



Australian Government
**Rural Industries Research and
Development Corporation**

Longitudinal cohort study of horse owners

**HHALTER: Horse owners and Hendra virus: A Longitudinal
study To Evaluate Risk**

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Foreword

Hendra virus (HeV) is a zoonotic disease that spills over from flying foxes to horses, and then can be transmitted from horses to horses and horses to humans and dogs. It has a high case fatality rate (>75% in horses and 57% in humans) making it a zoonosis of veterinary and public health significance.

HeV was first identified in 1994 and has occurred intermittently, with a total of 14 incidents in the period 1994 to 2010. However, in the period 20 June to 29 August 2011 a large spike of 18 incidents occurred, resulting in the death of 23 horses and sparking a great deal of concern across the horse industry as well as in the veterinary and public health sectors, and with the public at large. This ‘supercluster’ of HeV incidents prompted the establishment of the National Hendra Virus Research Program to fund research leading to strategies that minimise the impact of HeV.

HeV risk mitigation practices of horse owners and carers are critical in preventing the first step of transmission of the virus to horses. The HHALTER study (Horse owners and Hendra virus: A Longitudinal study To Evaluate Risk) was designed to capture factors that influence uptake of recommended HeV risk mitigation practices over time, primarily to inform policy makers in government, all sectors of the horse industry, and the veterinary sector.

This report presents the results of a series of five surveys and a set of interviews conducted with horse owners. This research identifies trends in risk perception, uptake of risk mitigation practices, and attitudes towards HeV control and risk communication. The report identifies a number of implications of these research findings and offers recommendations for improving communication with horse owners, addressing barriers to the uptake of risk mitigation practices, reviewing communication and approaches to current vaccination implementation, and preserving the important veterinarian-horse owner relationship.

The University of Western Sydney was contracted by the Rural Industries Research and Development Corporation to undertake this research project. This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program.

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our National Hendra Virus Research R&D program, which aims to improve strategies to prevent transmission of Hendra virus from flying foxes to horses, from horses to humans, from horses to horses, and potentially to other susceptible species.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Christine Quick
Acting Managing Director
Rural Industries Research and Development Corporation

Reflection

The reflection below is from a horse owner, based in Rockhampton. Her words express poignantly the way the risk of Hendra virus occupies her mind and impacts the routine of her daily life. We would like to thank Cherie Dooley for her permission to use her words in this report.

“I am in Rockhampton and have 19 horses here only 3 of whom are vacc by their owner’s choice. One of mine was vacc 3 times up until Dec 2013.

I woke this morning and first thought was for [my] horses’ health. Head count for injuries first and secondly for any sign of being unwell primarily looking for Hendra symptoms - then I had my coffee.

Rockhampton regional horse owners in their thousands would have done exactly the same thing!

If one of my horses I see laying down - there's an element of panic. I would love to be in Melbourne and wake up to see my horse laying down and smile thinking how tired he must be, isn't he cute laying flat out :) but nope my first thought is - oh hell why is he laying down now ? And I will watch until he hops up and goes on his merry way!

This is doing my head in!

Do I vacc? Don't I vacc?

Why? What if?

This morning a text message saying a friend’s horse has a haematoma between front legs and its last vacc was a month ago - is it a reaction? OMG!

This is a hotspot here and I'd dearly like to just think about how I made my coffee and simply forgot to sugar it!

Fear of the virus as well as fear of the vacc!

Fear of being mandated!

I lived here 20 years before vacc was available - why am I now unable to enjoy my coffee?”

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The project team would especially like to acknowledge the time, cooperation, and good-humour of the horse owners and carers who have taken part in the project. Thank you.

Abbreviations

ABLV	Australia Bat Lyssavirus
ACT	Australian Capital Territory
APVMA	Australian Pesticides and Veterinary Medicines Authority
HeV	Hendra virus
HHALTER	Horse owners and Hendra virus: A Longitudinal study To Evaluate Risk
NSW	New South Wales
NSW DPI	New South Wales Department of Primary Industries
QDAF	Queensland Department of Agriculture and Fisheries
QLD	Queensland
RIRDC	Rural Industries Research and Development Corporation
VIC	Victoria
WHSQ	Workplace Health and Safety Queensland

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Executive Summary

What the report is about

This report summarises the findings of a three-year mixed methods research study designed to capture factors that influence horse owner Hendra virus (HeV) risk mitigation practices. This research supports the Rural Industries Research and Development Corporation (RIRDC) Hendra Virus Research Priority 2: Improved strategies to prevent transmission of HeV. However, it may also contribute to Research Priority 3: Capacity to detect and respond effectively to HeV incidents.

The research project focuses on horse owners; their knowledge, attitudes, and risk mitigation practices, i.e. uptake of vaccination, property management, and biosecurity practices. A flexible research methodology enabled the tracking of core subject areas over time whilst also responding to new or evolving shifts in the HeV landscape, e.g. new HeV cases, event management, and issues arising in the vaccine roll-out.

By tracking relationships within the data and engaging with stakeholders and the horse owner population it is hoped that findings from the study will help to identify important linkages and effective strategies for communication/information and policy implementation.

Who is the report targeted at?

The report is directed to a wide range of stakeholders, including those involved in government, horse industry, veterinary, wildlife, HeV research, and public health sectors.

Where are the relevant industries located in Australia?

The Australian horse industry is the industry that is the focus of this study. It is anticipated that this research has the potential to benefit all sectors of the industry. Those based in the States of QLD and NSW and in regions that have been directly impacted by HeV cases are likely to have the greatest initial interest in the research, however flying foxes infected with HeV have been detected in other states in Australia and HeV has the potential to move beyond these geographic regions. In addition, horses within the industry are mobile, in particular in the competitive, racing, and breeding sectors. Concerns about the consequences of a HeV case at an event are widely discussed and take the audience for the research to a national, or even an international, scope. Now that a vaccine for horses is available, industry associations and groups (as well as veterinarians) are considering their policy options around vaccination. Similarly, those who employ people, or attract members of the public, to have contact with their horses are considering their duty of care responsibilities and need to know more about vaccine acceptance and horse owner attitudes to a range of policy options.

Estimates from 2001 suggest that there are between 600,000 and 1.2 million domestic horses held in Australia, contributing approximately \$6 billion dollars to the Australian economy each year through horse related business activities, events and expenditure on horse maintenance.

Background

HeV is a zoonotic disease that spills over from flying foxes to horses, and then can be transmitted from horses to horses and horses to humans and dogs. It has a high case fatality rate (>75% in equines, 57% in humans) making it a zoonosis of veterinary and public health significance. Since its identification in 1994 there have been 77 confirmed equine cases and seven human cases (to December 2015). A sudden upsurge in cases of HeV in 2011 triggered a public outcry, media frenzy, and a political response. Funding was made available through the National Hendra Virus Research Program (NHeVRP) to prioritise and fast-track HeV research, including the development of a novel vaccine.

In November 2012 a horse vaccine against HeV became available, making it possible to break the virus transmission pathway to horses and people. However, uptake of vaccination has been slow and the majority of horses remain unvaccinated. Minimising horse exposure to flying foxes and their excretions remains a fundamental risk management strategy and understanding the uptake of recommended practices over time is important for those involved in horse owner communication and engagement.

Aims/objectives

The research project (Horse owners and Hendra virus: A Longitudinal study To Evaluate Risk, or HHALTER) was designed to capture factors that influence horse owner HeV risk mitigation practices in the context of a dynamic and complex socio-political context. The study comprises two components; a series of surveys that captures baseline knowledge, attitudes, and practices and tracks these over a two year period, and a set of interviews that provides greater insight and understanding into the issues around HeV risk perception, uptake of risk mitigation practices, and engagement with government and industry stakeholders.

Methods used

This study was a mixed methods study conducted in two phases; a series of five online-administered surveys conducted at six-monthly intervals, and an in-depth interview study. Both study samples comprised horse owners or those who care for or manage horses. Participants were recruited from all industry sectors and all Australian States and Territories.

The quantitative survey component enabled relationships between HeV risk mitigation practices and a number of other factors, e.g. risk perception and awareness, knowledge, demographics, and types of horse involvement/ownership, to be statistically evaluated to understand the factors that determine these practices and their relative strengths in these relationships. The interview component (qualitative) complemented and expanded on these issues and provided a richer and more complex understanding of horse owner HeV risk conceptualisation and decision-making around risk mitigation.

Results/key findings

Some key findings from the HHALTER project are listed here as bullet points.

Main observations are:

- The majority of the sample was from QLD (47%), NSW (35%) and VIC (11%), and most participants were female (89%).
- The main primary sectors represented were recreational, competitive, and breeding.
- 1149 horse owners took part in the study, with a cohort of 341 taking part in all five surveys and more than 600 taking part in two or more surveys.
- Vaccination uptake in the sample rose from 11% in the first survey (Nov 2012) to peak around 58% from Nov 2013 onwards. This is much higher than the general level of uptake, even in known HeV risk areas (around 17% in QLD). For the purposes of interpretation of findings, the sample was considered to be more at risk, more engaged, and therefore in terms of likely risk mitigation practices ‘best case’, compared to the broader horse owning population.
- More than a quarter of respondents who had vaccinated their horses (29%) reported that they hadn’t been aware of the need for six-month vaccine boosters when their horses were first vaccinated. In the final survey (Nov 2014) 10% reported that none of their horses would be getting their 6-monthly boosters, a further 3% were unsure, and 19% reported that ‘some’ of their vaccinated horses would not be getting their 6-monthly boosters.

- Regarding vaccine policy, there was little support for blanket compulsory vaccination, but broader support for compulsory vaccination in HeV risk areas, although this support reduced over time (64% to 55% in agreement).
- There was modest support for veterinarians to adopt more stringent policies around non-vaccinated horses in areas where HeV cases have occurred, with around half agreeing that it was reasonable to make additional charges or refuse to treat unvaccinated horses.
- The uptake of recommended property management approaches was quite low in the study sample (20% in the final survey) and did not change over time. Recommendations to reduce horses' access to areas around trees were felt to be difficult to achieve and unlikely to be effective at reducing HeV risk by many participants.
- A large majority of horse owners (85%) reported that their horses always had access to uncovered water, and around half reported that their horses always had access to uncovered food. These figures changed little over time.
- Perceived risk of HeV decreased noticeably over the period of the study, moving from 75% to 39% reporting being very or extremely concerned about their horses if there was a HeV case in their area. Horse owners indicated that they had a greater sense of control over HeV risk over time, that their knowledge had increased, and that HeV was less of a priority as a horse health issue.
- There was fairly strong and steady support for State Departments of Primary Industries (Agricultural Departments) in their response to, and management of, HeV cases, and in the quality of their communication.
- Just over half the sample reported seeing flying foxes, although in the last survey only around a quarter of those respondents felt that flying foxes posed a direct threat to the health of their horses.

In addition to top-level survey findings noted above, statistical modelling and further more in-depth analysis has been completed or is underway in a number of areas. This has enabled investigation of the interrelationships between HeV risk attitudes, demographics, contexts, and risk mitigation practices. Some initial findings are as follows.

- Early uptake of vaccination was linked to concerns about the threat of HeV and concerns that veterinarians would refuse to treat unvaccinated horses. Those who were more likely to vaccinate had sought information from a veterinarian, felt that the vaccine was easy to get, and believed that it would be effective.
- Barriers to early uptake of vaccination were linked to opposing views to those above, but also concerns about costs and safety and use in the breeding sector.
- Vaccine uptake over the full study period generally was linked to higher perceived likelihood of HeV, greater concerns about the risks to self and family, greater sense of control over the risk of HeV, and higher levels of trust in elements of the official system. Issues that relate to financial considerations, such as having fewer numbers of horses and greater feelings of financial security are also linked to increased vaccine uptake. Those in Queensland were also more likely to vaccinate than those in other states.
- The corollary of the findings above is that those who chose not to vaccinate had lower levels of HeV risk perception, had less trust in the official system, had larger numbers of horses, felt less financially secure, and lived in states other than Queensland.

- Higher levels of biosecurity practice are linked to proximity to a HeV incident, greater veterinary contact, a greater likelihood to suspect HeV in a sick horse, and a greater sense of control over the risk of HeV.
- The perception of flying foxes as a health threat to horses is linked to horse owner perceptions of higher likelihood of HeV, greater concerns about HeV risks for their horse and themselves, a good sense of control over the risk of HeV, and having horse-related income.

The qualitative phase of the project enabled a more in-depth and nuanced evaluation of horse owner attitudes and opinions towards HeV risk and their risk mitigation practices. Interviews were conducted with horse owners in two known HeV risk areas; the Ballina-Lismore area in Northern NSW and the Rockhampton area in Central Queensland. Analysis of these interviews identified a complex weighing-up of barriers and benefits of risk mitigation strategies in light of personalised views of risk and modifying factors. Knowledge about recommended property management practices was good overall, although many interviewees felt that these practices were impractical, ineffective or felt that they were unable to do them. Views about vaccination were often polarised, although most interviewees (19/27) had vaccinated at least some of their horses. Veterinarians were again noted as important pathways for HeV communication, despite some issues voiced around trust and the motivation of veterinarians.

Finally, data are included from the final HHALTER survey (Nov 2014) that detail responses to vaccination-related questions, specifically, vaccination regime compliance; adverse reactions and reporting; pressure to vaccinate; and implications of vaccination. These data were collected from those respondents who had vaccinated some or all of their horses at this point in time (n=354). Some key findings were:

- More than a quarter of respondents (27%) reported that they had delayed having the 6-month booster or had withdrawn some or all of their horses from the vaccine program. These decisions were driven by cost considerations, beliefs that the vaccine regime would move to 12-monthly (annual) boosters, or that the risk of HeV infection in their horses was low.
- Around a quarter of respondents (24%) reported that their horses had shown some adverse reaction to the vaccination. Of this group, 30-44% reported 'moderate' levels of swelling around the site of the vaccine injection, general depression, or muscle stiffness, however 15-26% of this group felt that these reactions were 'severe'. Over half of the respondents (58%) indicated that they reported all the adverse reactions, and most reported to their local veterinarian.
- Twenty nine per cent of respondents reported that HeV vaccination was a requirement for them to maintain horse-related activity. Just over half of respondents (55%) felt a degree of pressure to vaccinate, with many citing formal horse associations or organisations as the main source of pressure, as well as their own veterinarian and other horse-related contacts, such as farriers, agistment owners and competition organisers.
- Although three quarter of respondents trust the efficacy of the HeV vaccine, a quarter have doubts; with 11% reporting that they still believe that their vaccinated horses could become infected with HeV, and a further 15% are unsure.

Due to differences in terminology, sampling, and methods of calculation only limited comparison was made between data from the HHALTER study on adverse reactions and the Australian Pesticides and Veterinary Medicines Authority (APVMA) reporting of adverse experiences, published in June 2015 six months after the conclusion of HHALTER data collection. In general, participants in the HHALTER study reported the same more frequently-reported adverse experiences that were reported to APVMA. Moderate or severe swelling around the vaccination site was reported by 39 respondents (10.5% of those who had vaccinated their horses at the time of the final survey). Severe swelling was

reported by 10 respondents (2.7%). In APVMA data the most frequently reported adverse experience was ‘injection site reaction’, classified as probably or possibly caused by vaccine in 451 reports and with an estimated reaction incidence of 0.18% (calculated against the total number of vaccine doses sold). Many HHALTER respondents had given their horses multiple doses of vaccine, potentially up to 6 or 7 doses by the time of the final survey in Nov 2014.

Implications and Recommendations

The report closes with a section on the implications of the findings and recommendations. As noted in this section, HeV risk perception is a dynamic process and cannot be viewed in isolation from the prevailing socio-political and disease-state context. For this reason the HHALTER project implications and recommendations section includes consideration of the impact of events that have occurred in the time since data collection was completed, e.g. full registration of the vaccine, the Australian Pesticides and Veterinary Medicines Authority (APVMA) summary of adverse experience reports of the vaccine, Workplace Health and Safety Queensland (WHSQ) prosecution of three veterinarians, and some veterinary practices adopting a policy of refusing to treat unvaccinated horses. This section focusses on four main interrelated areas: reduced HeV risk perception, poor uptake of recommended property management practices, poor uptake of vaccination, and the critical importance of the veterinarian – horse owner relationship.

Reduced HeV risk perception: a mismatch in stakeholder communication with horse owners

Perceived risk of HeV has been a core component of the HHALTER study and is fundamental in the consideration of the uptake of risk mitigation practices. During the study it was noted that although perceived probability of HeV infection had not shifted over time there was a marked decline in concern about the risk of HeV to horses and to self/family and other risk indicators. In general, findings were interpreted as positive – with indications of greater agency over the risk, lower anxiety and a more measured response to this low probability risk. However, the implications of this finding include lower vaccine uptake, poorer biosecurity practices, decreased interest in HeV generally, and challenges for future engagement. In response to this it is recommended that a more nuanced and balanced dialogue is adopted by stakeholders. With a background trend of decreasing HeV risk perception in horse owners ‘official’ stakeholder dialogues that ‘talk-up’ the risk are out-of-step and are interpreted with scepticism and accusations of scaremongering and manipulation. The audience is disengaged and the messages are ignored.

Poor uptake of recommended property management practices: addressing barriers, reframing risk beyond HeV, and filling gaps in knowledge and understanding of virus transmission

The uptake of recommended property management practices was generally low, around 20%, and did not change during the course of the study. Issues around the ease of adopting these practices and their perceived effectiveness were noted with practices regarded as being too hard, too expensive, too impractical, and/or ineffective. The implication of this finding is that a large proportion of horses and their owners are exposed to a greater risk of HeV transmission, especially when uptake of vaccination is also low. Recommendations include promoting uptake of property management practices through specifically addressing these concerns, reframing the promotion of these practices and biosecurity generally, in terms of other, more prevalent, disease threats – taking the focus away from HeV risk specifically, and undertaking further research to address gaps in understanding and knowledge of HeV in areas that could influence the uptake of recommended practices, such as virus survival in the environment.

Poor uptake of vaccination: addressing concerns about safety, preserving trust, and reducing the push for mandatory vaccination

Vaccination uptake has been poor generally in the horse-owning population and although much higher in the HHALTER sample, which is probably more at risk, more engaged, and more pro-vaccination, has peaked and is showing signs of delays and withdrawal from the recommended vaccination regime. The implication of this finding is, as above, that a large proportion of horses and their owners are exposed to a greater risk of HeV transmission, especially when the uptake of recommended property management practices is also low. Recommendations include an urgent need to address issues with vaccine implementation that are generating increased concerns about safety and fuelling mistrust. Horse owners need to be reassured about the safety and efficacy of the vaccine, approval for less frequent boosters is needed to meet owner expectations, and the pursuit of mandatory vaccination in the current risk climate (lower perceived HeV risk and increasing perceptions of the risks of (over) vaccinating) is counter-productive and is driving actions to undermine the vaccine.

The importance of the veterinarian – horse owner relationship: working together in collaboration and enabling safe and open debate

As already noted, risk perception and uptake of risk mitigation practices are highly interrelated and the current socio-political context cannot be ignored in the dynamics of HeV risk perception, and vaccine uptake in particular. Woven through all these elements is the critical role of the veterinarian. For many horse owners the local veterinarian is their trusted source of information; the main source of information, the person who can correct misunderstandings, the person owners approach for advice and information, and the person they report their concerns to. Although the main data in the HHALTER survey indicate that horse owners are broadly supportive of veterinarians and their practices there is evidence of increasing tensions in the veterinarian – horse owner relationship caused by (lack of) uptake of the vaccine, miscommunication, and more recently changes in veterinary policy in which some practices are refusing to treat unvaccinated horses.

Veterinarians are caught in a complex situation in which they are often regarded by horse owners as both promoting vaccination and being the primary beneficiaries of the vaccination (in terms of risk protection and income). In addition veterinarians are now facing possible prosecution for any lapses in workplace safety in relation to treating HeV cases. This litigious situation is adding to existing tensions and individual veterinary practice policy changes to refuse treatment to unvaccinated horses or delay treatment until HeV exclusion testing is completed is further driving a wedge between some veterinarians and horse owners. The implications are that there is an increasing risk of erosion of the veterinarian-horse owner relationship. HHALTER data analysis and other Australian research have shown clear associations between contact with a veterinarian and better biosecurity practices and uptake of risk mitigation practices, such as HeV vaccination. Maintaining an open and trusted communication channel between veterinarians and horse owners is critical for HeV risk management as well as broader response to animal health and welfare issues and emergency animal disease situations.

Recommendations support an urgent need to protect and preserve the veterinarian-horse owner relationship through encouraging an open and collaborative approach to HeV risk mitigation decision-making with horse owners, creating a safe context for debate in this area at a broad/national level, and raising the profile of government veterinarians as independent voices in HeV engagement and communication with horse owners.

Introduction

To prevent Hendra virus (HeV) spillover events from flying foxes to horses and from horses to humans, property management measures, such as keeping horses away from trees which attract flying foxes as well as HeV vaccination of horses, are highly recommended and widely publicised. Implementation of these risk mitigation measures however depends on initiative and action taken by horse owners as they mediate management, care, and treatment of their animals. According to social cognitive models of health behaviour many factors influence engagement in health-promoting (health protection) actions, such as risk perception and perceived vulnerability, sense of control and self-efficacy, trust and confidence in the behaviours/actions being recommended, and other associated costs and benefits.

Research on disease risk mitigation practices of farmers ([Palmer et al., 2009](#)) and horse owners ([Schemann et al., 2012](#)) in Australia so far shows that in particular perception of risk, knowledge of disease, and trust placed in information sources play a key role in reasoning and behavioural processes. Therefore it is important to understand the attitudes and lay beliefs of horse owners and qualitative methods are a highly suitable tool to facilitate such an understanding ([Christley and Perkins, 2010](#)).

Despite a quantitative study on HeV risk perception of horse owners ([Kung et al., 2013](#)) as well as a qualitative study of equine veterinarians on HeV-related issues ([Mendez et al., 2012](#)), little is known about horse owners' decision-making processes in regard to HeV risk mitigation and biosecurity strategies, or in understanding the barriers that hinder, or factors that might promote better engagement and uptake of recommended risk mitigation practices.

The current study was designed to capture factors that influence horse owner HeV risk mitigation practices in the context of a dynamic and complex socio-political context. The study comprises two components; a series of surveys that captures baseline knowledge, attitudes, and practices and tracks these over a two year period, and a set of interviews that provides greater insight and understanding into the issues around HeV risk perception, uptake of risk mitigation practices, and engagement with government and industry stakeholders.

The survey component (quantitative) enables relationships between HeV risk mitigation practices and a number of other factors, e.g. risk perception and awareness, knowledge, demographics, and types of horse involvement/ownership, to be statistically evaluated to understand the factors that determine these practices and their relative strengths in these relationships. The interview component (qualitative) complements and expands on these issues and provides a richer and more complex understanding of horse owner HeV risk conceptualisation and decision-making around risk mitigation.

The chronology of Hendra virus (HeV)

The project was designed to collect core data in areas pre-identified as important, such as risk perception, and risk mitigation practices. However, the aim was also to be responsive to emerging cases of HeV, emerging issues, and novel events. This was both to enable the capture of data to explore how such events influence risk perception and mitigation, and also to ensure that the surveys would be more interesting and relevant to participants.

As part of the background to the project it is useful to consider both the temporal pattern of HeV incidents, i.e. occurring spillover events which involved one or more cases in horses and humans or dogs, in the lead up to the study and during the study period, and a timeline of significant events that occurred during the study period and shaped the supplementary, and to an extent some of the core content of the surveys. Figure 1 summarises the history of confirmed HeV incidents.

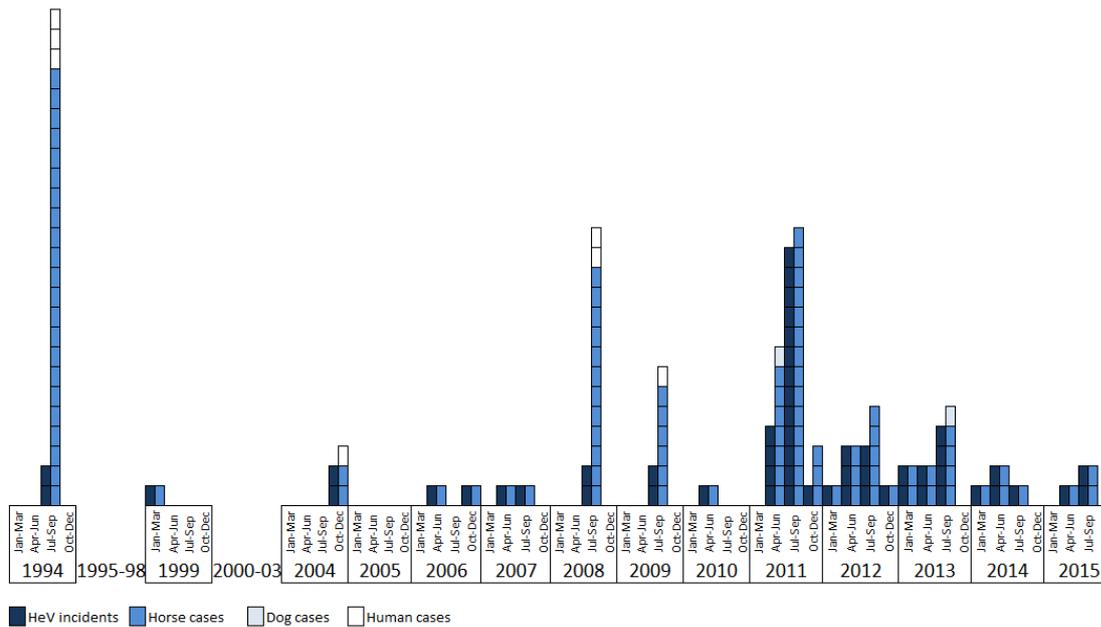


Figure 1. Confirmed Hendra virus incidents and corresponding cases in horses, dogs, and humans over time.¹

As can be seen, between 2004 and 2010 there were typically one or two incidents of HeV every year or two. The sudden and large spike in incidents in 2011 (super cluster) raised concerns about the conditions that lead to spillover (what was different in 2011?), increased the need to pursue development of a HeV vaccine and ensure that horse owners and veterinarians were engaged with risk management. There was also significant public concern. The National Hendra Virus Research Program (NHeVRP) was established in 2011. The NHeVRP prioritised research in a number of identified areas through commissioned research and open research granting schemes. The current research project was funded, through a competitive research process, administered by RIRDC, and was designed to address Research Priority 2 (Improved strategies to prevent transmission of HeV) as well as Priority 3 (Capacity to detect and respond effectively to HeV incidents).

