al. Rainfall and vector mosquito numbers as risk indicators for mosquito-borne disease in central Australia. Communicable Diseases Intelligence Quarterly Report. 2003;27(1):110-6.

54. Australian Government Department of Agriculture and Water Resources Biosecurity in Australia Canberra 2016 [cited 2016 18/6]. Available from: http://www.agriculture.gov.au/biosecurity

55. Mwangi W, de Figueiredo P, Criscitiello MF. One Health: Addressing Global Challenges at the Nexus of Human, Animal, and Environmental Health. PLOS Pathogens. 2016;12(9):e1005731.

56. Stark KD, Arroyo Kuribrena M, Dauphin G, Vokaty S, Ward MP, Wieland B, et al. One Health surveillance - More than a buzz word? Preventive Veterinary Medicine. 2015;120(1):124-30.

57. Narrod C, Zinsstag J, Tiongco M. A One Health Framework for Estimating the Economic Costs of Zoonotic Diseases on Society. Ecohealth. 2012;9(2):150-62.

58. Manlove KR, Walker JG, Craft ME, Huyvaert KP, Joseph MB, Miller RS, et al. "One Health" or Three? Publication Silos Among the One Health Disciplines. PLOS Biology. 2016;14(4):e1002448.

59. Zinsstag J, Mackenzie JS, Jeggo M, Heymann DL, Patz JA, Daszak P. Mainstreaming One Health. Ecohealth. 2012;9(2):107-10.

60. Allen-Scott LK, Buntain B, Hatfield JM, Meisser A, Thomas CJ. Academic Institutions and One Health: Building Capacity for Transdisciplinary Research Approaches to Address Complex Health Issues at the Animal–Human–Ecosystem Interface. Academic Medicine. 2015;90(7):866-71.

61. Garcia K, Gostin L. One Health, One World — The Intersecting Legal Regimes of Trade, Climate Change, Food Security, Humanitarian Crises, and Migration Laws 2012. 2012(1):4-38.

62. Yang J. Moving beyond traditional boundaries of health: Public health and multi-sectoral integration. Californian Journal of Health Promotion. 2011;9(1):5-6.

63. Godfroid J, Al Dahouk S, Pappas G, Roth F, Matope G, Muma J, et al. A "One Health" surveillance and control of brucellosis in developing countries: moving away from improvisation. Comparative Immunology, Microbiology & Infectious Diseases. 2013;36(3):241-8.

64. Rubin C, Dunham B, Sleeman J. Making One Health a Reality--Crossing Bureaucratic Boundaries. Microbiology Spectrum. 2014;2(1):OH-0016-2012.

65. Hueston W, Appert J, Denny T, King L, Umber J, Valeri L. Assessing Global Adoption of One Health Approaches. EcoHealth. 2013;10(3):228-33.

66. Rabinowitz PM, Kock R, Kachani M, Kunkel R, Thomas J, Gilbert J, et al. Toward proof of concept of a one health approach to disease prediction and control. Emerging Infectious Diseases. 2013;19(12).

67. Australian Bureau of Statistics. Value of Agricultural Commodoties Produced Canberra 2016 [cited 2016 8/10]. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/dossbytitle/F276A671BC2F9899CA256F0A007D8CB1.

68. Degeling C, Johnson J, Kerridge I, Wilson A, Ward M, Stewart C, et al. Implementing a One Health approach to emerging infectious disease: reflections on the socio-political, ethical and legal dimensions. BMC Public Health. 2015;15:1307.

69. Roest HI, Tilburg JJ, van der Hoek W, Vellema P, van Zijderveld FG, Klaassen CH, et al. The Q fever epidemic in The Netherlands: history, onset, response and reflection. Epidemiology & Infection. 2011;139(1):1-12.

70. van den Wijngaard CC, Dijkstra F, van Pelt W, van Asten L, Kretzschmar M, Schimmer B, et al. In search of hidden Q-fever outbreaks: linking syndromic hospital clusters to infected goat farms. Epidemiology & Infection. 2011;139(1):19-26.

71. Gubler DJ, Campbell GL, Nasci R, Komar N, Petersen L, Roehrig JT. West Nile virus in the United States: guidelines for detection, prevention, and control. Viral Immunology. 2000;13(4):469-75.

72. Crawford B, Roth I, Grillo T. One Health and Hendra virus: a collaborative approach in action. NSW Public Health Bulletin. 2012;23(8):160-.

73. Bond KA, Vincent G, Wilks CR, Franklin L, Sutton B, Stenos J, et al. One Health approach to controlling a Q fever outbreak on an Australian goat farm. Epidemiology & Infection. 2016;144(6):1129-41.

74. Marcotty T, Thys E, Conrad P, Godfroid J, Craig P, Zinsstag J, et al. Intersectoral collaboration between the medical and veterinary professions in low-resource societies: The role of research and training institutions. Comparative Immunology, Microbiology & Infectious Diseases. 2013;36(3):233-9.

75. Mendez D, Buttner P, Speare R. Hendra virus in Queensland, Australia, during the winter of 2011: veterinarians on the path to better management strategies. Preventive Veterinary Medicine. 2014;117(1):40-51.

76. Prime Minister's Science EaIC. Epidemics in a Changing World: Report of the Expert Working Group on Epidemics in a Changing World. Canberra: PMSEIC, 2009.

77. Schwind JS, Goldstein T, Thomas K, Mazet JA, Smith WA. Capacity building efforts and perceptions for wildlife surveillance to detect zoonotic pathogens: comparing stakeholder perspectives. BMC Public Health. 2014;14:684.

78. WHO. Draft Global Action Plan on Antimicrobial Resistance. Geneva: World Health Organisation, 2015. [cited 2016 2/10]. Available from: http://www.who.int/drugresistance/global_action_plan/ongoing_activities/en/

79. Australian Veterinary Association. Guidelines for Veterinary Personal Biosecurity. Sydney: 2013.

80. World Health Organization. SARS (Severe Acute Respiratory Syndrome) Geneva 2016 [cited 2016 7/8]. Available from: http://www.who.int/csr/sars/en/