During the study period (2012 – 2014 inclusive) there were 20 incidents of HeV involving 22 horse cases, one dog case (in NSW) and no cases of human infection. Also, the figure above shows that although the frequency of HeV incidents is generally greater during the study period compared to pre-2011, the total number of incidents over this three year period is only slightly greater than the number of incidents that occurred in 2011 alone (20 compared to 18, respectively). It is also clear that the majority of HeV incidents involved a single infected horse.

¹ Reference used for Figure 1.

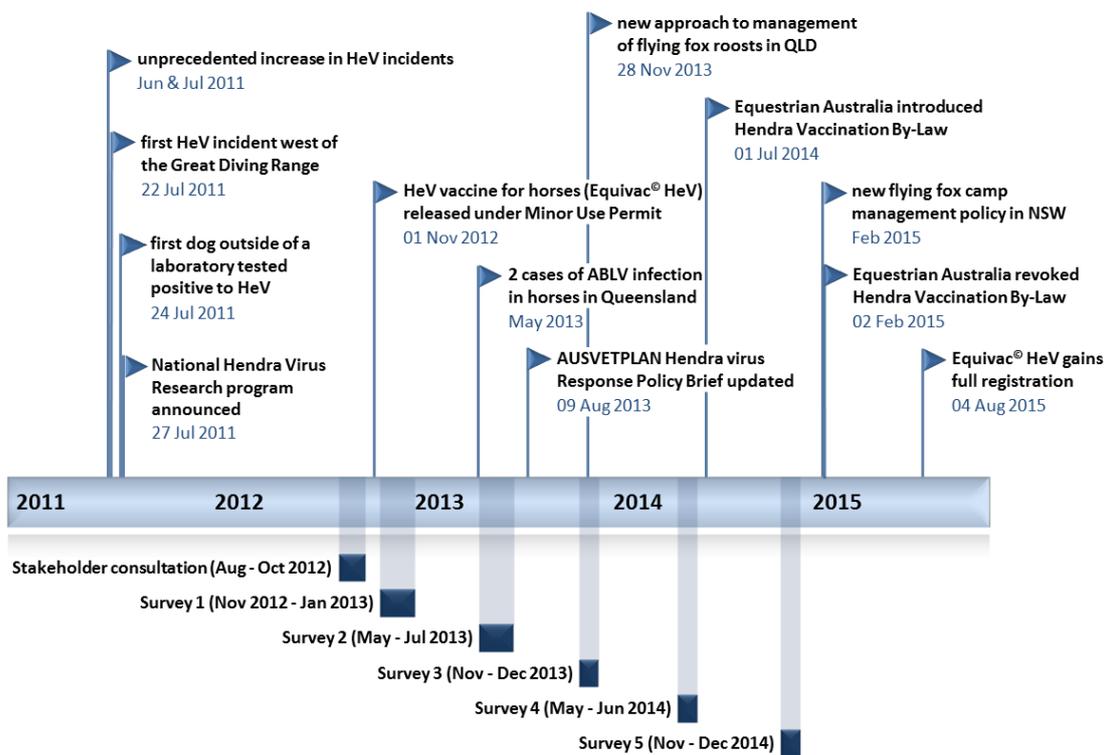


Figure 2. Timeline of salient HeV developments and activities during the study period.

Figure 2 shows that a number of salient events and activities took place during and around the study period. The release of the Hendra virus vaccine for horses (Equivac® HeV) was the most significant and had the greatest impact on the study design and content. In addition to vaccine introduction and individual HeV cases during this period the other main issues were related to vaccination policy in the horse industry and some sections of the veterinary profession, and changes to flying fox management policy. All these areas received moderate levels of media attention and widespread discussion on social media, blogs, Facebook etc. The surveys conducted as part of the HHALTER project addressed some of the issues that were being raised in its supplementary content.

Objectives

The objectives of the HHALTER project, as stated in the original project proposal, have been listed below. They have been numbered for ease of reference later and are as follows.

The core research project objectives are:

1. To recruit and maintain a large cross-industry sector cohort of horse owners to take part in five research surveys.
2. To obtain baseline cohort data and investigate epidemiological relationships between the following:
 - Owner demographics, horse ownership, horse demographics, horse premises, horse management and horse health management
 - Sources of information about general horse health and HeV
 - HeV risk awareness and knowledge
 - Implementation of HeV risk mitigation strategies and practices.
3. To track changes in core areas relating to HeV risk awareness and understanding, and uptake of recommended risk mitigation strategies and practices that will limit transmission pathways of HeV to horses and humans.
4. To investigate, through rigorous statistical analysis, interrelationships between HeV risk awareness and understanding and risk mitigation practices, and identify factors influencing changes in perceptions and in practices.
5. To investigate the impacts on risk awareness and uptake of risk mitigation practices of emerging issues as they arise, such as vaccination implementation and uptake, outbreaks in new geographical regions, media stories and issues around trust and confidence, or new host species.
6. To support and enable an engagement pathway between horse owners and agencies/departments tasked to respond and manage the HeV response in areas encompassed by the research project.
7. To communicate and disseminate new understanding about the relationships between HeV risk perceptions and mitigation practices, and influential factors impacting on these, to support stakeholder decisions on policy, advice, and action to reduce the risk of HeV transmission to horses and humans.
8. To develop, as an output of the randomised control trial, a set of evidence-based guidelines for an effective approach (engagement and communication strategies) to horse owner uptake of HeV risk mitigation practices and knowledge and awareness of HeV risks.

Changes to the project

Due to the dynamic nature of HeV, e.g. number of cases per year, locations, new research knowledge, media coverage, and vaccine implementation and testing, the HHALTER project was planned as a flexible platform for research. This was driven by a desire to be responsive to changing issues and areas of relevance to horse owners and those responding to and managing HeV risks. This aim was achieved largely through the addition of supplementary content in the surveys addressing emerging issues and keeping the survey content responsive and relevant from the perspective of horse owner participants.

The main change that was made to the initial project plan was to the fieldwork phase of the project (the non-survey component) which was originally planned to include a randomised control trial of potential communication strategies for horse owners. Operationalising that plan in practice in a sufficiently controlled way was problematic and the team was concerned that conducting the research under the HHALTER project name might also interfere with the cohort/survey research. Permission was granted by RIRDC in consultation with the National Hendra Virus Research Program Steering Committee to replace this part of the project with an in-depth interview study with horse owners.

In terms of the impact on the planned project objectives, this change impacts Objective 8. Rather than planning to produce a set of guidelines the project team has sought to identify recommendations. This has been during the project dissemination phase (June-Dec 2015) through dialogue with a range of stakeholders. Project dissemination is detailed in Appendix 2 and is ongoing, progressing beyond the research contract period.

Chapter 1. Longitudinal Survey Research

Introduction

In this chapter we report the results of the quantitative phase of the HHALTER project that comprised a series of five surveys administered at six-monthly intervals over a two-year period (Nov 2012 – Nov 2014). The survey was administered online, with a paper-copy/postal option available.

This part of the study was conducted to gain broad-ranging information on baseline levels and changes over time of:

- horse owners' knowledge, attitudes, and practices in relation to HeV and HeV risk mitigation.
- horse owners' uptake of vaccination against HeV and factors that influenced their decision-making to have all or some of their horses vaccinated, or to postpone or reject vaccination as an option.
- horse owner's attitudes to HeV-related policy and response, and attitudes to HeV policy scenarios that relate to veterinary care.

The Human Research Ethics Committee at the University of Western Sydney approved the study proposal (# H9824).

Methodology

Study population and participant recruitment

The inclusion criteria for the target population in this study were

- horse owners, or people who provided care for horses², who were
- aged 18 years of age or older at the time of the study, and who
- resided in Australia.

Horse industry related stakeholders (associations and interest groups) who participated in the stakeholder engagement component of this study (Sawford et al, 2014) acted as a conduit to promote and enrol new participants to the HHALTER survey study. At the commencement of each survey administration a HHALTER *Feedback* newsletter was sent to 84 horse industry association contacts with an email requesting that the associations make the newsletter available to their members and invite them to take part. An 'open' link to the online survey was included in the email. This link could be used by anyone and could be copied and passed on.

In addition, horse owners who participated in two previous team member-led research studies and who indicated a willingness to be contacted about further studies were invited to participate in the HHALTER survey. These two studies were a previous Equine Influenza study (Taylor et al, 2008) and a Hendra virus study (Kung et al, 2013). As the study progressed, additional participants were recruited via a number of additional routes, such as the HHALTER social media (Facebook) page, the

² The participants in the survey could be horse owners or they could lease horses or manage or care for horses. Throughout this report, for simplification, participants are all referred to as 'horse owners'. The majority of participants were horse 'owners' with 98.5% of the full sample (1412/1430) reporting that they own one or more horses.

HHALTER webpage, and through word-of-mouth from other participants. Prospective and current participants were encouraged to visit the HHALTER webpage (<http://www.uws.edu.au/hhalter>) or contact the project team for additional information about the study.

Participant information was provided at the beginning of all surveys with consent acknowledged in the participation and completion of the survey. Participants were able to stop participating (“opt out”) at any point during or after completing a survey.

Participants were invited to self-identify by supplying their email address which was then used to link subsequent completed surveys by that same participant and to issue email updates (such as HHALTER *Feedback* newsletters) and occasional reminders of survey-related activities.

Participants who self-identified throughout the study (76.2% in the first survey) were automatically contacted to participate in subsequent surveys, unless they requested to “opt out”. The online survey platform used for the HHALTER project (SurveyMonkey©) generated personalised links for these participants. This enabled the project team to monitor non-responses and selectively remind only those who didn’t respond (rather than rely on a ‘blanket’ reminder to all; regardless of whether they had responded).

Survey development

The main study comprised a series of five surveys (S1-S5) conducted at six-monthly intervals from November 2012 to November 2014. This schedule aimed to capture data across three consecutive peak HeV outbreak periods and two ‘quieter’ intervening periods. Six-monthly surveys provided an opportunity for quarterly contact with study participants, with research newsletters mid-way between survey administrations. This level of contact enabled the project team to maintain the interest of participants without being overly intrusive or irritating, particularly within the context of a well-publicised commitment and endpoint. Five surveys over a 24-month period provided an opportunity to capture ‘out of season’ variations in practices, be dynamic and responsive to changing situations with current issues still being current when surveys were released, and to explore trends in horse owners’ risk perception and behaviours.

Each survey was conducted online, with participants without internet access able to participate via postal methods. Each survey included:

- Consistent (core) sets of questions that were used to track changes over time, e.g. components of risk perception, risk mitigation practices/changes in practices, intention to vaccinate, attitudes to response management, trust in agencies (Table 1 and 2); and
- Supplementary questions in areas of emerging priority or interest, e.g. vaccination strategy, research/treatment break-through, awareness of education/communication campaigns, media stories/coverage (Table 3).

Figure 3 depicts the structure of the HHALTER survey study.

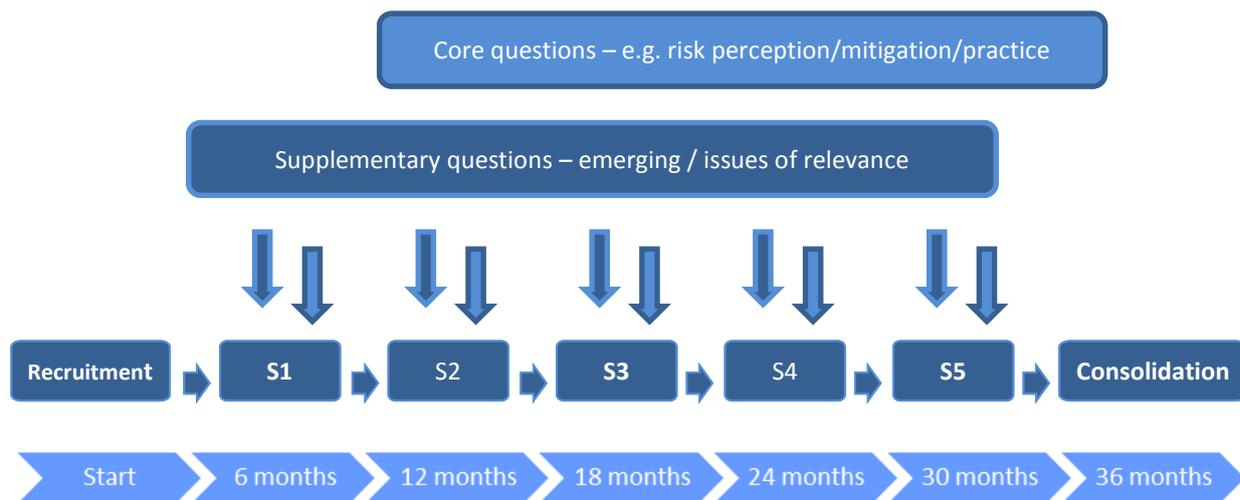


Figure 3. The HHALTER survey study structure.

All surveys were designed and maintained on a password protected account within SurveyMonkey© 1999-2014. Each survey took approximately 20-30 minutes to complete depending on the range of answers supplied and participants' willingness to provide optional comments.

Questions were presented in a number of formats from closed (single- or multiple-choice responses), semi-closed (with various 5-point Likert scales) and open questions. All surveys were piloted amongst the team and a group of local horse owners to assess the content, appropriateness and the logic of the surveys before they were released electronically.

Two variants of each survey were created from the second survey onwards (S2 to S5). One version was available for existing (self-identified) participants and was sent using personalised links, as noted earlier. The other, longer, version was designed for new participants and was sent as an 'open' link. This longer version included a range of baseline demographic questions that, once collected, were not asked again for continuing self-identified (cohort) participants. This approach enabled ongoing recruitment of horse owners throughout the 2-year survey period.

Table 1. Core question areas used in the HHALTER surveys.

Variable group	Variables (Unit)
Participant demographics	Household financial situation ¹
Horse demographics	No. horses owned ¹
Property demographics	State/Territory location of horse premises ¹ , post code location of the horse property ² ; suburb location of the horse property ³ ; and degree of control over property management ⁴
HeV vaccination	Responsible for decision to vaccinate ⁴ ; HeV vaccination status of horse(s) ¹ ; spoken with veterinarian about HeV vaccine in own horse(s) ¹ ; intention to vaccinate horse(s) against HeV ³ ; vaccination should be: compulsory for all horses, compulsory in HeV areas, compulsory for all horses attending events, up to the manager/owner ⁵ ; in HeV areas, it is reasonable for private veterinarians to: refuse to examine/treat sick unvaccinated horses, refuse to enter a property with an unknown HeV vaccine status, charge an additional “risk” fee for treating unvaccinated horses ⁵ ; presence of adverse reactions to the HeV vaccine ⁴ ; knowledge of booster requirement 6-monthly ⁴ ; intention to give vaccinated horses their booster ¹ ; status of up-to-date booster injections ⁴
Property management	Horse(s) spent any time in yards/paddocks ⁴ ; size of paddock that horse(s) had access to ¹ ; horse(s) had access to: open/uncovered water, feed, water at night, or areas under trees in the day or night ⁵ ; horse access around trees has been prevented ⁴ ; access to trees had been prevented by: moving horses away, use of permanent or temporary fencing, cutting or removing trees ⁴
HeV risk perception	Likelihood of HeV occurring in your area ⁵ ; concern about HeV in your horses ⁵ ; concern you could be infected with HeV ⁵ ; where HeV rates as a health concern for your horses ¹ ; perception that: HeV risk is decreasing, the state DPI can be trusted to provide sound advice or take appropriate action, have a good sense of control over the HeV risk to my horse(s), worried about family getting HeV, there should be a national register for horse movements and disease control, HeV cases have been well managed, HeV is not well understood, concern about pets getting HeV, HeV has raised concerns about proximity with horse(s) ⁵ ; horse owners self-rated HeV knowledge ⁵ ; proximity to known HeV case ¹
Flying foxes	Presence of flying foxes in the local area ¹ ; perception that flying foxes currently present a direct threat to the health of horse(s) on your property ⁵

¹ Categorical variables; ² Numerical variables; ³ Short text variables; ⁴ Binomial variable (1 = yes, 0 = no); ⁵ Ordinal variables

Survey response

Attempts were made to address sample attrition at each survey by maintaining contact via the distribution of HHALTER *Feedback* newsletters between survey periods, survey reminders, and an

incentive. In addition, participants were encouraged to contact the project team if their contact details changed or they had general questions either relating to the study or their horses and HeV in general.

A collection period of 6-8 weeks was used for each survey. This enabled maximum data capture among the target audience. Once each survey was made available, two email reminders were sent to non- and partial respondents. The first reminder was sent at around 3-4 weeks after the initial notification with the second reminder sent another 2 weeks later, following a modified version of the Dillman protocol for web surveys (Dillman, 2000).

Each participant of surveys 3, 4, and 5 was offered the incentive of a “chance to win” one of 20 AUD\$50 gift certificates at the conclusion of each of those three surveys. Recipients were randomly selected using a randomized number generation program (www.randomizer.org) and were contacted by email. If recipients did not acknowledge their “win” after three attempts to contact then, the next person on the randomly generated list would be contacted and so on, until all 20 gift certificates per survey were awarded.

Data handling and statistical analysis

At the completion of each survey, cohort and new participant responses were exported into SPSS (IBM® SPSS® Statistics version 21.0, 2012, New York, USA) where cohort responses from previous surveys in the series were linked to provide a comprehensive longitudinal dataset. Data cleaning was conducted in SPSS along with descriptive statistical analyses of both the demographic variables and longitudinal explanatory variables. All figures were produced using R (version 2.15.2. © 2012, The R Foundation for Statistical Computing). All spatial analysis was undertaken in ArcMap 10, Spatial Statistics Tools (ESRI, USA). Electronic versions of the survey data are being stored by the Principal Investigator (MT), for five years as required by the NHMRC under the Australian Code for the Responsible Conduct of Research.

Results

Overview

As mentioned in the previous section, survey questions were either categorised as ‘core’ questions or ‘supplementary’ questions. Typically, supplementary questions were asked only once, and were designed to address an emerging theme of interest or relevance to horse owners or an area identified as important by stakeholders – but not high priority content.

Core questions were asked in areas of more central interest to the broader objectives of the study and/or identified as high priority by stakeholders. These questions were asked more than once. Some question sets were asked in ALL surveys and others were asked in two or more surveys. Tables 2 and 3 summarise the content areas addressed over the series of surveys, indicating the general frequency with which they were asked. Table 2 summarises the ‘core’ question areas and Table 3 summarises the supplementary question areas.

Table 2. Summary of core question content areas covered in the surveys, including an indication of frequency of presentation.

(x = asked of all participants/asked if changed, o = only asked of new participants to the survey)

Main category	Sub-category	S1	S2	S3	S4	S5
Demographics	Participant	x	o	x/o	o	x/o
	Horse ownership and sector	x	o	x/o	o	x/o
	Property details	x	o	x/o	o	x/o
Vaccination	Responsibility, uptake and intentions	x	x	x	x	x
	Vaccination policy	x		x	x	x
	Veterinary policy					
	Booster awareness and intention to booster		x	x	x	x
Property management	Access to areas around trees	x	x	x	x	x
	Access to water/food/trees	x	x	x	x	x
	Perceived effectiveness and ease of property management recommendations	x				x
Risk and Control	Perceived likelihood and concern	x	x	x	x	x
	Priority of HeV as a horse health concern	x			x	x
	Perceptions of control and concern about HeV risk	x	x	x	x	x
	Perceptions of State Government management and control of HeV	x	x	x	x	x
	Perceptions of State Government information	x				x
Knowledge	Perceived level of knowledge	x	x	x	x	x
Information	Attitudes to media reporting	x				x
Flying foxes	Seeing and perceived as health threat		x	x	x	x
	Attitudes to flying foxes and management policy		x			x

Table 3. Summary of supplementary question content areas covered in the surveys, including an indication of frequency of presentation.

(x = asked of all participants, o = only asked of new participants to that survey)

Main category	Sub-category	S1	S2	S3	S4	S5
Horse ownership	Contact of horses with other people (split across S4 and S5)				x	x
	Contact of horses with other animals			x		
Vaccination	Factors influencing early uptake (vaccinating horse owners only)	x	x			
	Factors influencing reasons not to vaccinate (non-vaccinating horse owners only)				x	
	Adverse reactions and reporting		x		x	x
	Factors affecting recent decision to vaccinate			x		
	Human HeV vaccination			x		
	Booster delaying/withdrawing				x	x
	Perceived pressure to vaccinate					x
Biosecurity	Practices around sick and health horses		x	o		
	Access to personal protective equipment		x			
	Uptake of vaccination (other diseases)		x			
Knowledge	HeV symptoms	x				
Information	Sources of information	x				x
	Approach to information seeking	x				
	Information preferences					x
Flying foxes	Attitudes to changes in management strategy					x
ABLV	Awareness of ABLV and attitudes		x			
Horse events	Attendance at events and attitudes to HeV risk at events			x		
Horse health	Record keeping and veterinary contact			x		
HeV reporting	Likelihood of suspecting HeV				x	
	Awareness of HeV testing and response				x	
	Barriers and enablers for reporting HeV				x	
	Reporting responsibilities				x	
Awareness	Awareness of recent case and source of information				x	
Recovered horses	Attitudes to revised policy for handling recovered horses and concerns					x

Due to the large volume of data, only data for the core questions are provided in the main body of this report. Further data on vaccination-related supplementary content from the last survey (S5) are included in Appendix 1. Further statistical analyses are being conducted, conference papers and posters have been presented, and academic journal papers are being written in a number of areas, e.g. biosecurity, flying foxes, vaccination. Information about these are included in Appendices 2, 3 and 4.

The one-off and/or current relevance of the supplementary content areas led to some limited reporting of these areas being included in the HHALTER *Feedback* newsletters to the study participants. These newsletters can be accessed at <http://www.uws.edu.au/hhalter>

Demographics

A total of 1449 horse owners participated in the study across the full series of surveys. Responses were received from horse owners across all States and Territories, with the majority (81%) from the Hendra virus-impacted states of QLD and NSW, 46% and 35%, respectively. A further 11% of the sample was from VIC.

A sub-set of 341 of these horse owners took part in every survey and make up the 'cohort' group in the study. Figure 4 presents a spatial representation of the location and number of participants from across QLD, NSW, ACT, and VIC. Data are presented by postcode and the locations of confirmed HeV cases are also shown.

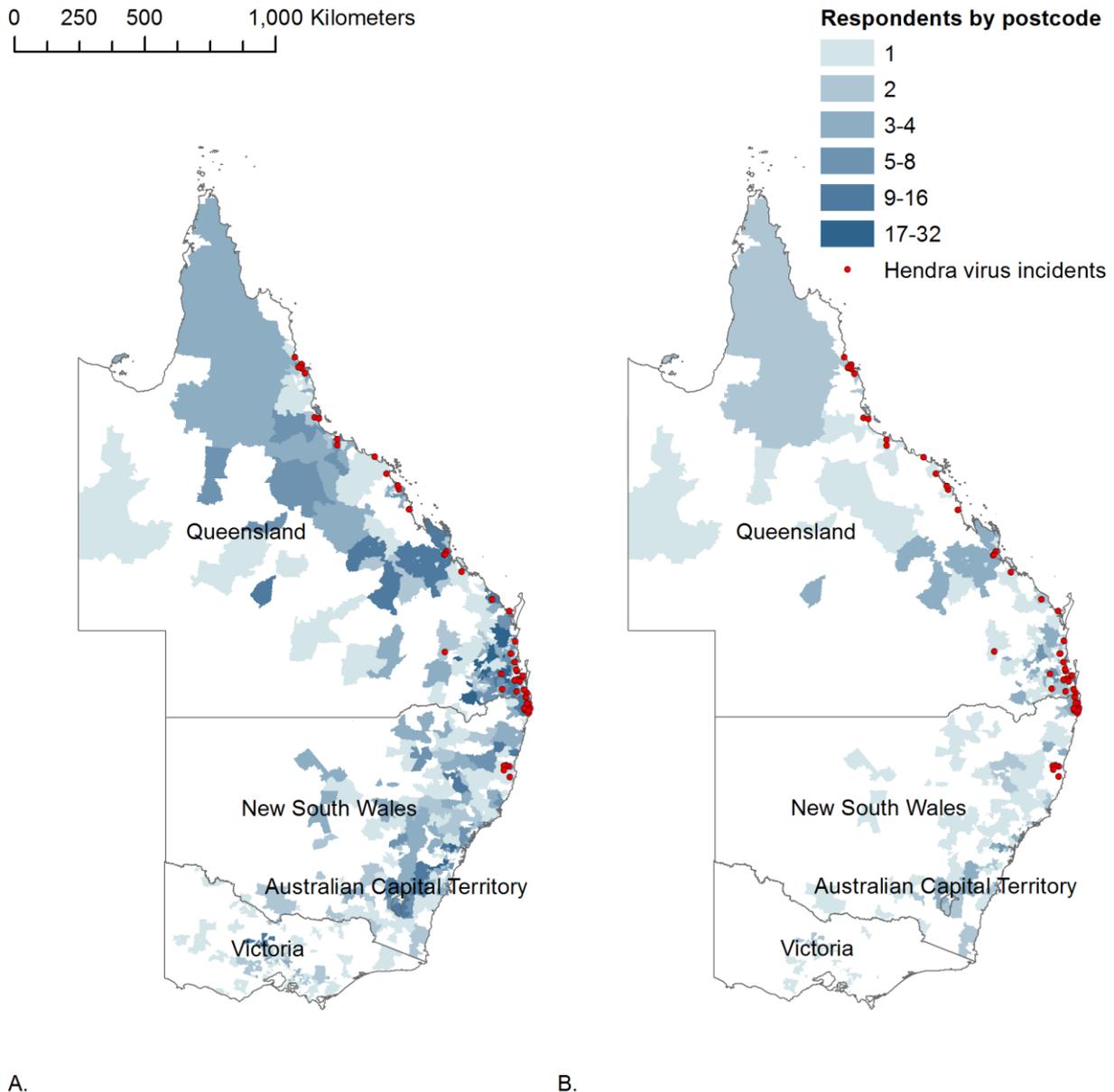


Figure 4. Spatial distribution of the full HHALTER sample (A) and the study cohort (B).

The extended set of demographic data for participants, their horse ownership and involvement, and their properties is shown in Table 4. This table also includes some of the main core question responses. Data are shown for participants in each survey in the series, for the cohort, and for the full sample.

Table 4. Demographic profile of the HHALTER participants.

Demographic N (%)^a	Nov-12 (S1)	May-13 (S2)	Nov-13 (S3)	May-14 (S4)	Nov-14 (S5)	Cohort^b	All
N ^c	1195	729	636	613	617	341	1449
Accumulated cohort ^d	-	630	472	387	341	341	-
Previously enrolled participants ^e	-	-	106	178	227	-	-
New participants	1195	99	58	48	49	-	1449
<i>Participant demographics</i>							
Respondent gender							
Male	119 (10.6)	73 (10.2)	65 (10.6)*	60 (9.9)	59 (9.8)	37 (10.8)	136 (10.3)
Female	1005 (89.4)	644 (89.8)	550 (89.4)*	545 (90.1)	546 (90.3)	304 (89.2)	1189 (89.7)
Respondent age							
< 25	58 (5.2)	39 (5.46)	33 (5.3)	37 (6.2)	32 (5.3)	18 (5.3)	78 (5.8)
25 – 34	140 (12.5)	81 (11.3)	70 (11.2)	62 (10.3)	63 (10.5)	34 (10.0)	172 (12.9)
35 – 44	267 (23.8)	164 (23.0)	144 (23.0)	132 (21.9)	141 (23.4)	67 (19.8)	328 (24.6)
45 – 54	356 (31.8)	227 (31.8)	195 (31.1)	193 (32.1)	198 (32.8)	111 (32.7)	418 (31.3)
55 – 64	226 (20.2)	152 (21.3)	137 (21.9)	138 (22.9)	133 (22.1)	82 (24.2)	260 (19.5)
> 64	74 (6.6)	51 (7.1)	48 (7.7)	40 (6.6)	36 (6.0)	27 (8.0)	80 (6.0)
Main language spoken at home							
English	1050 (94.7)	676 (95.5)	593 (95.3)	569 (95.5)	568 (95.3)	320 (95.2)	1250 (94.5)
Language other than English	59 (5.3)	32 (4.5)	29 (4.7)	27 (4.5)	28 (4.7)	16 (4.8)	73 (5.5)
Given current financial responsibilities, respondents are^f:							
Finding it difficult	105 (9.5)	99 (14.1)	67 (10.75)	92 (15.50)	57 (9.9)	25 (7.4)	123 (9.3)
Just getting along	325 (29.3)	237 (33.8)	215 (34.5)	198 (33.3)	198 (34.4)	90 (26.8)	402 (30.4)
Reasonably comfortable	520 (46.9)	310 (44.2)	285 (45.7)	253 (42.6)	254 (44.2)	169 (50.3)	618 (46.8)
Very comfortable	158 (14.3)	55 (7.8)	51 (8.6)	51 (8.6)	66 (11.5)	52 (15.5)	178 (13.5)
<i>Horse ownership and sector involvement</i>							
Number of horses owned							
0 – 2	367 (31.1)	235 (32.5)	208 (32.9)	199 (32.7)	210 (34.5)	114 (33.7)	454 (31.75)
3 – 4	302 (25.6)	206 (28.5)	172 (27.2)	164 (26.9)	160 (26.3)	94 (27.8)	367 (25.7)
5 – 8	239 (20.2)	138 (19.1)	120 (19.0)	129 (21.2)	112 (18.4)	62 (18.3)	278 (19.4)
> 8	274 (23.2)	145 (20.2)	132 (20.9)	117 (19.2)	127 (20.9)	68 (20.1)	331 (23.2)

Demographic N (%)^a	Nov-12 (S1)	May-13 (S2)	Nov-13 (S3)	May-14 (S4)	Nov-14 (S5)	Cohort^b	All
Main involvement in horse activity or business^f							
Recreational	381 (31.9)	253 (34.7)	217 (34.1)	213 (34.9)	197 (32.0)	120 (35.2)	463 (32.1)
Racing (Thoroughbred and Harness)	27 (2.3)	17 (2.3)	16 (2.5)	10 (1.6)	12 (1.9)	7 (2.1)	30 (2.1)
Competitive / Eventing	443 (37.1)	270 (37.0)	241 (37.9)	239 (39.1)	253 (41.1)	129 (37.8)	558 (38.6)
Breeding	190 (15.9)	102 (14.0)	89 (14.0)	78 (12.8)	82 (13.31)	48 (14.1)	216 (15.0)
Stable / Agistment	21 (1.8)	14 (1.9)	9 (1.4)	10 (1.6)	10 (1.6)	4 (1.2)	23 (1.6)
Commercial (Riding school, horse tourism)	35 (2.9)	20 (2.7)	17 (2.7)	15 (2.5)	16 (2.6)	12 (3.5)	37 (2.6)
Work (Farming, stock horses)	34 (2.9)	18 (2.5)	13 (2.0)	19 (3.1)	11 (1.8)	7 (2.1)	41 (2.8)
Other	62 (5.2)	35 (4.8)	34 (5.4)	27 (4.4)	35 (5.7)	14 (4.1)	76 (5.3)
Have more than one involvement in a horse industry or business^f							
Yes	577 (49.2)	359 (49.9)	315 (50.1)	296 (49.0)	304 (50.0)	160 (47.5)	703 (49.4)
No	597 (50.9)	361 (50.1)	314 (49.9)	308 (51.0)	304 (50.0)	177 (52.5)	720 (50.6)
Other involvement in horse activity or business^{f,g}							
Recreational	278 (23.3)	177 (24.3)	157 (24.7)	137 (22.4)	143 (23.2)	76 (22.3)	329 (46.8)
Racing (Thoroughbred and Harness)	107 (9.0)	61 (8.4)	55 (8.6)	44 (7.2)	49 (8.0)	27 (7.9)	124 (17.6)
Competitive / Eventing	290 (24.3)	181 (24.8)	147 (23.1)	144 (23.6)	152 (24.7)	71 (20.8)	352 (50.1)
Breeding	242 (20.3)	155 (21.3)	140 (22.0)	129 (21.1)	123 (20.0)	72 (21.1)	293 (41.7)
Stable / Agistment	119 (10.0)	76 (10.4)	61 (9.6)	58 (9.5)	62 (10.1)	33 (9.7)	143 (20.3)
Commercial (Riding school, horse tourism)	78 (6.5)	57 (7.8)	44 (6.9)	39 (6.4)	45 (7.3)	22 (6.5)	103 (14.7)
Work (Farming, stock horses)	117 (9.8)	74 (10.2)	61 (9.6)	57 (9.3)	58 (9.4)	29 (8.5)	142 (20.2)
Other	113 (9.5)	67 (9.2)	63 (9.9)	54 (8.8)	54 (8.8)	28 (8.2)	134 (19.1)
Income earned from a horse related business							
Primary income	119 (10.0)	65 (9.0)	55 (8.7)	49 (8.0)	60 (9.8)	33 (9.7)	138 (9.6)
Secondary income	271 (22.8)	169 (23.3)	156 (24.7)	132 (21.6)	132 (21.5)	70 (20.7)	328 (22.8)
None	797 (67.1)	492 (67.8)	422 (66.7)	429 (70.3)	421 (68.7)	236 (69.6)	970 (67.6)
Responsible for decision to vaccinate horse(s)^f							
Yes	1150 (96.5)	702 (96.6)	619 (98.3)	590 (96.7)	596 (96.8)	323 (94.7)	1391 (96.3)
No	42 (3.5)	25 (3.4)	11 (1.75)	20 (3.3)	20 (3.3)	18 (5.3)	53 (3.7)

Demographic N (%)^a	Nov-12 (S1)	May-13 (S2)	Nov-13 (S3)	May-14 (S4)	Nov-14 (S5)	Cohort^b	All
<i>Property details</i>							
Property location (State)							
Queensland	543 (47.3)	322 (44.7)	283 (44.6)	262 (43.2)	277 (45.3)	156 (45.8)	629 (45.5)
New South Wales /ACT	406 (35.4)	267 (37.0)	242 (38.1)	223 (36.8)	217 (35.5)	131 (38.4)	482 (34.9)
Victoria	123 (10.7)	76 (10.5)	61 (9.6)	68 (11.2)	60 (9.8)	28 (8.2)	154 (11.1)
Other (SA, WA, TAS, NT)	75 (6.5)	56 (7.8)	49 (7.7)	53 (8.75)	57 (9.3)	26 (7.6)	117 (8.5)
Proximity of horse property location to a previously confirmed Hendra virus case^f							
<50km	218 (19.4)	146 (20.7)	154 (24.7)	160 (26.9)	167 (28.0)	82 (24.3)	256 (19.0)
50 - 100km	149 (13.3)	96 (13.6)	83 (13.3)	65 (10.9)	68 (11.2)	40 (11.8)	166 (12.3)
> 100km	688 (61.2)	440 (62.3)	367 (58.9)	355 (59.8)	344 (57.7)	201 (59.5)	844 (62.5)
Don't know	69 (6.1)	24 (3.4)	19 (3.1)	14 (2.4)	17 (2.9)	15 (4.4)	85 (6.3)
Control over property management							
Yes	938 (82.2)	581 (81.1)	542 (78.7)	485 (80.4)	538 (79.5)	284 (83.8)	1074 (81.0)
No	203 (17.8)	135 (18.9)	147 (21.3)	118 (19.6)	139 (20.5)	55 (16.2)	257 (19.0)
Primary responsibilities for people working around horse(s)							
Yes	304 (25.6)	194 (26.7)	168 (26.6)	152 (25.0)	162 (26.4)	96 (28.2)	365 (25.4)
No	884 (74.4)	532 (73.3)	464 (73.4)	457 (75.0)	451 (73.6)	244 (71.8)	1071 (74.6)

^a The proportions (%) presented are for the column.

^b The term “cohort” refers only to those participants who responded to all five online surveys

^c Total number of participants completing the survey. NB: due to the nature of the survey (which included skip logic) not all questions within a survey were answered by all participants.

^d The accumulated cohort is the number of participants who responded to all surveys up to and including the survey number shown, i.e. at S2 630 participants had responded to S1 and S2, at S3 472 participants had responded to S1 and S2 and S3.

^e Previously enrolled participants responded in two or more surveys.

^f Data presented here for the cohort are values at S1 (although data were collected at all time-points, and will vary across time.)

^g This question allows for multiple responses (respondents can select as many option as apply). The percentage figures shown are calculated as the percentage of respondents who endorse each option.

*There was an error in this question in S3 which led to the gender of new participants (only) not being recorded (n=58).

As can be seen from data in Table 4, after the first two surveys the overall size of the horse owner samples remained fairly stable (from 613- 636 participants) with negligible attrition. There was some turnover of participants between surveys with new participants joining and some previously enrolled participants returning intermittently. The number of cohort participants who had completed all surveys to date declined over time and the attrition rate also declined over time. The gender balance of the sample remained stable throughout, at 89-90% female and 10-11% male. Most participant-related demographic variables remained consistent across surveys.

Horse ownership and sector demographics were also quite consistent, with around a third of the sample owning two or fewer horses, and around 20%-25% owning more than eight. The largest sector groups (main involvement) in the sample came from the Competitive/Eventing sector, the Recreational sector, and the Breeding sector (approximately 38%, 34%, and 13% respectively). This sample sector profile is typical of previous studies in Australia that have used online survey methods with horse owners (Taylor et al, 2008, Kung et al, 2013). Approximately one third of participants make an income from horse-related business or activity, with around 10% making their primary income through horse-related business.

Regarding property details, as shown in Figure 4 the majority of the total sample was from QLD and NSW, and approximately 20-25% kept their horses within 50km of a previously confirmed HeV case. Around a quarter of participants reported that they had primary responsibilities ('duty of care') for people working with, caring for, or having contact with their horses.

In terms of level of control over HeV risk mitigation decisions and practices, an overwhelming majority of the sample (~96%) reported that they were responsible for deciding whether their horses were vaccinated against HeV, and around 80% reported that they had a level of direct control over how the horse property was managed, e.g. they could modify fencing or structures.

Each core question area will now be considered. Assessment of the demographics of the survey samples across time and the cohort composition, as just outlined, were considered to be sufficiently similar on most variables to allow presentation of the full sample data over time in most of the following areas. This approach allows the responses of all study participants to be presented and provides additional confidence in the integrity of the data.

Vaccination

The subject of vaccination, as a main risk mitigation strategy against HeV infection, became a dominant subject across the HHALTER project. Although not known at the time the project was initially planned and commenced, the HeV vaccine (Equivac®) was launched earlier than the team had expected in November 2012, two weeks before administration of the first survey. Fortunately, the project team was able to adapt the S1 questionnaire before it was administered to incorporate a range of vaccination-related questions. Many of these questions became core questions; used in all surveys.

Vaccination uptake and intention to vaccinate

In all surveys participants were asked whether their horses had been vaccinated (all or some, from S2 onwards). Those whose horses had not been vaccinated were asked if they intended to vaccinate. Figure 5 summarises the proportions of the sample who had vaccinated their horses and who were responsible for making the vaccination decisions. These data are shown for both the full samples and the final cohort (n=341) across the five surveys.

Survey Questions Figure 5:

Q. Have your horse/s been vaccinated against Hendra virus?

A. Yes/No (S1)/ Yes, all; yes, some; no (S2-S5)

Q. Are you responsible for deciding whether or not any of your horses will be vaccinated against Hendra virus? (e.g. are you a horse owner or manager with this responsibility)

A. Yes/No

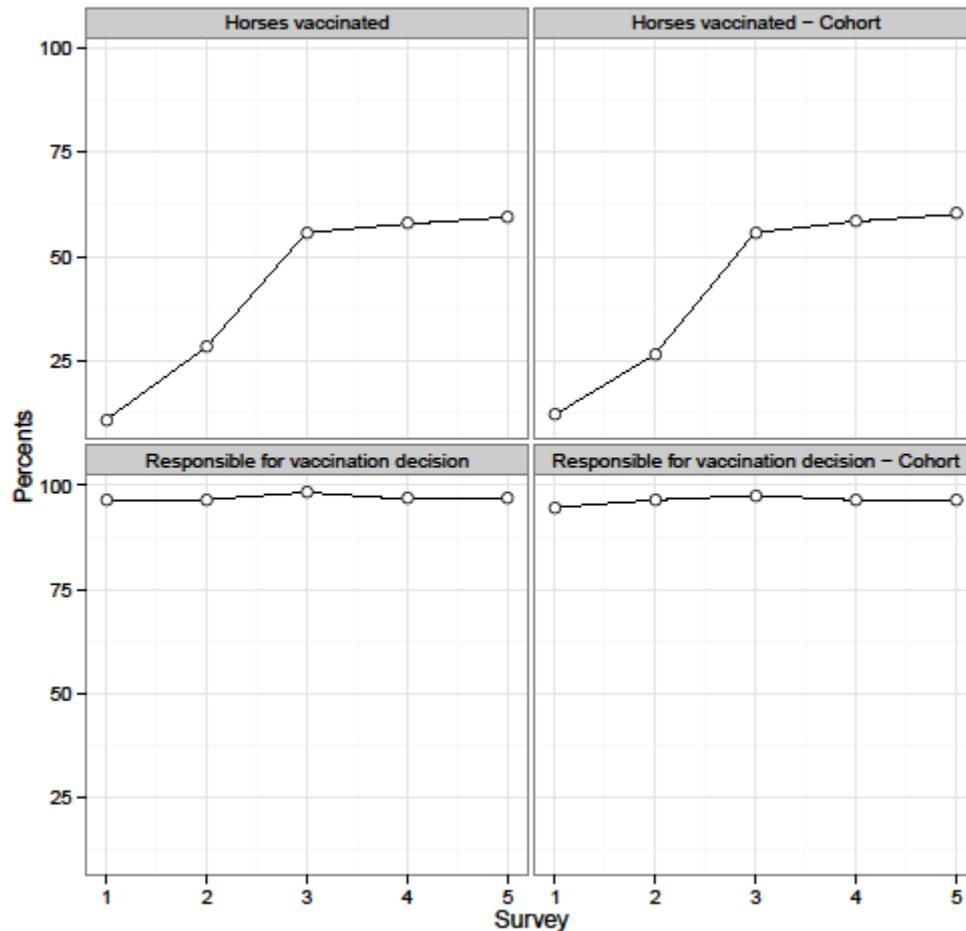


Figure 5. Summary of vaccination uptake and vaccination responsibility: full sample in each survey (left) and cohort (right).

Data presented in Figure 5 show that the proportions of the sample that vaccinated their horses rose sharply from S1 (Nov 2012) to S3 (Nov 2013) from 11% in S1, to 28% in S2, to 56% in S3. From S3 onwards the proportion of the sample vaccinating remained relatively flat with only a small increase, finishing at 60% at the end of the study (Nov 2014). As can be seen, the pattern of uptake in the full set of samples and in the cohort of 341 participants was very similar.

Figure 6 shows a combined presentation of those who had vaccinated and the intentions of those who hadn't vaccinated across the five surveys.

Survey Question Figure 6:

Q. Have your horse/s been vaccinated against Hendra virus?

A. Yes/No (S1)/ Yes, all; yes, some; no (S2-S5)

Q. Will you have any of your horses vaccinated?

A. Definitely yes; probably yes; unsure; probably no, definitely no.

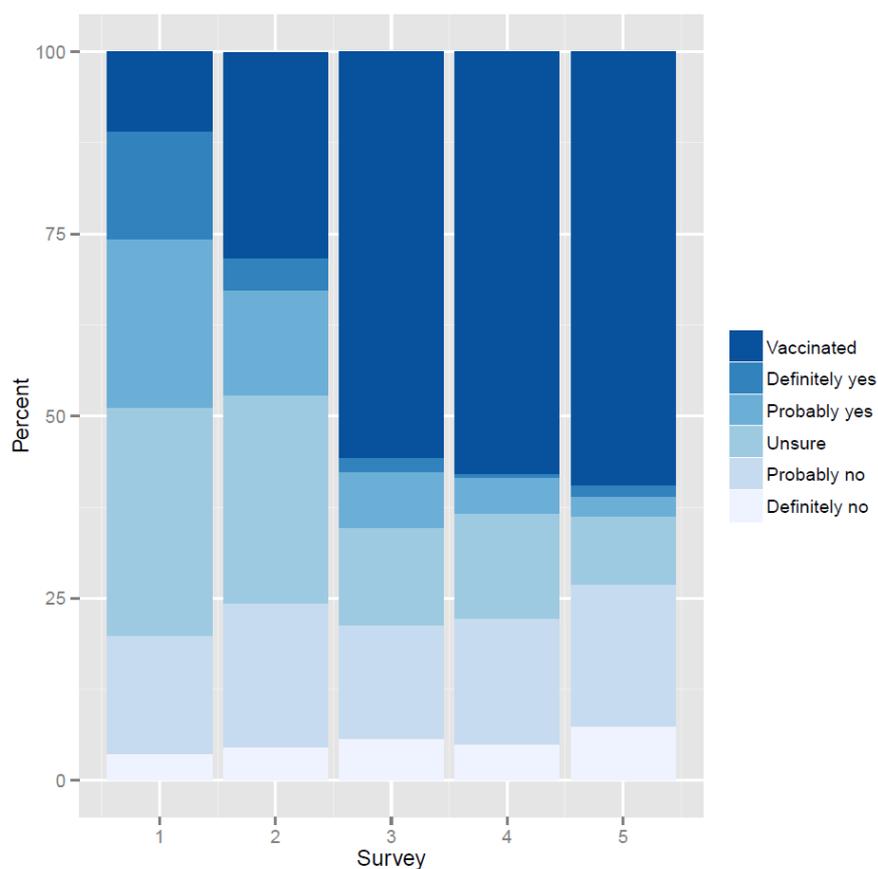


Figure 6. Vaccination uptake and intention to vaccinate against Hendra virus.

As can be seen in Figure 6, in S1 (Nov 2012) shortly after vaccine release and when a small proportion of the sample had vaccinated their horses, 38% of the sample intended to vaccinate (15% definitely and 23% probably). This proportion reduced, as more of the sample vaccinated over time, from 19% at S2 down to just 4% by the end of the study period (Nov 2014). Those who were unsure about whether they would vaccinate also dropped over time from 31% at S1 to 9% at S5. Those who reported they would probably or definitely not vaccinate varied over time from 20% at S1 to 27% at S5.

Vaccination policy

Participants were asked to indicate their level of agreement-disagreement with a number of statements relating to plausible HeV vaccination policy scenarios. These data are summarised in Figure 7.

Survey statements for Figure 7:

S. Hendra virus vaccination should...

- ... be made compulsory for all horses.
- ... not be made compulsory for horses – it should be the decision of the owner/manager.
- ... be made compulsory for all horses that attend events.
- ... be made compulsory for all horses in areas where Hendra virus cases have occurred.

R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

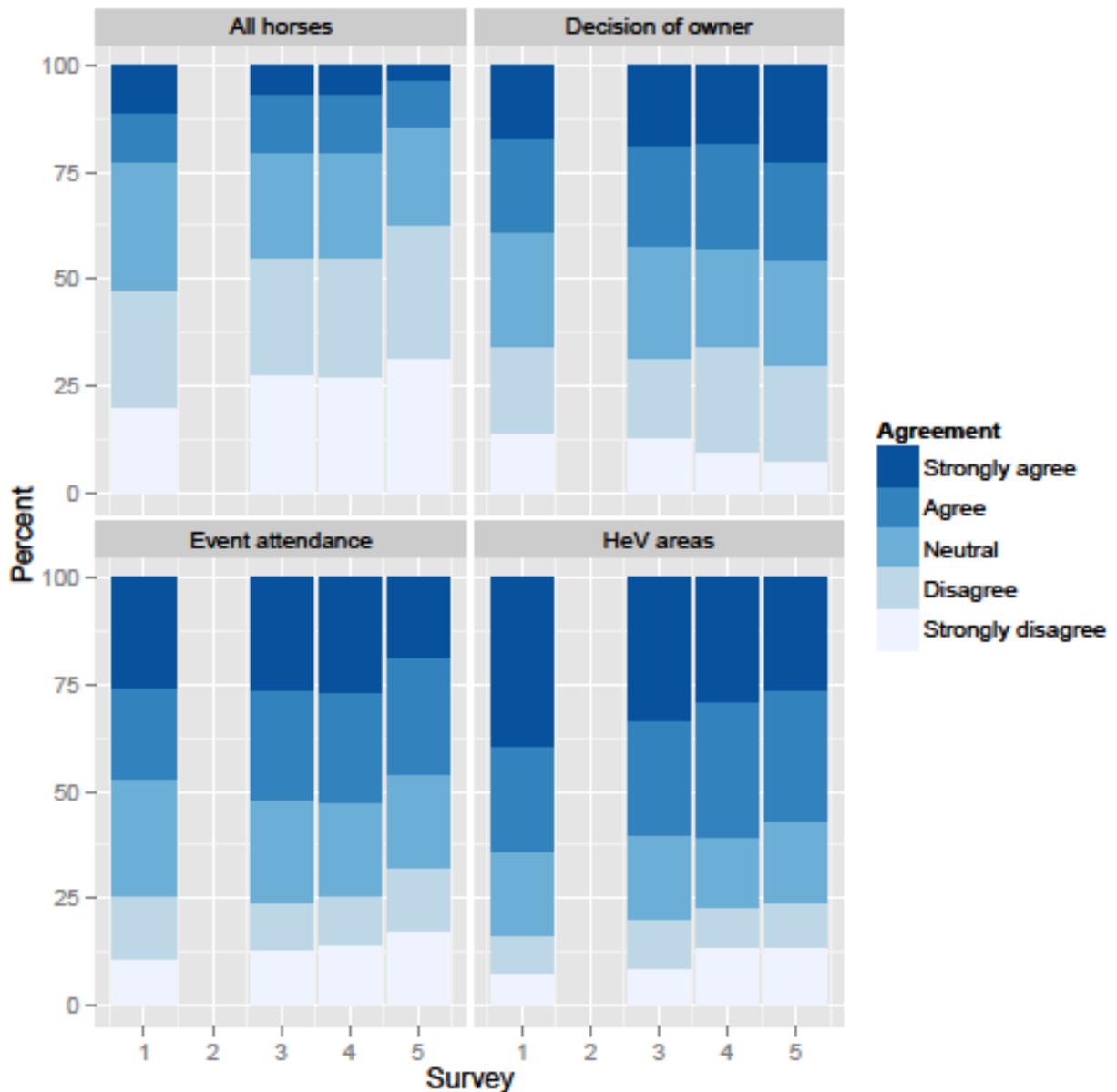


Figure 7. Level of agreement with statements about vaccination policy.

Attitudes to vaccination policy, shown in Figure 7, indicate that relatively small proportions of the sample agree/strongly agree that all horses should be vaccinated; fewer than a quarter of the S1 sample agreed with this statement and overall support for this stance decreased over time. A greater proportion of the sample agreed that vaccination should be the decision of the owner (around 40%) and this

proportion increased slightly over the study period. Around half the sample agreed that vaccination for horses that attend events should be compulsory, although this proportion declined noticeably at the time of the last survey (Nov 2014); possibly triggered by media reporting of concerns being raised in opposition to mandatory vaccination for certain events.

The highest level of agreement reported was for compulsory vaccination of horses in known HeV areas (compared to the other policy scenarios presented) with around two thirds of the sample supporting this approach in the first survey (Nov 2012). There does, however, appear to have been a slow decline in support for this option over time, to around 55% in S5 (Nov 2014). It is possible that this decline relates to a combination of delays in registration of the vaccine and reporting of concerns regarding safety of the vaccine as well as a decline in support for mandatory HeV vaccination generally.

Veterinary policy

A similar approach was taken to exploring plausible veterinary policy scenarios in areas where HeV cases had occurred previously. Participants were asked to indicate their level of agreement-disagreement with a number of statements. These data are summarised in Figure 8.

Survey statements for Figure 8:

S. Now that a Hendra virus vaccine for horses is available it will be reasonable for private veterinarians in areas where Hendra virus cases have occurred to...

- ...charge an additional fee to cover the higher risk associated with unvaccinated horses.
- ... refuse to examine or treat sick horses that have not been vaccinated.
- ... refuse to come onto a property where the vaccination status of horses is unknown.

R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

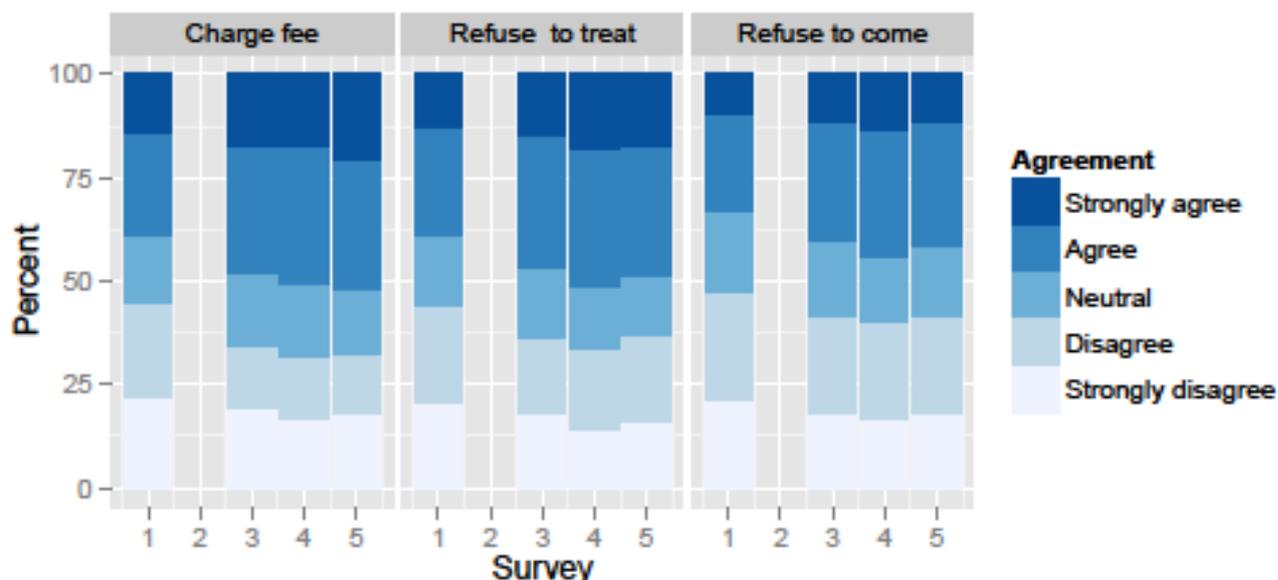


Figure 8. Level of agreement with statements about veterinary policy in areas where HeV cases have occurred.

In general, compared to attitudes in the first survey, there was slightly greater agreement with all three statements in S3- S5. There was less agreement with the proposition that it was reasonable for veterinarians to refuse to come on to a property when the vaccination status of horses is unknown. By

S5 around half the sample agreed that it was reasonable for veterinarians to charge additional fees to cover increased risk and to refuse to treat unvaccinated horses in areas where there had been previous HeV cases.

When considering responses gathered for the two sets of statements it appears that horse owners in this study generally agreed that fellow horse owners should be able to decide whether to vaccinate their horses, but also they felt that it was reasonable for veterinarians to have the right to adjust their treatment policy in known HeV risk areas.

Booster awareness and intention to booster

Horse owners who had vaccinated their horses were asked whether they were aware of the need for a six-month booster dose of vaccine and whether their vaccinated horses would be given the six-month booster.

Figure 9 summarises these data.

Survey Questions Figure 9:

Q. When your horses were vaccinated initially (with the first two doses of vaccine) did you know that they would need to receive a booster vaccine dose at six months?

A. Yes/No

Q. Will your vaccinated horses be getting (or have they already had) their six-month booster vaccine dose?

A. Yes/No (S2); Yes/Unsure/No (S3); Yes, all, Yes, some, Unsure, No (S4, S5)

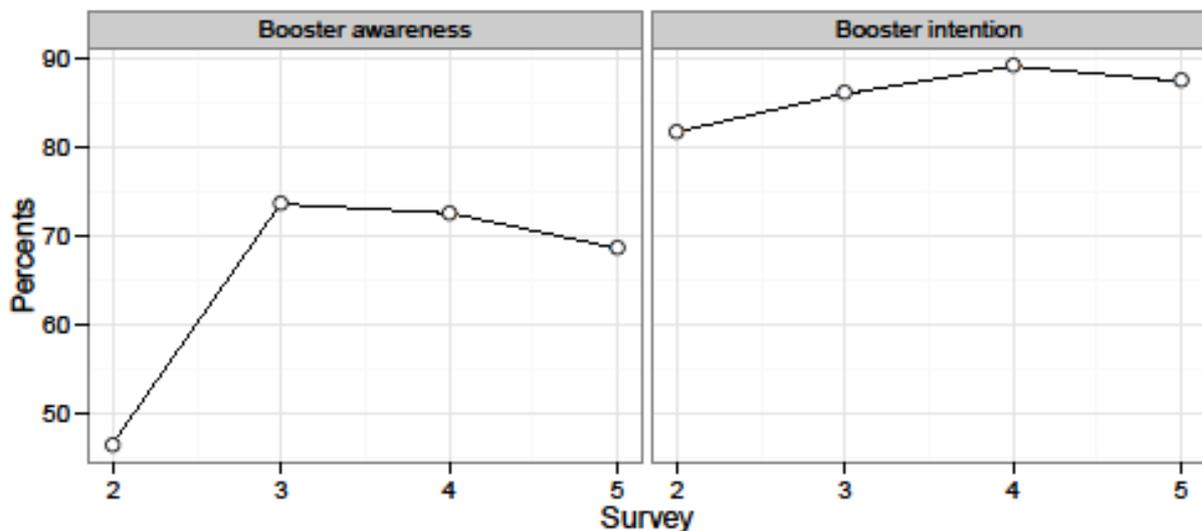


Figure 9. Booster awareness and intention to booster (all/some) horses.

The data in Figure 9 show a marked increase in booster awareness between S2 and S3. Participants at S2 would have had their horses vaccinated initially in the period November 2012 – June 2013. It's not known whether veterinarians did not clearly communicate the need for a six-month booster or if the vaccination regime wasn't known or communicated to veterinarians at the early stage of vaccination roll-out. It is also interesting to note that reported awareness of the need for boosters appears to have peaked in S3-S4 at only 72%, with this proportion declining slightly in the final survey. It is possible

that horse owners were aware of the need for boosters, but that regulatory delays that would see boosters being required annually (rather than six-monthly) had led to confusion at the time of vaccination around booster expectations. With regard to booster intention, a high proportion of the sample intended to booster their horses and maintain the recommended vaccination regime, with a slight increase from S2 to S4.

Property Management

In relation to HeV risk mitigation strategies to prevent transmission of HeV, horse owners have two main options; to vaccinate and/or to implement property management recommendations that reduce the probability of contamination of water/feed and pasture from flying fox body fluids and that reduce horse-flying fox contact.

Access to areas around trees

Horse owners were asked if their horses spent any time in yards/paddocks. If they answered ‘no’ to this question they skipped this section of questions because their horses were unlikely to be exposed to flying foxes; for example, if they were permanently stabled.

Owners whose horses spent time in yard/paddocks were then asked if access to areas around trees was being prevented. Participants who reported that they were currently preventing access to areas around trees were asked, at each survey, to indicate how this was being achieved. Specifically they were asked whether horses were being moved away to different paddocks or areas without trees, if permanent or temporary barriers/fencing were being used, and if trees were being cut back or removed. Table 5 summarises these responses.

Table 5. Methods used to prevent access to areas around trees.

	S1	S2	S3	S4	S5
Preventing access	305 (25.5)	119 (16.3)	84 (13.2)	80 (13.1)	124 (20.1)
Total number and (%)					
Methods used^a					
Moving horses away (to different paddock/area)	140 (11.7)	51 (7.0)	33 (5.2)	24 (3.9)	47 (7.6)
Using permanent fencing/barriers	128 (10.7)	47 (6.4)	35 (5.5)	36 (5.9)	63 (10.2)
Using temporary fencing/barriers	124 (10.4)	55 (7.5)	36 (5.7)	33 (5.4)	39 (6.3)
Cutting back trees so they don't overhang areas where there were horses	113 (9.5)	46 (6.3)	35 (5.5)	36 (5.9)	52 (8.4)
Removal of trees	93 (7.8)	45 (6.2)	34 (5.3)	28 (4.6)	41 (6.6)

^a multiple responses were allowed

Almost all horses were given access to yards and paddock, with levels around 99-100% across the surveys. The proportion of owners reporting that they were currently taking action to prevent horses having access to areas around trees was generally fairly low, with around a quarter reporting a level of access control in S1 and with this proportion dropping to around 13% in S3 and S4 and increasing slightly to 20% in S5.

Over the series of surveys no specific method to prevent access to trees was reported more frequently than any other. Data in Table 5 indicate that most owners were using a mix of approaches.

Access to water/food/trees

In each survey horse owners were asked about the level of access their horses have to open/uncovered water and food and their access to areas under trees in the day and at night. Figure 10 summarises these data.

Survey Questions Figure 10:

Q. Currently, in the yards/paddocks where your horses are kept...

...do they have access to areas under any types of trees during the day?

...do they have access to areas under any types of trees during the night?

...do they have access to open/uncovered feed (in containers/on the ground)?

...do they have access to open/uncovered water (in containers/dams)?

...do you remove access to water at night (empty/overturn water containers/troughs)?

A. Never/rarely/sometimes/often/always

The top two graphs in Figure 10 show that most owners reported that their horses always had access to areas under trees in the day and at night, with at most around 75% of horses always having access to areas under trees in the day (S1). These findings tie-in with the previous data, reporting the degree of access prevention (around 25% in S1).

There appears to be a small adjustment in the data between access to areas around trees in the day and at night, with slightly lower levels of access at night, presumably due to some horses being moved or stabled at night. There also appears to be some periodicity in the responses with level of access to trees being slightly lower in the winter months (S2 and S4; May-June), possibly reflecting increased sheltering/less time in paddocks in the colder weather.

In relation to access to uncovered water and feed, it is clear that the majority of horses always have access to uncovered water, and fewer always have access to uncovered feed (approximately 85% compared to 47%, respectively). Presumably this reflects the greater difficulty in covering or preventing access to open water; especially in dams or creeks.

Finally, the majority of horse owners never remove access to water at night (approximately 85%), and only around 3-5% report that this is a standard practice that they always do.

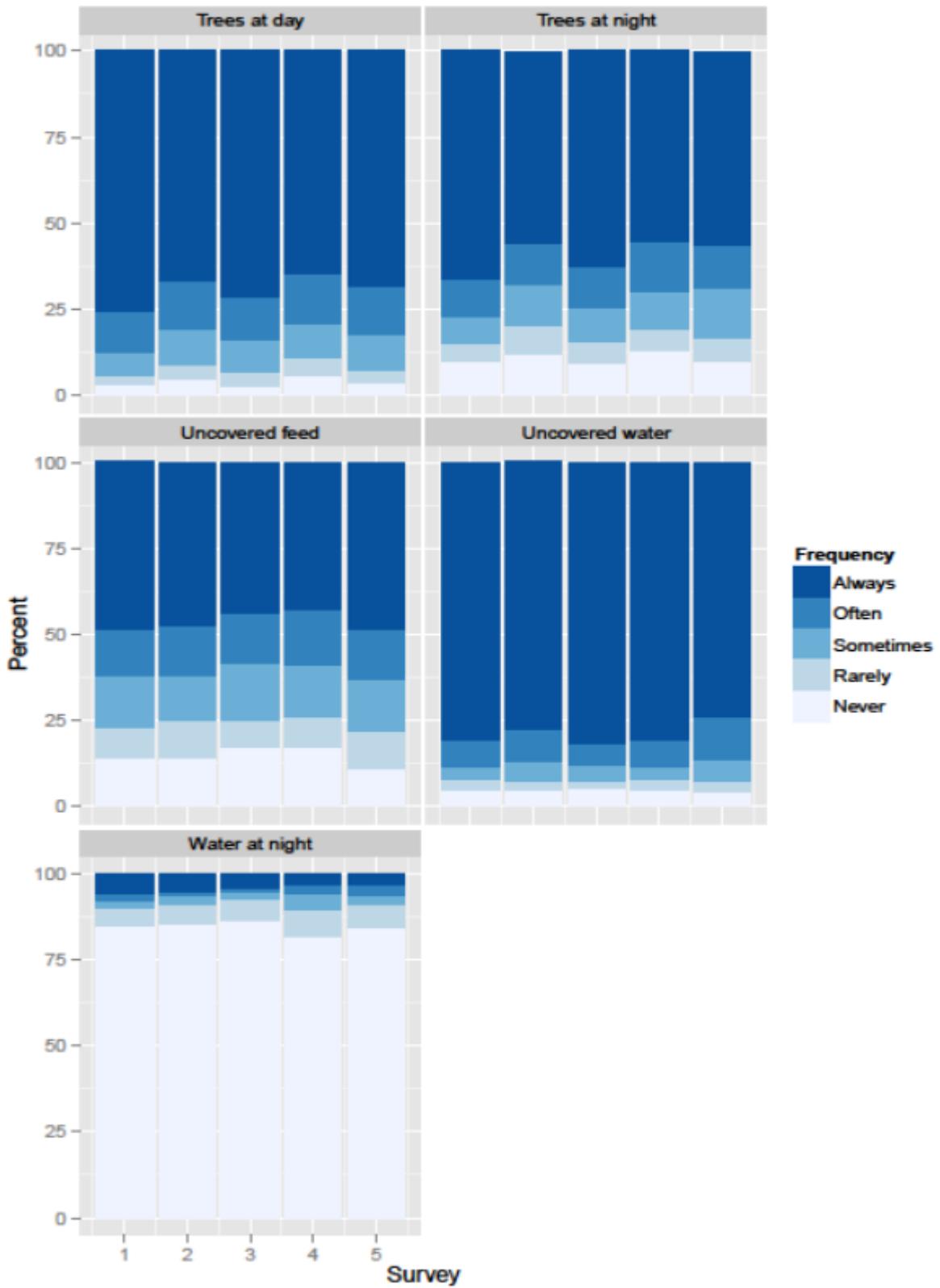


Figure 10. Access to areas around trees in the day and at night, access to uncovered water and feed, and removal of water in containers at night.

Perceived effectiveness and ease of property management recommendations

Extensive literature from the field of health protection (Milnes et al, 2000), and more recently animal disease management (Schemann et al, 2011) strongly suggest that the extent to which horse owners believe that recommended risk mitigation strategies are easy to perform and are likely to be effective will influence the uptake of those behaviours. In the first and last surveys (Nov 2012 and Nov 2014) horse owners were asked about the ease and effectiveness of the main risk mitigation strategies recommended by State Departments of Primary Industries, namely; covering feed and water, keeping horses away from under trees at night and in the day, getting horses vaccinated against HeV and separating sick horses away from other horses. Figures 11 and 12 show these findings.

Survey Questions Figure 11:

Q. How EFFECTIVE do you think the following would be at reducing the risk of Hendra virus infection in your horses?

- Covering water and feed containers?
- Keeping them away from trees at night?
- Keeping them away from trees during the day?
- Separating a sick horse from other horses?
- Getting them vaccinated against Hendra virus?

A. Not at all/a little/moderately/very/extremely

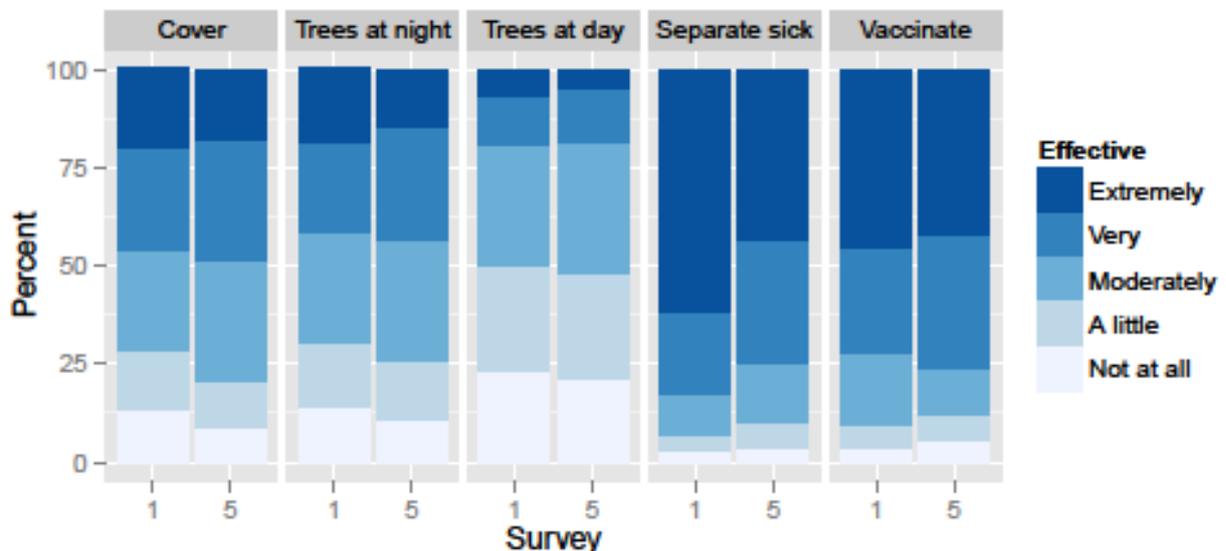


Figure 11. The perceived effectiveness of recommended HeV risk mitigation strategies.

It is clear from Figure 11 that horse owners believed that separating sick horses and vaccinating horses are likely to be the more effective of the recommended risk mitigation strategies for HeV and that keeping horses away from trees during the day was likely to be the least effective of those presented. The perceived effectiveness of separating a sick horse is the main strategy that attitudes appear to have shifted on over the two year study period (from S1 to S5) with this being viewed as less effective in more recent times. It's unclear why attitudes may have shifted. It could be due to a small number of HeV incidents in 2014 or a lack of incidents in which multiple horses have been infected; reducing the perception that horse to horse transmission of HeV is likely or a possible outcome. The perceived effectiveness of vaccination is also interesting. Clearly the majority feels that vaccination is *extremely*

or *very* effective (approximately 75%) but a quarter of the sample reports that they feel it would be only *moderately* (or less) effective at reducing the risk of HeV in their horses.

Survey Questions Figure 12:

Q. How EASY was it/would it be for you to do the following to reduce the risk of Hendra virus in your horses?

- To cover water and feed containers?
- To keep them away from trees at night?
- To keep them away from trees during the day?
- To separate a sick horse from other horses?
- To get them vaccinated against Hendra virus?

A. Not at all/a little/moderately/very/extremely

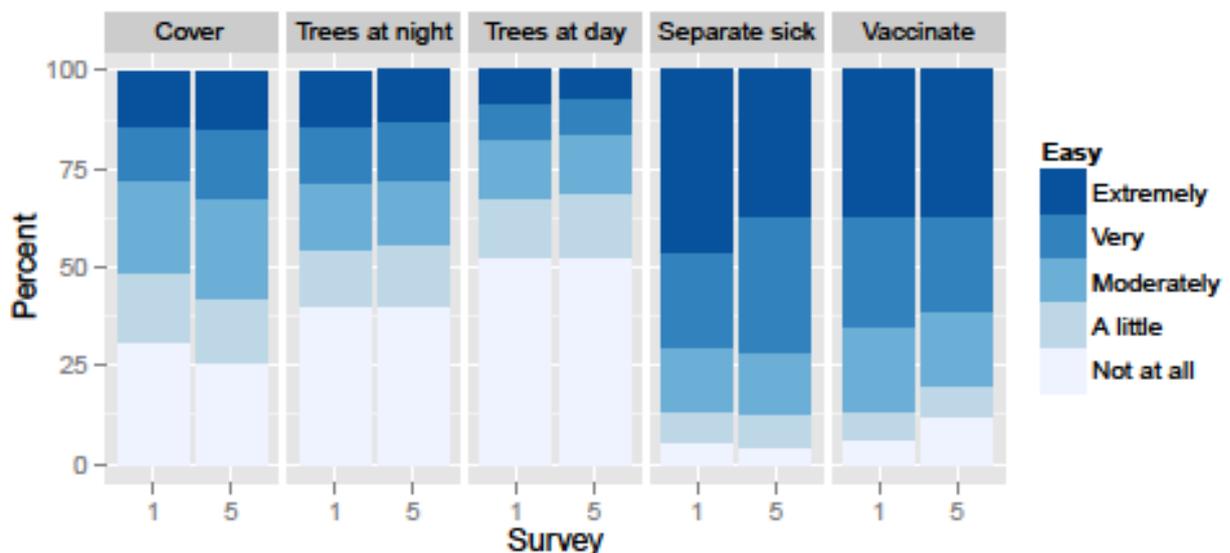


Figure 12. The perceived ease of doing the recommended HeV risk mitigation strategies.

Data in Figure 12 show a similar general pattern to Figure 11, in which separating sick horses and vaccinating horses are viewed more positively overall. Both risk mitigation strategies are considered *extremely* or *very* easy to do by around two thirds of the samples, with relatively few feeling that these approaches would be *not at all* easy. By comparison, keeping horses away from trees and covering food and water sources were rated as far less easy to do, with around half to two-thirds of the samples rating these practices as *not at all* or *a little* easy to do.

The proportion of the samples reporting that getting horses vaccinated would be either *extremely* or *very* easy has remained fairly stable over the two year study period. There does appear to be a small increase in the proportion of those who feel that getting horses vaccinated is *not at all* easy, increasing from 6% in Nov 2012 (S1) to 12% in Nov 2014 (S5). It's not clear why this proportion increased but it is possible that this simply reflects the reality for some now that the vaccine is widely available (as it was only recently launched at S1 and responses could have been based more on expectations), or it could be compounded by the need to arrange six-month booster appointments; some horse owners may have had horses boosted four times by S5.

Risk and Control

Perceived likelihood and concern

As part of the HHALTER project we were keen to assess changes in horse owner risk perception for HeV. Risk perception is an important gating mechanism for risk mitigation action or other protective behaviours (Rogers and Prentice-Dunn, 1997). If people (in whatever risk context) don't feel a degree of vulnerability they will not be motivated to seek information or advice or implement recommended risk mitigation strategies. HeV vulnerability was assessed in HHALTER using a combination of perceived likelihood of HeV (probability) and concern about infection in horses and self (consequence). These questions were asked in all surveys, and Figure 13 summarises these data.

Survey Questions Figure 13:

Q. How LIKELY do you think it is that a Hendra virus case could occur in your area?

Q. How CONCERNED would you be about Hendra virus infection in your horses if there was a Hendra virus case in your area?

Q. How CONCERNED would you be that YOU could become infected with Hendra virus if there was a Hendra virus case in your area?

A. Not at all/a little/moderately/very/extremely

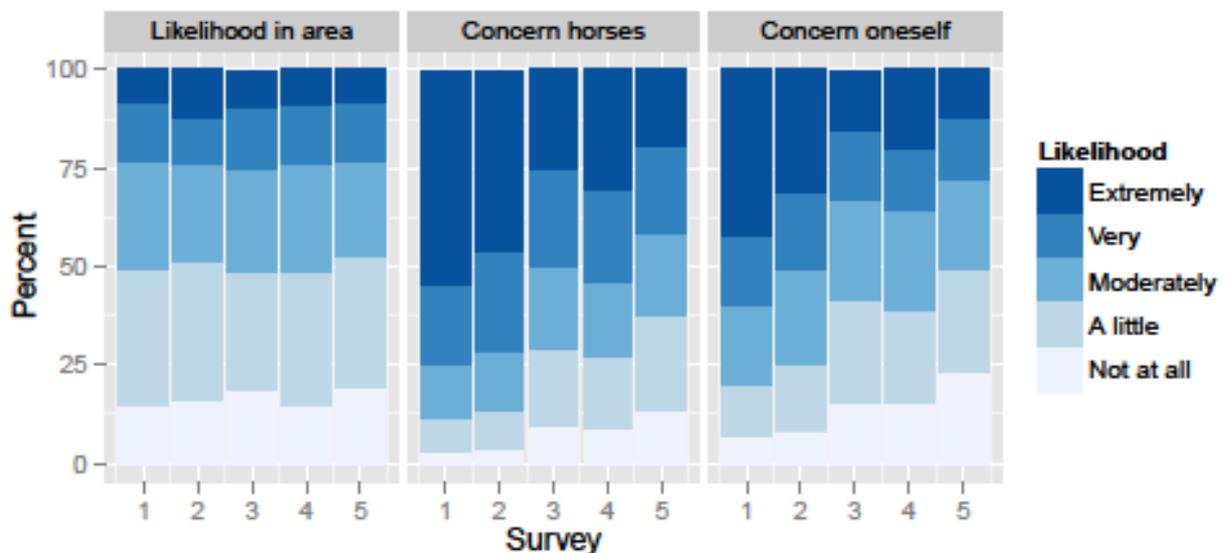


Figure 13. Perceived HeV risk: likelihood and concern for horses and self.

It can be seen clearly in Figure 13 that perceived likelihood of a local HeV case remained quite stable over the study period with approximately a quarter of the sample reporting that they felt a local HeV case was either *very* or *extremely* likely and around half felt a local HeV case was *not at all* or only *a little* likely to occur.

Level of concern for horses and self as a result of a local case, however, has declined quite markedly; most notably between S1/S2 and S3/S4/S5. Levels of those reporting being *extremely* concerned for their horses and themselves reduced by around half, from approximately 50% and 37%, respectively in S1/S2, to around 25% and 16% in S3/S4/S5. This pattern mirrors the large shift in vaccine uptake in the cohort between S2 and S3, noted in Figure 5. However, preliminary analysis does not suggest that

vaccination status is driving this effect, even though it seems like a plausible explanation for the finding. It is interesting to note that in the most recent survey that around half the sample report that they would feel *not at all* or only *a little* concerned for themselves if there were a local HeV case.

Priority of HeV as a horse health concern

Participants were asked about the priority they placed on HeV; where it would come on a list of horse health concerns. This question was asked in S1, S4 and S5. Figure 14 presents these data.

Survey Questions Figure 14:

Q. Where would Hendra virus come if you made a list of the greatest health concerns you have for your horses?

- A.
- At the top of the list – the highest health concern
 - Towards the top of the list – one of the higher-level health concerns
 - Somewhere around the middle – mid-level health concern
 - Towards the bottom of the list – one of the lower-level health concerns
 - At the bottom of the list – the lowest health concern

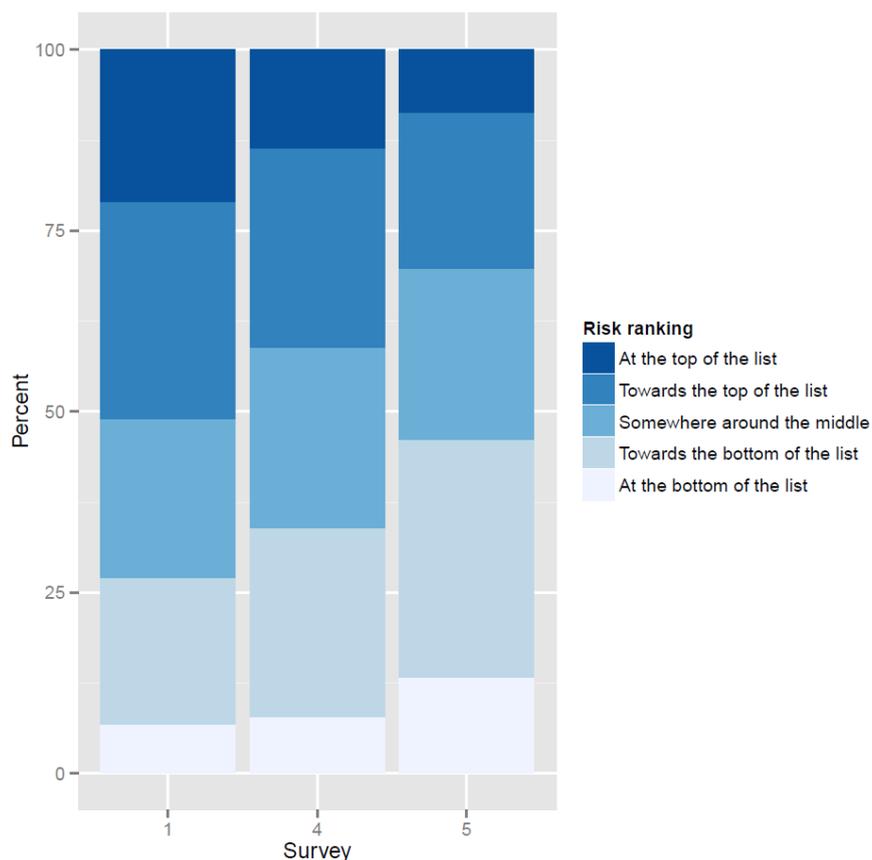


Figure 14. HeV priority in a list of horse health concerns.

The drift of HeV as a priority horse health concern across the two-year study period is clear from the data shown in Figure 14. The proportion of those rating HeV at or towards the top of the list declined from around 50% at S1 (Nov 2012) to 30% in S5 (Nov 2014).

Perceptions of control and concern about HeV risk

Within the surveys, participants were asked a number of questions about their attitudes towards aspects of HeV risk and also about the performance of their State Department of Primary Industries in relation to HeV control and communication. These sections have been split for presentation, with the former section presented in Figure 15 and the latter in Figure 16. The same format of a statement with an agreement-disagreement response scale was used for these questions, as used in the vaccination policy section earlier. The communication statements were only used in S1 and S5, whereas the other statements were included in all surveys.

Survey statements for Figure 15:

- S. I have a good sense of control over the risk of Hendra virus to my horses.
 - S. The risk of Hendra virus is decreasing.
 - S. Hendra virus has made me worried about being close to my horses.
 - S. I am worried about myself or members of my family getting Hendra virus.
 - S. I am worried about pets (cats/dogs) getting Hendra virus.
 - S. Hendra virus is not well understood.
- R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

Looking at data presented in Figure 15 some general trends can be seen over time. Level of concern for self/family and pets and being close to one's horse appear to be reducing steadily over the two-year study period, with lower levels of agreement with statements about these concerns.

Although changes over time are less apparent in responses to the other statements, it generally seems that horse owners agree more that they have good control over the risk of HeV to their horses, that they disagree more with the statement that HeV is not well understood, and there is generally a little more agreement with the statement that the risk of HeV is decreasing, with this latter trend being clearer from S3 to S5; over the second year of the study.

Combining the general finding from survey responses in this risk and control section there is clear evidence that general concern around the risk of HeV has been steadily decreasing over the last two years, even though more than half of respondents agree with the statement that HeV is poorly understood.

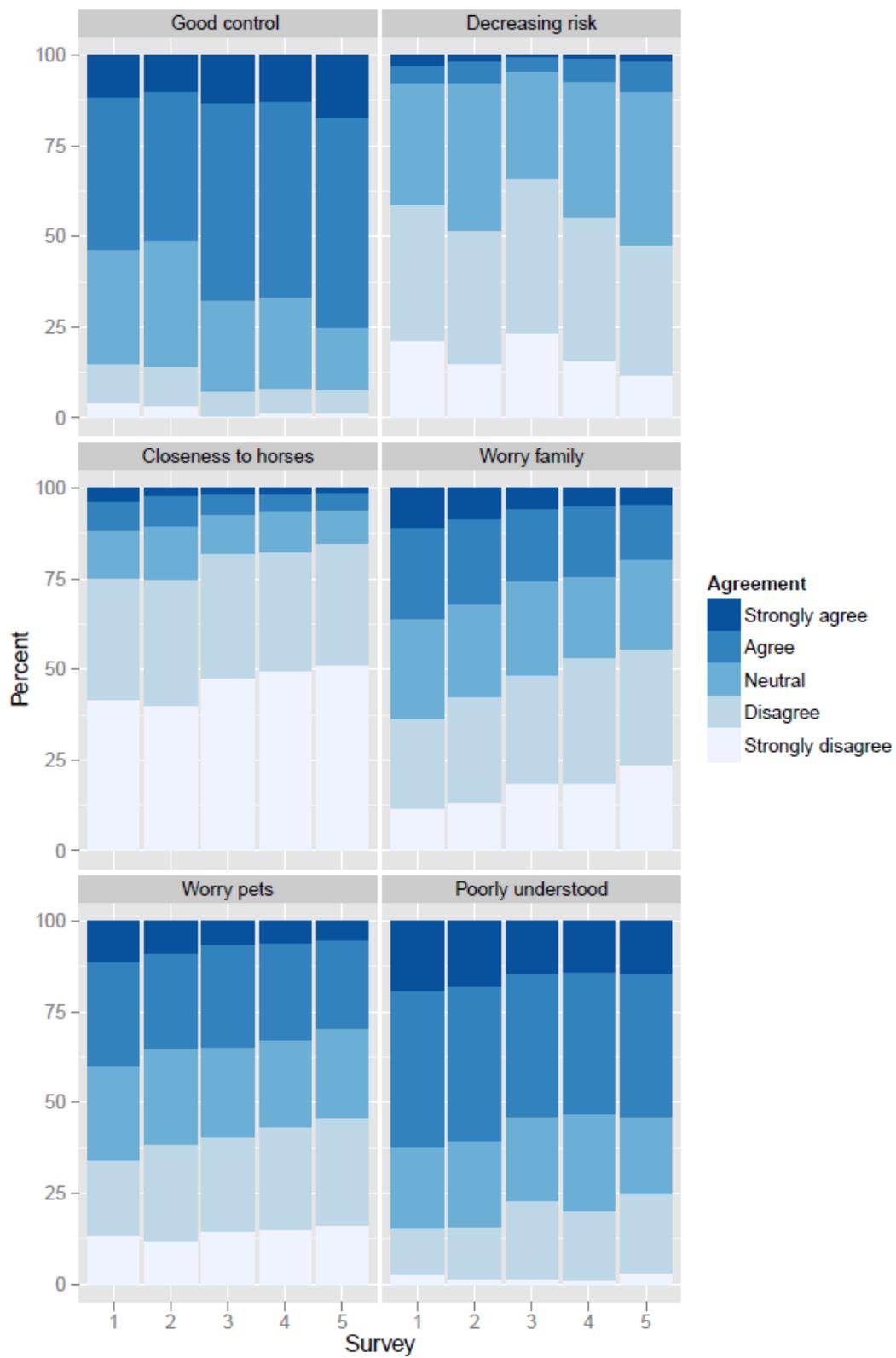


Figure 15. Level of agreement with statements about HeV risk.

Perceptions of State Government management and control of HeV and information

Survey statements for Figure 16:

- S. Hendra virus cases have been well managed when they have occurred.
 - S. There should be a national horse registration system to assist with disease control and horse movements.
 - S. My State Department of Primary Industries can be trusted to take appropriate action against Hendra virus infection if/when it occurs.
 - S. My State Department of Primary Industries can be trusted to provide sound advice about reducing Hendra virus risk.
 - S. My State Department of Primary Industries has been active in informing people about Hendra virus and how to protect themselves and their horses.
 - S. My State Department of Primary Industries Hendra virus information is good.
- R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

Data in Figure 16 indicate that attitudes towards the management of HeV cases and the need for a national horse registration system have remained fairly steady over time. More than half of participants agree that HeV cases have been well managed when they have occurred, and around 55% agree that there should be a national horse registration system to assist with disease control and horse movements.

With regard to the State Departments of Primary Industries, there is a small increase in agreement over time to the statements that that they can be trusted to take appropriate action against HeV when it occurs and that they can be trusted to provide sound advice about reducing HeV risk. Slightly more than half the participants agree with these statements.

For the two statements regarding State Departments of Primary Industries and their provision of information, fewer participants agree that their State Department of Primary Industries has been active in informing people about HeV risk in the most recent survey (Nov 2014) compared to the first survey (Nov 2012). With agreement levels falling from just over a half of the sample agreeing with this statement at S1 to around 38% agreeing at S5. Similarly, there is a small decrease in those agreeing that their State Department of Primary Industries HeV information is good, with this falling from around 53% in S1 to 48% in S5. The proportion of the sample that gave a *neutral* response to the two statements increased from S1 to S5. This may indicate an increased level of uncertainty.

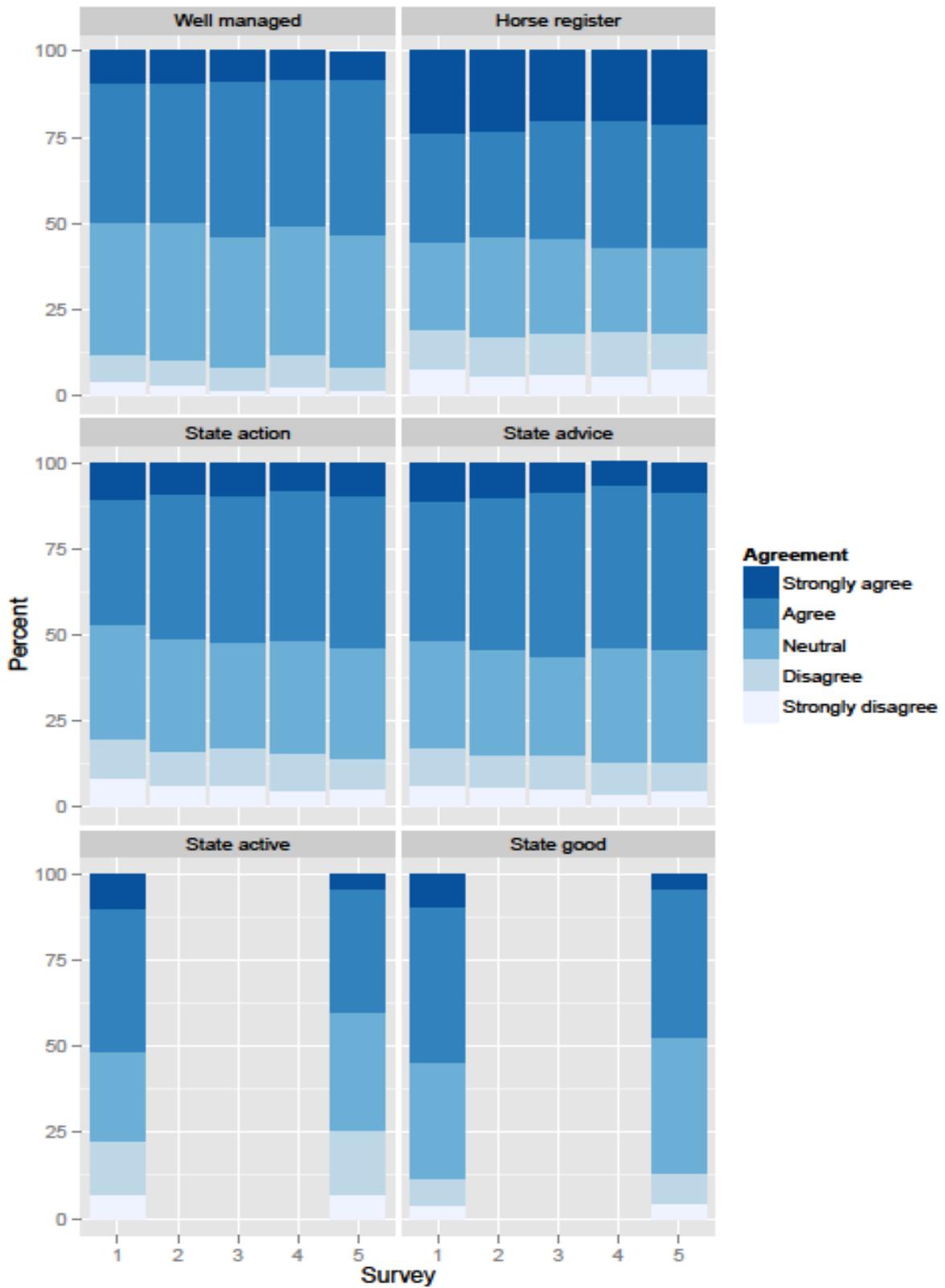


Figure 16. Level of agreement with statements about State Department of Primary Industries HeV response and communication.

Knowledge

Perceived level of knowledge

The HHALTER study tracked participant self-rated level of knowledge of HeV. This question was included in all surveys. Figure 17 summarises the data.

Survey Questions Figure 17:

Q. In general, how would you rate your level of Hendra virus knowledge?

A. Very poor/poor/fair/good/very good

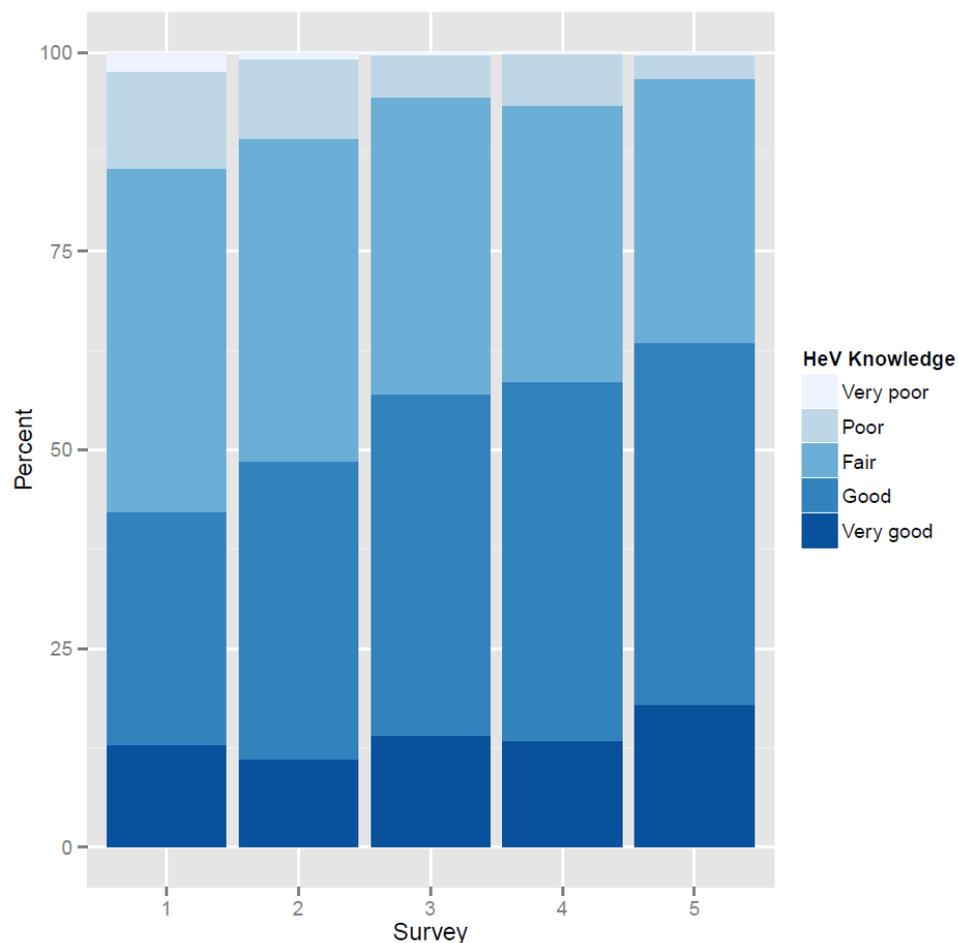


Figure 17. Self-rated Hendra virus knowledge.

Data in Figure 17 indicate that, over time, participants rated their HeV knowledge as improving. Overall, the proportions of participants who rated their HeV knowledge as *very good* or *good* increased incrementally from 42% in S1 to 63% in S5.

Information

Attitudes to media reporting

Over the duration of the HHALTER project we asked horse owners a range of different questions about HeV information and communication. Most of this content was one-off/supplementary content

and is not included in this report. Information and communication was also an area covered as a major component of the interview phase of the study.

In the first and last surveys participants were asked about local and national media reporting on HeV. The format used was the statement and level of agreement format as used in other sections. Figure 18 summarises these data.

Survey statements for Figure 18:

- S. Media reporting around Hendra virus has been sensationalised and unhelpful.
- S. National media has provided good coverage of Hendra virus cases.
- S. My local media has provided good coverage of Hendra virus cases.

R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

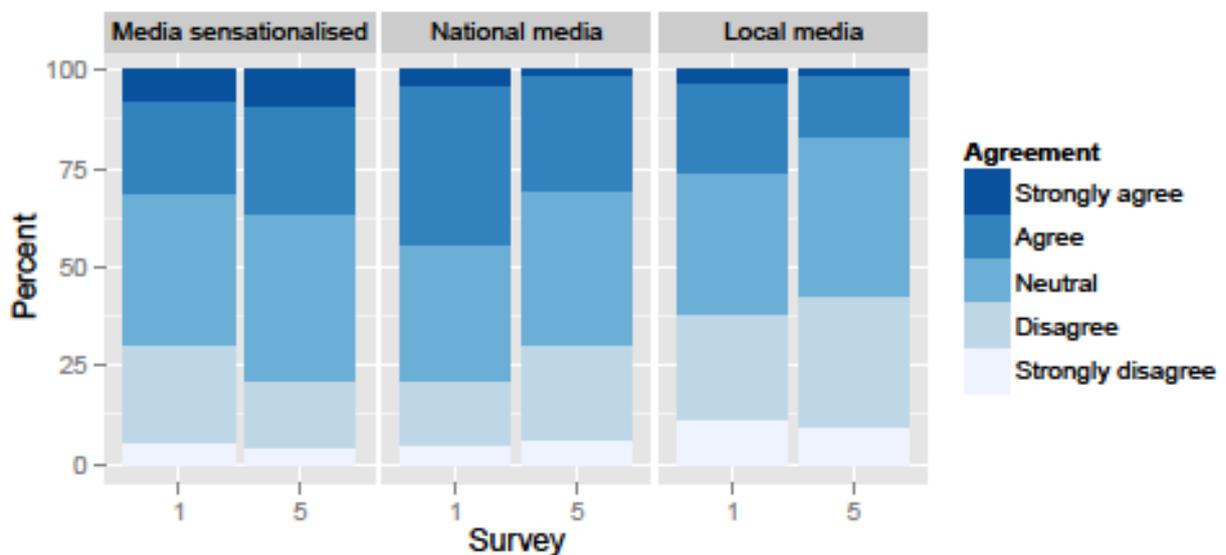


Figure 18. Level of agreement with national and local media statements.

As can be seen from Figure 18, from S1 to S5 participants reported higher levels of agreement that media reporting of HeV was sensationalised and unhelpful, and lower agreement that local and national media coverage was good. A relatively low proportion of participants agreed that local media coverage was good (around 26-30%)

Flying foxes

Seeing flying foxes and perceiving them as a health threat

In this final section of the core survey results attitudes towards flying foxes are explored. To gain an understanding of flying fox sightings and perceptions of threat from flying foxes participants were asked if they saw flying foxes in their local area, either nearby or on their horse property, and they were asked if they felt that flying foxes were currently presenting a direct health threat to their horses. These questions were included as core questions from S2 (May 2013) onwards. In addition a set of statements about attitudes to flying foxes was assessed in S2 and S5 to investigate specific aspects of horse owner attitudes.

The proportions of the samples that saw flying foxes remained fairly stable across surveys, between 52- 57%. Figure 19 shows the responses to the question concerning direct health threat.

Survey Question Figure 19:

Q. Do you think that flying foxes are CURRENTLY presenting a direct threat to the health of horses on your property?

R. Definitely no/ probably no/ unsure/ probably yes/ definitely yes

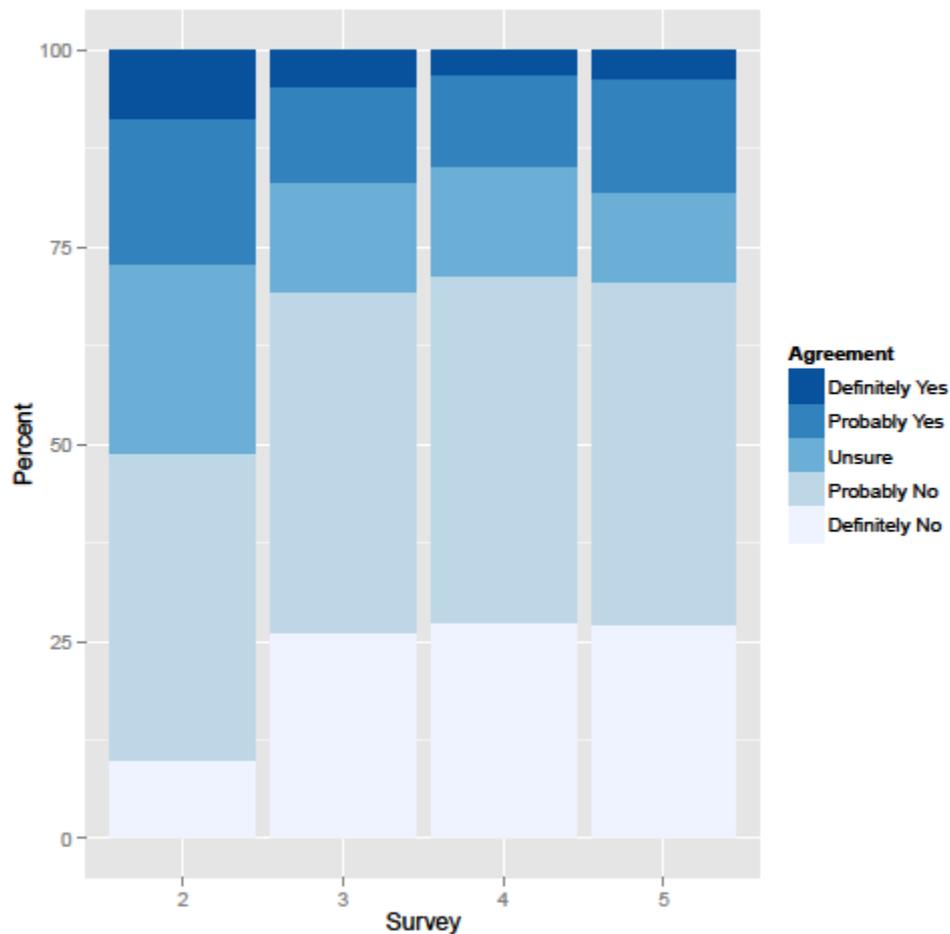


Figure 19. Perceptions that flying foxes are currently presenting a direct threat to the health of horses.

As can be seen from Figure 19, the proportion of the sample that doesn't feel that flying foxes are posing a direct threat to the health of their horses increased in S3 (Nov 2013) and has stayed quite stable since then. In the last three surveys the majority of participants felt that flying foxes weren't a threat to horse health with around a quarter responding *definitely no*, and a further 44% responding *probably no*. Again, it's interesting that the sharp decline in perceptions of flying foxes as a health threat coincides with the large increase in the proportion of the sample that vaccinated their horses. Further analysis is required to investigate if this is associated with the shift in attitude.

Ten statements were presented in S2 and S5 to assess participants' attitudes towards flying foxes. Responses to these statements are summarised in Figure 20.

Survey statements for Figure 20:

- S. Flying foxes pose a significant health threat to horses.
 - S. Flying foxes pose a significant health threat to people.
 - S. We don't need flying foxes.
 - S. Flying foxes should NOT be protected.
 - S. Flying foxes should be moved away (dispersed) from areas where there are horses.
 - S. Flying foxes should be culled/shot if they are roosting in areas where ...there are horses (S2) / ...they are causing a nuisance (damage/noise) (S5).
 - S. The protection of flying foxes means that their welfare is being put ahead of human health.
 - S. Moving (dispersing) flying foxes does not reduce the risk they pose to horse/human health – it just moves the problem somewhere else (S2) / The dispersal of flying foxes does not work, it just moves the problem somewhere else (S5).
 - S. Flying foxes should not be culled/shot.
 - S. Flying foxes play an important role in the environment (e.g. pollinate trees/plants, disperse seeds).
- R. Strongly disagree/disagree/neither agree nor disagree/agree/strongly agree

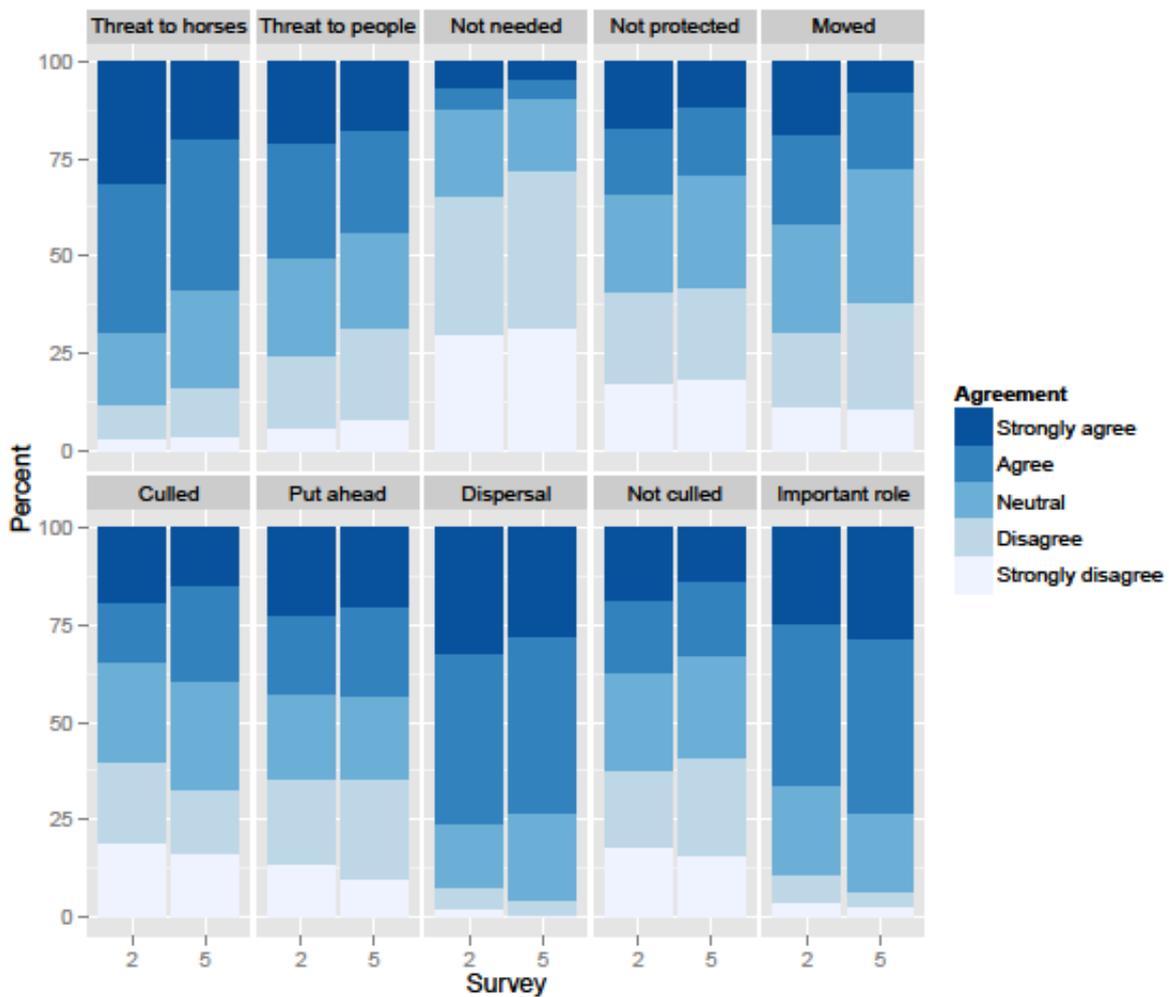


Figure 20. Attitudes towards flying foxes.

In terms of overall attitude towards flying foxes there are high levels of agreement with statements that they pose a health threat to horses and to people (around 63% and 47% overall, respectively), but that dispersal isn't an effective method of flying fox management because it just moves the problem somewhere else (around 75%) and that flying foxes play an important role in the environment (around 70%). Consistent with that last response, there are high levels of disagreement with the statement that we don't need flying foxes (around 69%).

Over time, there generally appears to be a reduction in agreement with many of the statements presented in Figure 20, most notably that flying foxes are regarded as less of a health threat to horses and to people, with shifts of around 10% and 7% in those that *strongly agree* or *agree* with the statements, respectively. There is also a reduction in those who agree that flying foxes should be moved from areas where there are horses, with a shift from 38% to 30% of participants responding that they *strongly agree* or *agree* with the statement and with a notable decline in those who *strongly agree* in particular. Just over a third of the sample (34%) agrees that flying foxes shouldn't be protected and this proportion decline slightly in S5.

A stable proportion of the sample agreed that the protection of flying foxes means that their welfare is being put ahead of human health (43-44% responding that they *strongly agree* or *agree*), but around a third of the sample disagreed with the statement too. Attitudes were also quite evenly split for the statement that flying foxes should not be culled/shot, with around 40% disagreeing and around 35% agreeing with the statement.

Discussion and Conclusion

This Chapter of the report has summarised top-level findings from core questions administered in a series of five surveys undertaken over the period November 2012 to November 2014. In terms of the project objectives the successful execution of the project has fulfilled Objectives 1 and 6, by recruiting and maintaining a large cross-industry cohort of horse owners in the research surveys and in supporting an engagement pathway between horse owners, industry, and agencies tasked with the response to and management of HeV.

At the outset of the project it was hoped that the cohort in the study would be substantially larger. However, the cohort size (n=341) is large enough for robust statistical analysis, and the overall demographics of the survey differ very little to the full samples for each individual survey. This makes the presentation of data for the whole sample sufficiently equivalent for reporting core survey data. In addition, each survey provides a large sample suitable for cross-sectional survey-based analyses.

The team worked hard to maintain and sustain horse owner participation over the life of the project; with regular feedback, social media and online presence, and the use of incentives. Although the vaccine roll-out and occasional issues covered in the media or the industry provided a focus for sustained interest in HeV, there were no other ‘big’ risk-inducing events – such as another super-cluster of cases as seen in 2011, or further human infection, or cases in new states. Although this is a very fortunate situation, it is less conducive to sustained broad interest from horse owners in a project such as this.

In relation to engagement pathways, as the project progressed the team chose to focus on engagement with horse owners and industry and protection of the cohort. Rather than produce two sets of feedback as originally planned for different segments of stakeholders (horse owner participants and others – government, industry), a single set of project feedback newsletters was produced. This reduced the risk of more detailed or rich project data leaking back to the participants. Feedback to government and industry was provided in dedicated presentations. Similarly, the team resisted courting the media to discuss findings; limiting this activity mostly to project launch and participant recruitment activities.

Objective 3 of this project relates to tracking changes in core areas over time. The provision of data in this Chapter of the report demonstrates the ways in which this objective has been met. The report Appendices contain some supplementary vaccination-related data and further analyses, and addresses more fully Objective 5, which included consideration of emerging issues on risk mitigation and risk awareness.

Data provided in this Chapter show that uptake of vaccination by participants in the study was higher than for that in the general horse-owning population. The final sample uptake was 60%, whereas Zoetis reports uptake estimates of around 12% overall; 17% in QLD and 12% in NSW. It is clear from these figures alone that the HHALTER sample is likely to be more aware of HeV risk, is engaged in the issue of HeV, and is probably more pro-vaccination than the average horse owner. From the distribution of the sample it is possible that some of this bias may be explained by proximity to HeV cases; with more of the sample living closer to these locations than the general horse-owning population. However, given limited population data on horse ownership in Australia (Smyth & Dagley, 2015) it is hard to prove the extent to which the sample is representative (or otherwise) of horse owners more broadly. For the purposes of interpretation of the findings, it is probably helpful to consider the HHALTER sample as more at risk, more engaged, and in terms of likely risk mitigation practices therefore, ‘best case’.

Further consideration of the representativeness of the study sample can be based on other sample demographics. The sample overall was heavily involved with the recreational, competitive, and breeding sectors of the industry, with 86% identifying one of these as their primary sector of horse involvement. Again, it is not clear how this relates to horse owners generally, although it is probably representative of the industry sectors most impacted by HeV in the last 10 years and those most in need of engagement in HeV risk mitigation. Finally, it is also clear that the sample is heavily gender-

skewed, with 90% of the sample female. This gender distribution is not surprising, and typical of similar research (Kung et al, 2013, Taylor et al 2008) and the best demographic information currently available (Smyth and Dagley, 2015). The study design (opt-in online surveys) may have been more appealing to female respondents, however, it is not unusual for females to report on behalf of households in other research areas (e.g. health research) and personal comment from industry representatives in these sectors during research presentations has suggested that this heavy female-skew is typical of industry association membership and participation generally.

As previously mentioned, vaccination uptake in the sample is high compared to the general horse-owning population. Our study noted a sharp rise in uptake over the first 12 months of vaccination availability and then a plateau for the following 12 months. This seems to suggest that uptake has peaked in this sample, under current circumstances, e.g. booster regime, price regime, rate/location of recent cases. Although compliance with the vaccination regime appears to be high (around 80-90%) there is evidence from S5 supplementary data (Appendix 1) of a sharp decline in those who are delaying or withdrawing from the formal 6-monthly vaccination regime (around 27%). From monitoring official sources of information (APVMA, Zoetis) and horse owner interactions on social media, there was general uncertainty about when the vaccination would be registered³ and approved for annual boosters with some debate around the effects of giving multiple frequent booster vaccinations. This general uncertainty was raising concern in some owners and was causing horse owners to delay booster injections until nearer 12 months. It was clear that discussions were taking place between owners and veterinarians about how this delaying approach could enable horses to stay certified - registered on the vaccination database – whilst also reducing booster frequency, costs and potential for adverse effects.

Further information gained from supplementary questions around vaccination in the final HHALTER survey (Appendix 1) also helps to break down factors influencing delay or withdrawal from the vaccination program, details the types and perceived severity of adverse effects of vaccination that are driving some horse owner concerns, and helps scope perceived sources of pressure to vaccinate. These data show how owners are deciding on their own level of risk and offsetting that against the various 'costs' of vaccination. Adverse reactions to the vaccine are reported by a sizeable minority of respondents at varying degrees of severity. The HHALTER project did not seek to quantify such data in representative or objective terms or in verifiable ways, however the level of reporting of *perceived* adverse reactions is an important driving force in vaccine acceptance and continued uptake in the current 6-monthly booster regime. The pressure to vaccinate in the face of concern and uncertainty, especially when the sources are large and distant (i.e. approaches to mandate vaccination by larger groups/organisations) have increased potential to disenfranchise some horse owners and result in negative attributions and resistance. These findings support the need to maintain trusted relationships between local veterinarians and horse owners to keep open this important channel of communication.

With regard to statistical modelling of vaccination uptake, further analysis of the vaccination data (Appendix 4) identified that uptake of vaccination was linked to a number of HeV risk perception variables, such as feeling that HeV was more likely to occur. Early uptake was also linked to the ease with which vaccine could be obtained, beliefs about its effectiveness, concerns about the consequences of infection, being based in Queensland, and the involvement of veterinarians as sources of information. Barriers included concerns about safety/adverse reactions, costs, and involvement in the breeding sector of the industry. In the longer term, lower uptake was also linked to being in the breeding sector and issues around cost, e.g. owning fewer horses, feeling more financially secure. Higher uptake was linked to perceived likelihood of HeV, concerns for self and family and indicators of trust in the official system, e.g. feeling that HeV cases were well managed, being supportive of a national registration scheme.

³ Equivac® full registration occurred in August 2015 after the last set of data collection in Nov 2014 –Jan 2015.

Generally, regarding vaccine policy, there appears to be little support for blanket compulsory vaccination of horses. Compulsory vaccination of horses in HeV risk areas has broader support, as does compulsory vaccination for attendance at events, although support for both appears to be reducing over time. In general, there is also modest support for veterinarians to adopt more stringent policies around non-vaccinated horses in areas where HeV cases have occurred.

The general uptake of recommended property management approaches (non-vaccination risk mitigation practices) is quite low in the study sample and appears to have changed little during the study period, or relative to levels reported in a prior study conducted in 2012 (Kung et al., 2013). Prevention of access to areas around trees was only being undertaken by 20% of the sample at the end of the study period, with 10% using permanent fencing to achieve this. There is a general indication that keeping horses from trees, especially in the day time, is not easy and is not regarded as likely to be effective at reducing HeV risk in participants' horses. Vaccination and the separation of sick horses from other horses are generally regarded as easier to achieve and more likely to be effective.

Approaches to avoid potential contamination of horses' food and water are also subject to fairly low levels of uptake with 85% of participants reporting that their horses always have access to uncovered water and around half reporting that their horses always have access to uncovered food. Responses have not changed in any systematic way during the project period.

One consistent finding over the study period, based on a number of measures, is that the perceived risk of HeV has decreased. Horse owners indicate that they have a greater sense of control over HeV risk, their knowledge has increased, and HeV is less of a priority horse health issue. Further analysis is required to assess what is driving this reduction in perceived risk. The availability and uptake of vaccination is one obvious potential factor, although cross tabulation does not appear to show that there is a simple relationship between the two. It is also true that there has been less media coverage of HeV in recent years and the number of cases of HeV has not been higher in recent years. The potential significance of lowered perception of HeV risk is that it could have two important impacts; it could lead to a reduction in risk mitigation practices, e.g. withdrawal from the vaccination program, reduction in recommended property management practices, reduced surveillance, and it could lead to lower general engagement in the issue, e.g. less information seeking, monitoring, awareness of risk messaging, or awareness of changes in risk messaging.

Generally there is fairly strong and steady support for State Departments of Primary Industries in their response to, and management of, HeV cases. There is evidence of some increased uncertainty around the quality of information provided and how active State Departments of Primary Industries are in informing horse owners about HeV risks. It is possible that this is a general reflection of a more stable and less reactive period in which HeV communication is low key and, therefore, less salient. Another possibility is that communications have become more targeted and strategic in terms of timing and risk groups. Towards the end of the study period general media had been fairly quiet, with recent reporting focussed more on HeV vaccination policy in relation to attendance at horse events rather than directed at the reality of HeV cases and consequences or risks of infection.

Finally, horse owners indicated how they felt about flying foxes; their awareness of them in the local area and perception of them as a threat. Just over half the sample reported seeing flying foxes, although in the final survey only around a quarter felt that they posed a direct threat to the health of their horses. Although it is clear that a proportion of the sample felt negatively towards flying foxes, the majority appeared to have quite balanced views on a range of flying fox issues, these findings reflect those of the general population (Kung et al., 2015). Further analyses revealed that risk perception and concern about HeV was linked to perceptions of flying foxes as a health threat to horses.

Chapter 2: In-depth interviews with horse owners

Introduction

In this chapter we report the results of the qualitative phase of the HHALTER project. This sought to complement the longitudinal survey study (see Chapter 1) and was conducted to gain in-depth information on:

- horse owners' process of risk assessment, the intentions and beliefs stemming from this process, and finally the resultant decisions and behaviours, as well as
- horse owners' process of engagement with the HeV risk, including forms of communication and sources of information, and the relative importance and trust they place in the gathered information.

The Human Research Ethics Committee at the University of Western Sydney approved the study proposal (# H10518).

Methodology

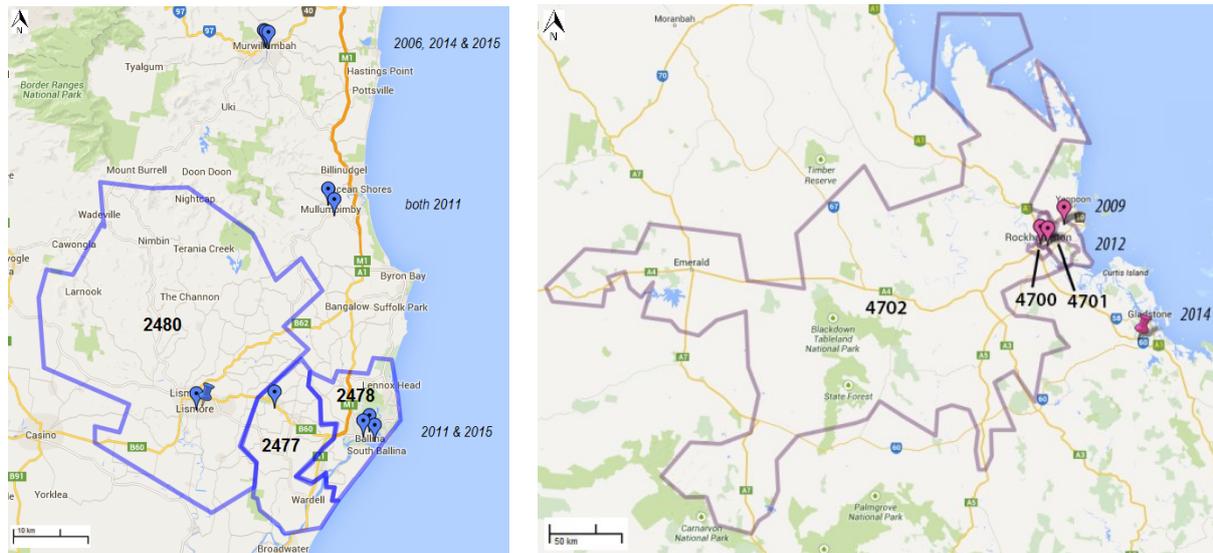
A qualitative research approach was applied to provide insight into the beliefs, values, attitudes, and behaviours of horse owners in relation to HeV. Focused ethnography, in which research is directed towards exploring a subculture, i.e. common beliefs and values within a group of people that share some features and experiences ([Richards and Morse, 2007](#)), was utilized here. A series of audio-recorded face-to-face interviews with horse owners was conducted, complemented by field notes and a reflective journal to further describe the research process and to document any observational data. This method is suitable when research questions are best responded to through descriptive analysis and interpretation ([Richards and Morse, 2007](#)).

Study area

The aim of site selection was to include two areas where Hendra virus cases in horses have occurred that differed in terms of case year and state jurisdiction. Two different equine infection 'hot spots' were purposively chosen, assuming that horse owners in these areas are more likely to have been engaged in HeV events and therefore constitute 'information-rich cases', which are ideal for qualitative in-depth studies ([Patton, 2002](#)). Since research on risk perception shows that not only the hazard in itself, but also characteristics ascribed to the hazard and other factors such as personal memories play an important role ([Slovic, 1987](#), [Sandmann, 2012](#)), emphasis was placed on areas where multiple Hendra incidents in horses or even human cases occurred. In addition, the risk of HeV transmission from horses to humans is high in equine infection hot spots and therefore risk mitigation practices are of particular importance in these areas.

The first step involved compiling a complete list of postcodes and corresponding case years based on all known HeV incidents ([Queensland Government, 2015](#)). These postcodes were then mapped according to year; cases in neighbouring postcode areas were grouped together. From this list two sites were selected: Site one was located in Northern NSW and included three postcodes: 2477, 2478, and 2480, which form a continuous area (Figure 21-A). In 2011, five equine HeV cases were detected in this area, as well as a recent equine HeV case in September 2015. Additional HeV incidents occurred in close proximity in 2006 (one horse in Murwillumbah), 2011 (two horses in Mullumbimby), 2014 (one horse in Murwillumbah), and 2015 respectively (one horse in Murwillumbah). Site two was located in Central QLD and included the postcodes 4700, 4701, and 4702 forming one area (Figure 21-B). In 2009, four equine cases as well as one fatal human case occurred in this area and in 2012

another four equine HeV cases were detected. Furthermore, one equine HeV case occurred in relative proximity in Gladstone in 2014.



A. Field site area in NSW.

B. Field site area QLD.

Figure 21. Field site areas in NSW (A) and QLD (B).

Data collection

A non-probabilistic, people focused, purposive sampling approach targeting information-rich individuals with a maximum variation ([Patton, 2002](#)) was applied. This qualitative sampling method is directed by a desire to capture all variations of a central theme and to identify common patterns. Eligible participants were linked by their experience as horse care providers (horse owners and/or those who provided regular care for any number of horses) in one of the two sites selected and were 18 years of age or older at the time the interviews were conducted (September to October 2014). Potential participants were identified in the HHALTER project database by searching for site postcodes. They were then sent an email containing a brief description of the research project and its format and asked if they were willing to participate. To identify additional participants, an initial scoping visit was made to the two sites in August 2014 to network with the community of people involved with horses in each of the two sites. Activities included contacting horse industry associations, private equine veterinarians, commercial horse operations, and the district veterinarians responsible for managing infectious disease outbreaks for the state government in each of the sites. Possible participants were either indirectly approached by a contact made in the horse community or directly by the research team, given a brief description of the research project and its format and asked if they were willing to participate.

In qualitative research data saturation is defined as the point during data collection, when there are no new information or themes emerging from subsequent interviews, and when the categories, themes and relationships among them are thoroughly described ([Bowen, 2008](#)). In similar studies six in-depth interviews usually allow for data saturation, while when twelve in-depth interviews are performed data saturation is almost always attained ([Guest et al., 2006](#)). Therefore, possible participants were characterized by age, sex, number of horses owned/cared for, horse industry sector involvement, years of involvement in the horse industry, and uptake of HeV vaccination for their horses. Twelve of the possible participants from each site were then purposively selected to participate in the interview process with the aim to construct a group of participants with maximum demographic variation in the characteristics listed previously.

Selected participants were contacted to schedule a time for their interview. An in-depth interview was conducted at the participant's location of choice; often this was at the property where the participant

kept the horse(s) under their care, but also public spaces such as libraries, community centres, and club houses were used. Prior to the interview, each participant reviewed and signed a consent form.

Participants were asked at the beginning of the interview to confirm orally that they had signed the consent form. A semi-structured format consisting of a series of nine mostly open-ended key questions was used covering three major areas (1) experience with and awareness of HeV, (2) risk perception of HeV and resulting response behaviour, and (3) communication pathways around HeV (Table 6). An initial set of follow-up probes was drafted to delve into participants' individual responses. The developed interview guide was pretested during the scoping visits and updated according to comments received. The key questions remained the same for all interviews although there were occasional difference in the ordering of questions to aid the flow of the conversation. All interviews were recorded using digital audio recorders. After each interview the audio file was downloaded onto a password-protected laptop and reviewed to ensure the interview had been recorded in its entirety. Audio files were reviewed between interviews where possible to inform probes used in subsequent interviews and to allow interviews early in the research process to inform those that came later.

Table 6. Topics and key questions covered during in-depth interviews

<i>Topics</i>	Key questions
<i>Experiences with Hendra virus</i>	<p>Can you tell me a little bit about your experience with Hendra virus since it first appeared in Australia?</p> <p>What do you think about the government's response to Hendra virus?</p> <p>What do you think about the horse industry's response to Hendra virus?</p>
<i>Perception of Hendra virus</i>	<p>Tell me about what Hendra virus represents to you today. What does it mean to you?</p> <p>Do you give Hendra virus much consideration when you are around your horses?</p> <p>Have you taken any actions in hope of reducing the chance of your horses getting Hendra virus?</p>
<i>Communication around Hendra virus</i>	<p>Can you tell me a little bit about ways in which you have learned about Hendra virus?</p> <p>Do you think that any knowledge you have gained about Hendra virus has changed the way you manage your horses?</p> <p>Is Hendra virus something about which you continue to seek information?</p>

Data analysis

Interviews were transcribed *verbatim* from the audio recordings by a professional transcription service at the end of the interview data collection period. Personal identifiers were removed from the transcribed files to ensure participants' responses remained anonymous. All transcripts as well as additional data accumulated (field notes, reflective journal) were imported into NVivo (version 10 for Windows, QRS International). Descriptive analysis was used to summarize the characteristics of the study participants. Thematic analysis was performed in NVivo using *verbatim* interview transcripts. This involved reading through all transcripts to get a sense of the data and to develop the initial code followed by an iterative process of data coding and revisiting earlier coded transcripts for comparison by two researchers independently. In thematic analysis, concepts are basic units of analysis whose central meaning is described in a short statement, referred to as a code. These were grouped into categories that shared common features. Similarly, categories were organized around themes, which is a way of linking underlying meanings. Emerging themes and patterns were analysed and are presented here. All data presented in the results section reflect the observations, insights, and opinions expressed by participants.

Results

Twenty-four face-to-face interviews were conducted with a total of 27 respondents across the two study sites. Interviewees covered a wide range of demographic characteristics (Table 7) and were involved in various sectors of the horse industry, mainly recreational riding/pony club (n=8) or commercial enterprises (n=8) such as riding schools, veterinary/equine health services, and equine outfitters. Overall, interviewees were highly engaged in their respective horse sector and demonstrated a long experience with handling of horses (median of years cared for horse: 40, range: 8 to 78 years).

Table 7. Demographic characteristics of interviewees.

Demographics	N (%)
Gender	
female	16 (59.3)
male	11 (40.7)
Age	
<25	1 (3.7)
25-64	22 (81.5)
>64	4 (14.8)
Location	
NSW	12 (44.4)
QLD	15 (55.6)
Main horse industry sector	
recreational	8 (29.6)
racing	2 (7.4)
competitive	3 (11.1)
breeding	2 (7.4)
stable/agistment	2 (7.4)
commercial	8 (29.6)
work/farm	2 (7.4)
Number of horses owned	
0-2	2 (7.4)
3-4	7 (25.9)
5-8	8 (29.6)
>8	10 (37)
Years cared for horses	
<25	5 (18.5)
25-64	21 (77.8)
>64	1 (3.7)
Horses vaccinated against HeV	
none	8 (29.6)
yes, some	4 (14.8)
yes, all	15 (55.6)

Emerging themes

Interviews lasted on average 50 minutes (length range 29 to 78 minutes) and revealed several insights which are summarised and illustrated by quotes of interviewees in the following paragraphs.

HeV experience and awareness

All interviewees linked their first awareness of Hendra virus more or less detailed to either the first reported outbreak in 1994 in the Brisbane suburb of Hendra, or to one of other three outbreaks comprising fatal human cases.

“I'd heard of old Vic Rail, went down with it up there in Queensland. I reckon we've been living with the bloody thing for 200 years. Generally if an old horse died, you dragged him up the paddock, pushed him over the bank - and the dogs and the foxes cleaned him up. End of story. Unless they started testing, when they found out what they had. How would they call it? They wanted to find out what killed old Vic. It happened at Hendra racecourse, so they called it Hendra virus.”

Nevertheless, it became also clear that awareness increased the closer to their horse property HeV cases occurred.

“Well, I suppose my first awareness was when we started hearing about the death of the vet in Queensland. That was a few years ago. But then, when it came closer to home and there were about six horses in this area, perhaps. That filled me with a lot of fear.”

Personal experience with HeV differed among interviewed horse owners; many had no experience whatsoever, meaning that they had not been involved in dealing with either a suspected or confirmed equine HeV case.

“I would say, very little first-hand. I've not had seen or been involved with any sort of infectious cases. And it's starting to become fairly overwhelmed by the industry - in all the disciplines at the moment. And it's a bit of a-- we're all wondering where it's going to go, how far it's going to go. Or, what restrictions might be yet to be put in place, just waiting, [...] -- wait and see game, I think.”

Other horse owners reported on experiences made during suspected HeV infections of their horses.

“He showed some funny symptoms, like colic, but.... So the vet came and took his temp, and then had to say to me, ‘I have to consider Hendra.’ And I thought, ‘Why didn't I think of that?’ You know, I've been hugging this horse and fussing all over it. The vet went, gowned up, took blood samples, and said-- that was in the morning and said, ‘If it's not Hendra, he'll be showing signs of improving. But if he's no better this afternoon, things are grim. And it'll take a few days to get the results.’ I then experienced huge anxiety about-- on one hand, I was like, ‘Oh.’ He actually improved within a fairly short time of the vet leaving. Yeah, but it was... The fear was there until I got the actual response back. Then all the things-- because I didn't think clearly, put myself in jeopardy and the whole family.”

Some horse owners had been involved in HeV cases and were able to narrate incidents and their feelings encountered during this time.

“It was just devastating. It all was quite surreal, too, you know, the horse just appeared to be a bit lethargic in the morning-- and I didn't take much notice. I just thought it was a bellyache or something. And it just progressed very, very quickly, until 1:00 o'clock in the morning. It was at that stage where something had to be done to put him out of his misery. [...] And then, when it came back positive, we just sat with our own thoughts and head in our hands - so to speak - and just thinking, ‘What have we done?’ Anyway, [the government veterinarian] said, ‘I think you better get to the doctor - just get a check, and have some blood tests’.”

They not only had to deal with the suffering and loss of the affected horses, but also with the fear of being infected themselves as well as with public stigmatization within their communities.

“I cut my whole hair off, because I couldn't stand, like I couldn't go to restaurants. I stayed out of the media as much as I could, and yet people were just staring at you like you were dirty, you couldn't cough anywhere. They all thought they were going to catch it.”

Risk perception and mitigation processes

Hendra virus risk perception varied amongst horse owners, mainly influenced by awareness of and proximity to local cases, knowledge, personal experience, and observation of flying foxes (*Pteropus* spp.) on or nearby the horse property. Some interviewees perceived their horses and/or themselves at risk and expressed fear and concern.

“Well, when it very first occurred and that vet died in Queensland, it was far away and not to worry about. It crept closer and it happened more often and we did have a Hendra virus [case] down the road, which was a big shock then suddenly, ‘Oops!’ you know.”

“The outbreak, and even the people I work with said, ‘That’s too close to home. It’s just too close.’ When you hear of things happening in Brisbane and further away, you think, ‘Oh, it’s not here. It’s not close.’ But there was the first one in [place] and then the next one was at [place]. And that sort of area is not far, it’s not too many kilometres apart. And we were aware that bats were in our trees at that time. Then they finally came out and sort of, said it was the bats. That was the scary part.”

“I think I’m a high risk, definitely. Like I said, there are 2,000 [flying foxes] coming and going every day. They grab oranges and stuff and they drop them somewhere on the way. So I do find fruit which they drop. And so I think I’m quite a high risk candidate, my horses and that includes me, I guess, and my kids and everyone. So I’m grateful for the vaccine. Really are.”

Other horse owners expressed less concern and perceived the risk as overstated.

“I’m not overly concerned at the moment. We haven’t had any cases in [place] that I’m aware of. If cases were popping up locally, then I’d be a lot more concerned.”

“I guess you could say it’s just a concern. But for me, personally, at this moment in time, I don’t see it as a huge risk. I’m not panicking. I’m not going, ‘This is epic proportions.’ I’m kind of going, ‘There’s a chance here of something being a problem.’ But I’m not battenning down the hatches; I’m carry on as I am usually. I’m in work and employment. I’m carrying on in the industry. I don’t see it affecting me enough long term to think, ‘I better get out of this industry.’”

“At this stage, no person who owned a horse, except the initial person – but he obviously intervened – but no other person has caught the Hendra off a horse, a dog, or any other form, except vets that intervened or the original owner that intervened. There is no evidence at this stage that just caring, riding, general care, general visitors will contract it. And even though the vets say that the dogs carry it, no one’s ever caught it off a dog either. I think there need to be more investigation before they overreact.”

A few owners used a risk analysis approach taking the likelihood and consequences of a Hendra virus infection into account. However, the conclusions drawn differed depending on whether emphasis was placed on the severe consequences or rather on the low likelihood.

“Even if you rate the risk as rare, unlikely, or even, possible - the risk is deemed high, because the consequences are catastrophic. The consequences of contracting the Hendra disease will be catastrophic or extreme.”

“I guess if you say Hendra, you suddenly get frightened because I know someone who’s died from it. So, but you have to measure that with how difficult is it to catch. [...] just to be a bit more aware, but I definitely don’t think that much about it. But it is something that you-- it’s in the back of your mind.”

In order to put the risk in perspective interviewees used comparisons between HeV and other diseases. During September and October 2014 – while the interviews were conducted – the Ebola outbreak in West Africa made prominent headlines and interviewees linked it to their HeV situation.

“Because it's a disease which can take a week or two to come up in the horse before it shows symptoms, it's still scary. Even my horses are vaccinated, it still, for me, it feels like a threat, probably like Ebola or something. Still far away, but it could hit you any time.”

“It was very, very scary in the sense of like the Ebola that's around now. It is something that if it gets let loose, that's it. It's going to destroy not only horses but humans as well.”

Interestingly, HeV risk and observed responses were also compared to the Australian equine influenza outbreak in 2007/2008, which impacted directly on some interviewees.

“When the equine flu hit a few years ago [...] the vet came, he had to gown up and that. To my understanding, it was highly contagious horse-to-horse, but not horse-to-human. But we were closed from August to February, which meant we had no income. A lot of people suffered much worse [...]. And then, when Hendra came - which is such a risk to humans, you know - life went on. We just kept working. It just struck me as-- there was such a reaction to it, the equine flu.”

All interviewees were aware of recommended risk mitigation strategies and changes required taking HeV into account.

“Horse people have never had to worry about that before, and I think that's a cultural shift that has to be made, that there are certain things you do and don't do with your horses now.”

Another interviewee hinted that such a cultural shift might already have been triggered by the equine influenza outbreak.

“Probably just taking that bit of precaution and because I think too, the year before we had equine influenza which shut us down for eight months. So I guess things started to make you more aware of having a bit more of a biosecurity on your property. Not going too over the top type stuff, because we didn't have equine influenza in this area, but we were locked down for eight months, or ten months, whatever it was.”

The threshold at which an owner considered it important to implement risk mitigation measures, however, differed between individuals and was largely dependent on their risk perception. Owners described several types of behaviours ranging from being more vigilant, over changes made to their property and horse management, to increased personal infection control practices.

“Horses are stabled at dusk, water troughs are covered, and, yeah, not much of a chance. They're let out in the morning by half past seven, eight o'clock. The sun's been on the virus and dried it up pretty much by then.”

“We stable all of our horses, so a lot of the things that they've recommended are already done on this property. We don't put water under trees, we don't feed under trees, most of our good horses are boxed at night. We never-- we try not to allow our paddocks to get too low so they will scavenge unnecessarily for bits of fruit. Our fruit trees are not near our paddocks, so we feel that our property is sort of run accordingly.”

“I've gone ahead and gotten rid of most of the fruit trees on my property, just to cut down the risk of fruit bats entering the area. Not that you can stop them, but you've got to do something to try and prevent it.”

“If any new horses come on to the place, I always keep them separate until I know that they're healthy - they're not carrying anything. I don't mix them with my horses. Keep them separate. Any animals that come here, like dogs, I like to know where they've come from, what they've done, where they've been. So that's about all you can do is try and protect yourself like that.”

“If we get anything that even remotely looks sick now, we isolate them straight up, and do respiratory, heart rate, capillary, everything. We've got Hendra kits in every shed; it's just a basic: gloves, mask, thermometer, stethoscope. Definitely would not have done that two years ago.”

“Look, I think you tend to wash your hands more, too, than what I used to. Because I still feed them every night during winter - twice a day - and I ride them. [...]. I'm quite involved with them, but I'm a lot more aware of washing my hands afterwards. So I suppose in that regard, that's absolutely changed a little bit.”

Attitudes towards HeV vaccination – recommended as the most effective way of reducing the risk of HeV infections in horses – were largely polarised. Owners, who had their horses vaccinated, described it positively as ‘a relief to have’ and ‘the right thing to do’ and also reported that they felt a moral obligation to vaccinate their horses.

“The vaccination made me feel better, definitely, even though there is no 100% guarantee it will protect us, but it definitely gives you the feeling-- it feels a bit better, yes. It feels like, okay, they're vaccinated. We don't need to freak out now because they [flying foxes] are sitting up there in the tree.”

“I definitely see a change in myself because you are talking to someone who at first went, ‘No, I'm not going to vaccinate. It'll be all right.’ But thinking about it now, I can't just put people's lives at risk. Realising I wasn't that-- I mean I'm concerned about my horses and I love my horses, but if they became really, really sick, I would have no hesitation to having them put down. But, it's not in my control for them to pass-- if they got it, to pass the virus onto another human outside my control. I can decide to put my own life at risk, but I can't decide to put my vet's life at risk or my children's life at risk or things like that.”

“I wouldn't risk my kids getting it so it probably comes down to a moral decision on you as a person.”

On the other hand resentment and mistrust against the HeV vaccine was largely driven by factors such as safety and efficacy concerns, cost, booster schedules, and compulsory horse vaccination for attendance of some events.

“I haven't vaccinated yet because I don't know enough people that have done it, and I haven't heard enough research into warranting exactly what the vaccine does, because I know, well from what I've heard, it's still in its trial stage as it is.”

“If you vaccinate against it, are you sure you're not going to get it anyway? I mean is it 100%? See, I don't know that.”

“Well, whenever you're vaccinating racehorses for certain things it can set them back and make them very sick. If that was the case, I wouldn't appreciate vaccinating my horses. It's hard enough to win races as it is, let alone with a sick one.”

“And I think yes, if you only got one horse you probably swallow, you put it in the trailer and drive it out to the vet. So it's a bit cheaper to, you know, you look at probably \$100 or whatever it is. But you time that multiple for each horse, and then it becomes critical. It's probably-- for people, who got a lot of horses, it is critical, yeah the costs. And you still look at every six months to keep it up.”

“The other problem is, if we're competing - and that's what Equestrian Australia is about - then it is very restricted because unless the horses are Hendraed, we won't be able to compete. Not in this area, not in Queensland, and so a lot of people aren't going to come into the sport. They are not going to bring their young horses in. And to make matters worse, the good horses from Sydney aren't going to come near us, because they're going to have to be Hendraed. What's going to happen to the horses in Victoria or West Australia? It doesn't affect them at all. So it's an overreaction.”

“I think if you do that, you turn into a criminal in not vaccinating your horse or something; I think it would be too much. I think if something happens, you've only got yourself to blame. I don't think they should do that. No. It would take the freedom of choice, wouldn't it?”

Ultimately, for many owners these concerns and issues resulted in the decision to rather accept the risk and/or to rely on other risk mitigation strategies than to vaccinate their horses.

“I don't really know, I guess you should vaccinate, but you know, we don't, because I think we - you know, I guess I'm prepared to take a chance on it.”

Interviewees, who had their horses vaccinated, showed that they considered the same factors when making their vaccination decision, but attached a different importance to these factors and consequently reached a different conclusion.

“There's the risk, so the risk of the stallion becoming sterile or the mare not going in foal so easily and things like that might be one in a million, like one in a million kids get adverse reaction from a vaccination as well, so yeah, you've got to put that into perspective as well. Some people only pick on the negatives of things, and don't take in the positives.”

“Considering the high consequences of contracting Hendra, I don't regard it as-- owning horses is expensive, if you're kind of not prepared to do what's necessary, perhaps you shouldn't have them. Compared to other things that consume your money with horses: dentistry, farriers, tack, it's not that much money. It's just a shame that you've got to treat it all at once.”

“I find it frustrating that people seem to think it's so expensive. I mean it would be good if it was only once a year instead of once every six months, it can get expensive, but it just seems to me that people need to be doing a better assessment of what the alternatives are, like if you don't vaccinate and your horse gets sick and your kids get sick, or your business goes downhill because you've got your property quarantined for six weeks or something and you can't earn income.”

“I would love it to be two-year, would love it to be 12-month, but it's not, and there's no point whinging about it. I imagine in time it will become a 12-month. I'd like the booster to be self-administered, but then how do you do that? People will just say they've done it.”

Communication around HeV

Horse owners utilized different communication pathways in regard to HeV information. Many interviewees reported that media reports on new equine cases – either in radio, local newspapers, or television – triggered their awareness and interest.

“Normally, when there's a Hendra outbreak it's all over everything. We don't really follow the mainstream media, it doesn't interest me much, but it lets us know if there's been an outbreak, then we go and find out what we can.”

Interviewees also indicated that media interest and consequently their awareness has declined.

“I'm aware that my vigilance has certainly dropped off since we stopped having cases reported all the time, and then it's dropped off even more since we've had the vaccine, so I'm not clear how much of a risk it still is if your horses are actually vaccinated.”

Other frequently mentioned information sources included the Internet, social media, as well as word of mouth.

“And then, I started looking on the internet. Now, I don't remember exactly where I looked. I know there are a few sites out there. I think I would have gone on the DPI site at one stage. There's a couple of other private websites that had information. There's supposed to be video footage of a horse up north as it was dying, that sort of stuff. I was looking on some of those webpages to try and get some basic information.”

“It'd be the web - World Wide Web. I just google. I'm pretty good at doing research. Just, if you want to know, you can find out. You look at the correct sources - university sources, medical sources, veterinary sources.”

“Just on rally days we talked about it and then talked about with other clubs, like on the gymkhana. You just talked with other clubs and their members and all that. More verbal than anything else.”

Out of all the different HeV communication pathways veterinarians seem to play a central role. They are a trusted and readily available source of information for horse owners.

“We have the vets out every few months for something, so we can always ask them questions about the Hendra as well. They have been very forthcoming with any information they have. So-- they're vets, so I suppose we trust them.”

“I think the issue needs to be dealt with by professionals, and that being the vets. I think their responsibility is primarily health of horses, and I think that's where it needs to stay.”

Nevertheless, discussions around veterinarians not attending unvaccinated horses raised some animal welfare concern and might actually damage the client relationship to horse owners.

“I guess there are ways to cover things, aren't there? Like the doctor who needs to do an operation on you and he knows you're not injected for Hendra, is he going to say ‘Oh no, you can die, I'm not operating on you!’? And they wouldn't do that. Only because they can take precautions, can't they? They can cover themselves up completely. I guess that's where a lot of horse people have always had such a trust and a bond with their vets. We always trust our vets totally. And now it almost seems like we are losing a little bit of a trust relationship there with our vet. But we're not sure if the vet's hands are tied because the company's tying them up in that, or what is it? I don't know.”

Discussion and Conclusion

In depth-interviews are valuable tools for comprehensively exploring personal perspectives on a particular situation with a small number of respondents. By investigating perceptions, attitudes, and lay beliefs of horse owners in regard to HeV we were able to elucidate their HeV risk perception processes and resulting behaviour and to illustrate the value of undertaking qualitative research ([Christley and Perkins, 2010](#)).

The theoretical model (Figure 22) shows an overview of perceived benefits and barriers to the uptake of HeV risk mitigation strategies as well as modifying factors influencing risk, benefit and barrier perception mentioned by horse owners. Perceived barriers and benefits were arranged in order of importance; the ones listed on the left hand side refer to HeV vaccine, whereas the ones on the right hand side allude to property and horse management strategies such as covering feed and water, keeping horses away from trees which might attract flying foxes, or isolating sick horses.

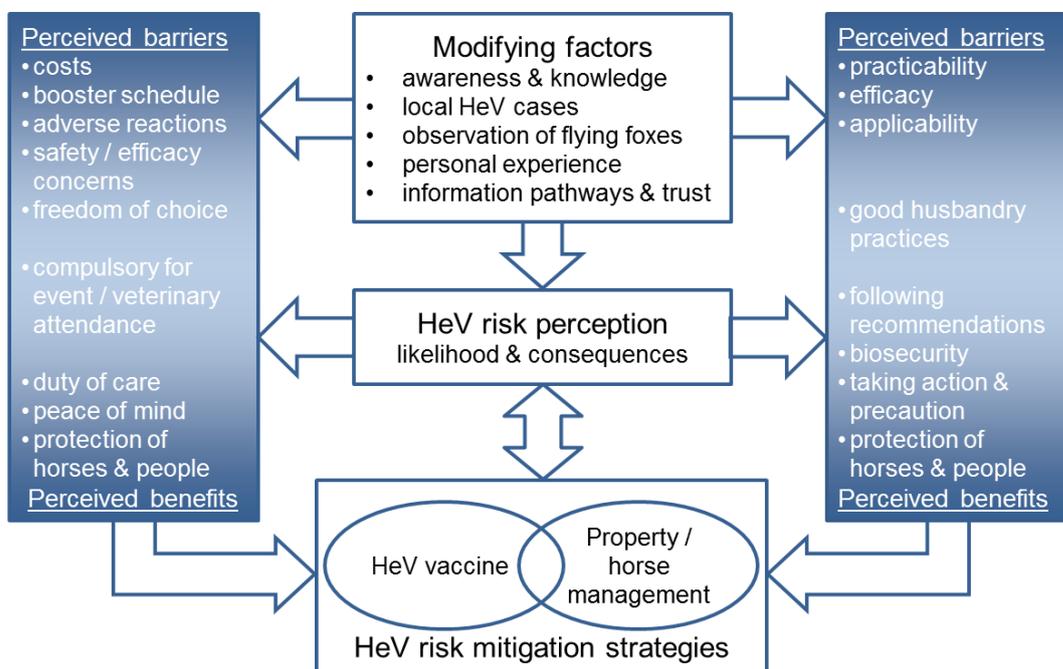


Figure 22. Theoretical model of horse owners' approaches to Hendra virus (HeV) risk and mitigation practices.

Following the tenet of rational decision making, which underlies most models of health behaviour, horse owners base their decision mainly on weighing up benefits and barriers of risk mitigation strategies in the light of their personal situation and risk assessment of HeV. Owners reported a range of objective and subjective assessments they use in determining HeV risk of their horses and themselves, many taking the likelihood and consequences of a potential HeV case into account. Results suggest that the assessment is largely influenced by knowledge of local HeV cases and disease transmission pathways as well as personal observation of flying foxes on or nearby the horse property. Furthermore, different assessments seem to result in a diverging uptake of risk mitigation strategies.

Generally interviewees indicated a good knowledge of recommended risk mitigation strategies. All owners mentioned measures like covering feed and water, keeping water and feed away from trees as well as keeping horses away from trees or cutting trees down which might attract flying foxes.

Nevertheless, not all owners actually implement these measures on their horse property, either due to impracticability (e.g. having dams instead of water troughs), perceived inefficacy, or a perceived external locus of control (Strudler Wallston and Wallston, 1978). Attitudes towards the HeV vaccine were largely polarised. The majority of interviewees had vaccinated all or some of their horses, or thought about vaccination in the near future, but a few owners adamantly refused vaccination driven by factors such as safety and efficacy concerns, cost, booster schedules, and regulations or policies around mandating vaccination. Although expressed by a minority in this study, these issues and concerns are likely to be representative of resentments of horse owners in general against the HeV vaccine and should be addressed in communication and information material.

Owners' knowledge and information of HeV was assimilated from many sources. While government websites like NSW DPI and QDAFF were often named as trusted information sources, social media and word of mouth also seem to have some influence, which could potentially lend a strong voice to a small group of people. In contrast to a qualitative study of pony club members in Australia where veterinarians were mainly mentioned in a negative context ([Buckley et al., 2004](#)), interviewees here reported that they primarily seek opinions of professionals in regard to HeV and that their veterinarians are a valuable and trusted source of information. Hence veterinarians seem to play an important role in HeV communication pathways and although research suggests that they are by now better prepared to manage HeV ([Mendez et al., 2014](#)) their continuing professional education is fundamental to ensure effective risk management communications.

Our analyses suggest that awareness of HeV amongst horse owners is high. Awareness seems to be mainly triggered by attention directed towards fatal human HeV cases and media reports of current equine cases in local proximity. This finding is supported by other work on risk awareness showing that public perception is affected by severe outcomes (e.g. human deaths) and memorability (e.g. news and personal experiences) (Sandmann, 2012). However, it is important to note that horse owners interviewed here are living in high risk areas, are highly involved in their respective horse industry sector and more than 50% have cared for horses for over 40 years. Consequently, their HeV awareness is likely to be higher than average.

Our findings demonstrate the multifactorial determinants of behavioural processes and facilitate a better understanding of horse owners' decision-making around HeV risk mitigation and influencing factors. They help to assess the usefulness of HeV related messages to horse owners and how these communication and engagement strategies have impacted on their risk perception and the implementation of risk mitigation measures. Thereby, this research provides valuable feedback to authorities on effective communication strategies with horse owners that could result in positive changes in horse owner uptake of risk mitigation practices and perceptions of trust and confidence in government agencies.

Implications and Recommendations

The dynamic nature of Hendra virus risk

The HHALTER study was designed to identify, explore, and track over time factors that influence horse owner Hendra virus (HeV) risk mitigation practices, such as property management practices, uptake of vaccination for horses, and biosecurity practices. From the project outset it was acknowledged that the perception of HeV as a risk is a dynamic process, embedded in a complex socio-political context. The study methodology was designed to be flexible to enable it to stay coupled to this changing landscape.

A month before data collection began a vaccine was released for use in horses and this dramatically altered the risk environment. In simple terms it provided an additional risk mitigation strategy for horse owners and it influenced the HHALTER study focus. Just as the release of the HeV vaccine influenced the context of HeV risk, intervening events that occurred during the study (see Figure 2), also impacted horse owner perceptions and attitudes towards HeV risk and risk mitigation.

Subsequent to the completion of data collection (Nov 2014 – Jan 2015) there have continued to be significant events that alter the HeV risk context, most notably full vaccine registration (Aug 2015), release of the APVMA summary of adverse experience reports of the vaccine (Aug 2015), actions by Workplace Health and Safety Queensland (WHSQ) to prosecute three veterinarians for their handling of HeV cases (Sept 2015), and an increasing shift by some veterinary practices to enforce a policy of refusing to treat unvaccinated horses.

Although these 2015 events have occurred after HHALTER study data collection it is not possible to overlook or ignore them in the context of project recommendations, as they are currently contributing to HeV risk dynamics and the context within which the study implications and recommendations must be considered.

In terms of the implications and recommendations section that follows, it should be born in mind that the HHALTER project focussed on the knowledge, perceptions and practices of horse owners and reflects their views of the HeV risk context and risk mitigation options, not those of government, industry, the veterinary profession or the organisations employing the project team members.

The main HHALTER survey data show trends in some areas that are noted in the results and discussion section, the implications and recommendations section is directed to some of the broader findings, mindful of the current HeV context, and areas that have been highlighted by the team as either current or potential problem areas or opportunities for improvement. In addition, we suggest that the HHALTER sample is likely to be a more engaged and possibly a ‘best case’ group within the horse owning population in the context of HeV risk and risk mitigation. As such, the recommendations should be aimed not at this group as a whole but at those among this group that are not adopting practices and those who did not participate in the study that share similar concerns/characteristics that are impeding adoption

Reduced Hendra virus risk perception

Fundamental to the consideration of risk mitigation practice uptake is the perception of risk. Core question data collected in the HHALTER surveys indicate that although the perceived probability of HeV infection has not shifted over time there has been a marked decrease in concern about the risk of HeV to horses and to self/family, a decrease in concern over HeV as a priority horse health issue, an increase in sense of control over the risk of HeV to horses, and an increase in self-reported knowledge of HeV. Overall, this combination of findings appears positive. Greater agency, lower anxiety, and a

more measured response to a very low probability event are likely to be more conducive to balanced dialogue and a less reactive response. It is likely that vaccine availability along with a steady low incidence of HeV infection since the supercluster of HeV incidents in 2011 have enabled this reduction in HeV risk perception.

Separately, statistical analyses of HHALTER data have linked higher levels of HeV risk perception to increased uptake of HeV risk mitigation practices and behaviours, such as early vaccine uptake, longer term vaccination uptake, better biosecurity practices, and increased likelihood of regarding flying foxes as a health threat to horses.

Although it is difficult to argue against a case for a more measured horse owner view of HeV risk our data suggest that horse owners are conducting their own cost-benefit analyses with regard to vaccination. They are weighing up their own view of their horses' risk of HeV against the costs of the vaccination (e.g. financial, safety, convenience). If the perceived risk of infection is low the costs of the vaccination also need to be low to maintain/justify uptake. Horse owners' persistent concerns about vaccine safety, mixed views of its effectiveness, and the requirement for 6-monthly boosters (especially with expectation of annual boosters) all load onto vaccination 'costs'. Data from the last HHALTER survey suggest that vaccination uptake in this sample has peaked and there is a clear suggestion that more horse owners are delaying vaccine boosters and/or withdrawing from the recommended vaccination regime.

In addition to the link between lower levels of HeV risk perception and lower uptake of risk mitigation practices it is also likely that low HeV risk perception will be associated with decreased interest in this subject and greater difficulty in engaging horse owners in general dialogue or guidance about this risk.

Recommendations

- The general reduction in horse owners' HeV risk perception and an increasing sense of control of the risk and greater knowledge of HeV call for a more nuanced and balanced dialogue by stakeholders. Perceptions of veterinarians and horse associations 'talking-up' the risks to encourage vaccination when horse owners' risk perceptions are reducing, can lead to the 'official response'/'expert advice' appearing out of step and exaggerated – leading to scepticism, mistrust, a loss of credibility, and accusations of 'scaremongering'. It is recommended that this trend in horse owner sentiment be discussed and acknowledged and that HeV risk communication is reviewed accordingly. It is important that verbal communication, as well as written text, is considered.

Poor uptake of recommended property management practices

HHALTER data indicated that uptake of recommended property management practices was generally low, around 20%, and did not change during the course of the study. Issues around the ease of performing these practices and their perceived effectiveness were noted. With regard to the implications of these findings; if only 20% of horse owners are instigating these practices that leaves a large proportion still exposed to risk (especially with poor vaccination uptake).

Recommendations

- More needs to be done to encourage uptake of these practices. Guidance/podcasts/videos of short cuts, 'how to', and low cost suggestions could be promoted to help to overcome perceptions that this is too hard, too expensive, too impractical, not effective.
- In a climate of decreasing HeV risk perception and potentially less interest in HeV as a horse health concern it is important to consider additional ways to encourage uptake of these practices and biosecurity generally. Reframing the benefits, reviewing and possibly extending

the guidance, and turning the focus away from HeV risk specifically may open up additional avenues for engagement and uptake. Biosecurity practice messages are relevant to more common diseases that have financial and horse health/welfare impacts across industry sectors e.g. Strangles, and therefore additional benefits could be gained through this expanded focus.

- Concerns about the effectiveness of recommended property management and biosecurity practices could be more easily addressed if there was better understanding of HeV transmission pathways. Therefore, we recommend that additional research in this area be considered to assist in addressing gaps in understanding and knowledge of HeV in areas that could influence the uptake of recommended practices, such as information around virus survival in water, the oral dose needed to infect a horse.

Poor uptake of vaccination

Having a vaccine available is not enough to guarantee uptake. As noted above, uptake of vaccination nationally by horse owners is poor, and for the HHALTER survey participants who have a moderate level of vaccination uptake there is evidence that it has peaked and a sizeable proportion of horse owners are delaying and/or withdrawing from the vaccination program. For the HHALTER participants, although HeV risk perception is a factor in this, there are a number of issues that have contributed related to the vaccine implementation, such as horse owner concerns about safety - adverse reactions, effectiveness, cost, over-vaccination, as well as unmet expectations around the booster regime, and the approaches used to mandate and compel vaccination.

Recommendations

- Horse owners need to be reassured about the safety of the vaccine. The passage of time and consequent collation of safety and efficacy data will probably result in greater acceptance of the vaccine, however this is a very long-term approach. It is important for all stakeholders to continue to be as open and honest and transparent about the vaccine as possible and to engage in the acknowledgement of horse owner concerns. Broad and top-down assertions of HeV risk and the need to vaccinate are unlikely to be persuasive and will not be perceived as relevant to individual horse owners' circumstances.
- The vaccine regime needs to be approved for annual boosters as soon as possible. Clearly this decision needs to be based on appropriate safety/efficacy data, but many horse owners have expected boosters to be required annually for some time (two years or more) the ongoing delays with this approval are leading to concerns about the costs and safety of multiple boosters, and in the context of reduce risk perception horse owners are deciding that the vaccine is not worth it. In addition these perceived delays are leading to some horse owners feeling that there are problems with the vaccine, and this is feeding a spiral of increasing mistrust in the authorities involved.
- In the context of horse owner concerns about safety, what is perceived to be an excessive and costly booster regime, and a low level of perceived risk to horses (and more so to people, given no human cases since 2009) it would be prudent to reconsider blanket measures to mandate or compel horse owners to vaccinate until these situations are resolved. The actions of horse associations and some veterinary practices to force vaccination are driving a ground swell of mistrust and are alienating horse owners and mobilising collective resistance to undermine the vaccine. Neutralising negativity and regaining trust are substantial challenges that will be costly to resolve in the future if allowed to continue unabated. This situation could also lead to poor or delayed engagement and cooperation in any future emergency animal disease situation.

- Given that results from the last HHALTER survey reflect a level of confusion about the efficacy of the vaccine to protect vaccinated horses it is recommended that communication about the results of vaccine trials is provided in language and modes that can be readily understood by a range of horse owners and other interested groups within the general population.

Veterinarians – a critical partner in HeV risk communication with horse owners

Throughout the HHALTER study there is evidence of the importance of veterinarians in the context of horse owner HeV risk perception and HeV risk mitigation practices. In our data contact with, and information from, veterinarians is linked to intentions to vaccinate and good biosecurity practices. For most horse owners the local veterinarian is their trusted source of information; the main source of information, the person who can correct misunderstandings, the person owners approach for advice and information, and the person they report their concerns to.

Although the main data in the HHALTER survey indicate that horse owners are broadly supportive of veterinarians and their practices there is evidence of tensions in the veterinarian – horse owner relationship caused by (lack of) uptake of the vaccine, miscommunication, and more recently changes in veterinary policy in some practices to refuse to treat unvaccinated horses which is leading to reports of animal suffering and acute owner distress.

Recommendations

- In the context of HeV and for future equine health management it is essential that relationships between veterinarians and horse owners are protected and preserved. Veterinarians are the best-placed people to understand and influence horse owners risk mitigation practices, behaviours and knowledge. Maintaining trust and credibility are critical to this relationship.
- Related to the point above, perceptions of impartiality, openness, and shared goals of equine health and wellbeing are important for all risk-related decision-making. Veterinarians are likely to be more effective in their role if they can engage with their horse owner clients to help them work through their approaches to risk mitigation in a collaborative way and in an advisory capacity. This collaborative decision-making approach is especially important when decisions contain elements of uncertainty or risk. In addition, this balanced position is difficult to maintain when there are competing pressures and real or perceived motives to pursue one risk mitigation option over another or to ‘tell’ clients what they must do to be able to receive veterinary treatment for their horses. The benefits of pursuing one path of action need to be carefully considered against the costs (potential harm) of doing so. There is a need for open discussion and broader public debate in this area to identify a balanced position regarding mandatory vaccination and veterinary policy.

As mentioned earlier and linked to the above point, HHALTER recommendations based on data collected at the end of 2014 cannot ignore the existing HeV context and policy environment. The recent announcement of the prosecution of three veterinarians by WHSQ over their handling of HeV cases appears to have potential for damaging consequences for the veterinarian – horse owner relationship and is insensitive to the complexities and fragility of the HeV risk mitigation debate.

Veterinarians are caught in a very difficult position in which the current situation regarding vaccination (as discussed above) is not resolved in the minds of many horse owners, and yet veterinarians risk prosecution if they expose themselves and others to HeV risk in their work. As the easiest way to ensure safety is by vaccination this is the preferred approach by many, the alternative is the use of personal protective equipment (PPE) which has a number of limitations and comes with additional safety risk for veterinarians. Given the complexity and the litigious nature of this situation

currently it is difficult to know how best to approach this, however, there is a clear need for an open discussion in this area.

- It is recommended that a safe context for ‘debate’ in this area is created and that avenues for clear communication to sectors of the horse industry are provided. It is recommended that the Animal Health Committee, the Australian Veterinary Association and the Equine Veterinarians Australia contribute as part of a guided debate that enables general consensus to be reached on risk mitigation messages and modes for communication of these messages. Specific institutions could be tasked with carrying out the communication strategy, and this will require dedicated funds and input from the communication/media experts in these organisations.
- Given concerns about deteriorating relationships between private veterinarians and horse owners, there is a clear role for government veterinarians to engage with industry sectors to provide a voice for biosecurity practices that is independent of vaccine income and the conflict with veterinarian safety. In high HeV risk communities horse health and welfare events or information sessions could be provided. Although these veterinarians represent government, HHALTER data suggest that participants considered information and communication from state departments of primary industries useful. Given the typically low levels of contact between horse owners and government veterinarians this approach would also help to build a profile for government veterinarians.

Appendices

Appendix 1. Vaccination-related supplementary data

As mentioned in Chapter 1 and listed in Table 3, during the course of the HHALTER project a number of supplementary subject areas were studied. Vaccination-related issues were a major focus due to a number of emerging issues arising over the course of the research period. Given the priority of vaccination as a risk mitigation solution for HeV we were keen to ensure that this report included some coverage of the more recent and relevant findings from the HHALTER research.

In this appendix we present data, mostly from S5 (Nov 2014) on

- Vaccination regime compliance
- Adverse reactions and reporting
- Pressure to vaccinate
- Implications of vaccination

At S5 60% of the sample had vaccinated. Therefore data in this section are from a subset of 354 horse owners. Uptake within the sample was 74% for those in QLD, 59% for those in NSW/ACT, 23% for those in VIC, and 12% for those in other states and territories.

Vaccination regime compliance

As shown earlier in Figure 9, most respondents in the full sample intended to give their vaccinated horses the 6-month booster and this stayed fairly constant over time. In the last HHALTER survey (S5) of those whose horses had been vaccinated in the preceding six-months 75% were intending to give all their horses the first 6-month booster and 20% intended to give some of their horses the booster. Only 1% had decided not to booster and 5% were unsure. Of those who had vaccinated earlier, and therefore had horses due for second or subsequent boosters at S5, only 65% intended to give the booster to all their horses and 20% to some of their horses. 13% had decided not to give the next booster and 3% were unsure.

In S5 (Nov 2014) we investigated those who had decided to delay or withdraw from the vaccination program. In response to the question ‘Have you delayed or withdrawn any of your horses from the Hendra virus vaccination program (e.g. not given your horses their booster dose within the required period)? 14% of respondents said ‘yes, all horses’, 14% said ‘yes, some horses’, and 73% said no. We then asked respondents to indicate the extent to which a number of potential factors influenced their decision. The response options presented were informed by social media discussions, prior survey responses, and preliminary information from the interviews undertaken as part of the HHALTER study. Figure A1.1 summarises the responses to this question.

Extent to which the following issues influenced decision to delay or withdraw from the vaccination program (n=86)

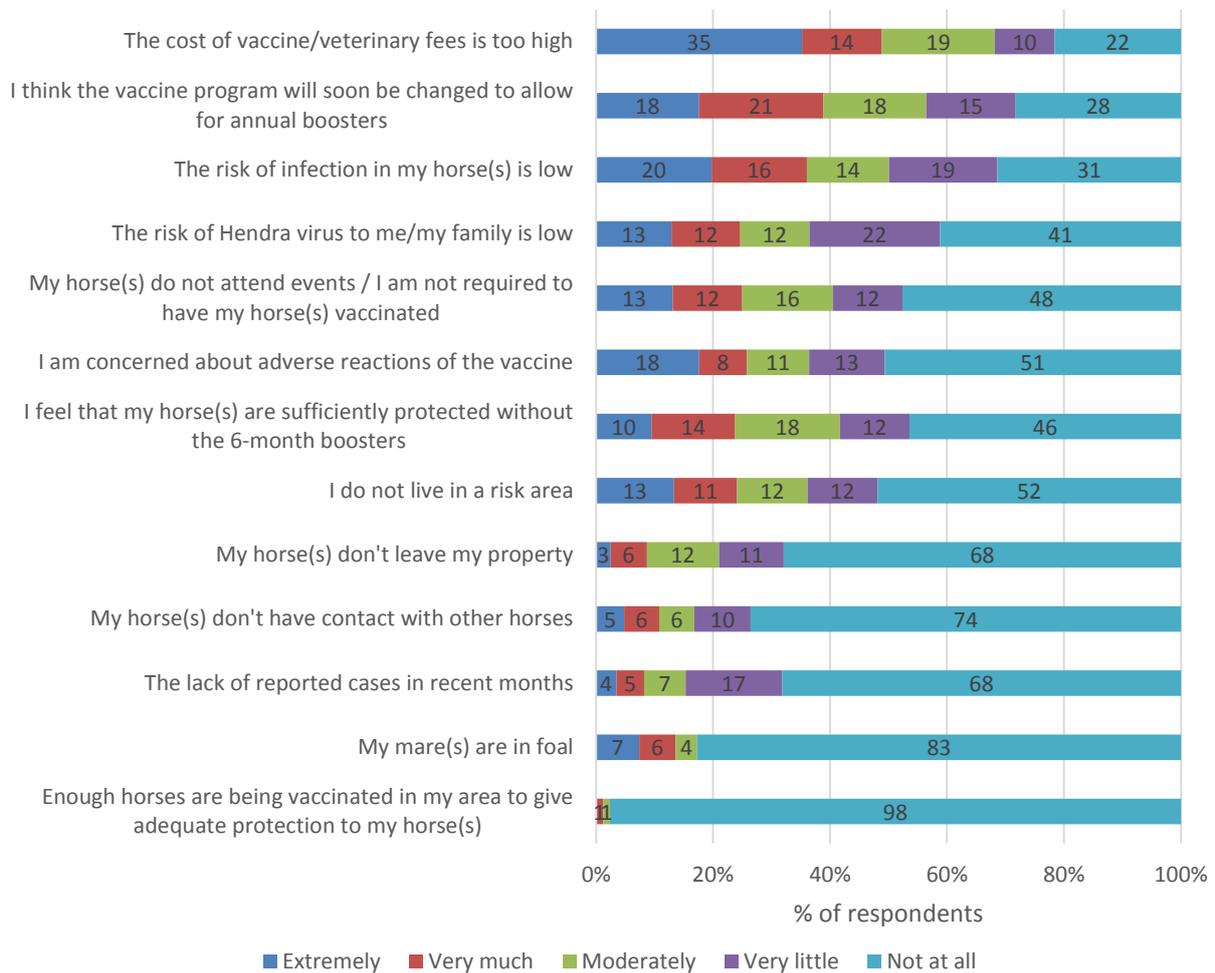


Figure A1.1. Decisions for delaying or withdrawing horses from the vaccination program.

Although data presented in Figure A1.1 are limited to the options provided to respondents, these results suggest that horse owners were weighing up costs and risks and moderating this with their expectations about the future booster regime and the necessity to vaccinate/involvement in events.

To explore issues further respondents were given the opportunity to comment about other factors that influenced their decision. Many made comments (n=42) although many also reiterated points covered in the given responses. Other reasons included delaying vaccination to get mares into foal, delaying due to health issues and circumstances that meant they felt vaccination was not a priority, e.g. horses not attending events, feeling they had received enough boosters, elderly horses. Some owners commented that they had consulted with their veterinarians and had decided together to take delaying action to draw out the booster regime.

Adverse reactions and reporting

During 2015, since S5 data collection, issues concerning adverse reactions to vaccination and horse owner concerns about this issue have led to extensive social media discussion, mainstream media coverage and tensions around mandating vaccination. A summary document issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA) detailing reported adverse events was

published mid-year (APVMA, 2015) and added further information into the ongoing debate around vaccination safety.

In the HHALTER project we asked horse owners about their experiences of perceived adverse events. A general question ‘Did you think any of your horses showed any adverse reactions to the Hendra virus vaccination?’ was asked in S2, S4 and S5.

In S2 (May 2013) when just over a quarter of the S2 sample had vaccinated their horses (n=199), 12% of respondents (n=23) reported that their horses had shown adverse reactions. In S4 (May 2014), when over half the S4 sample had vaccinated (n=342) 24% of respondents reported that their horses had shown adverse reactions (n=80). In S5 this proportion stayed the same at 24% (n=84).

In S4 and S5 we also asked respondents about the types of reactions they had seen and the severity of these reactions. Respondents were provided with a list of potential reactions, as before these were informed by reactions being discussed in social media discussions, comments from earlier surveys and interviews undertaken as part of the HHALTER study. Figure A1.2 summarises the responses from S5 (Nov 2014).

Respondents reporting adverse reactions to the vaccine: types of reaction and perceived severity (n=66)

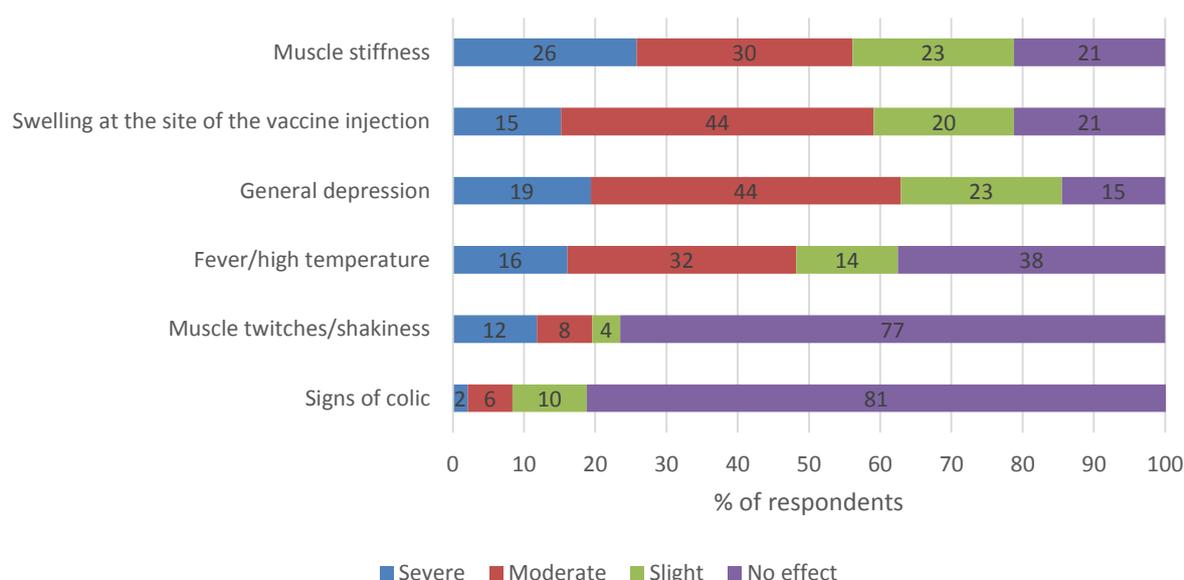


Figure A1.2. Types of adverse reactions noted by owners following vaccination and their perceived severity.

As can be seen from Figure A1.2 muscle stiffness, swelling, and general depression were reactions noted most frequently with 15-26% of those reporting adverse reactions feeling that these reactions were severe. Although there is no independent verification of these reactions or their severity available to the HHALTER project, the fact that owners perceived these reactions to be severe is highly likely to determine their subsequent acceptance of the vaccine for these specific horses.

Just over a third of respondents made additional comments (n=27), mostly these comments detailed additional reactions not listed in the question including, ataxia, nose bleed, laminitis, diarrhoea, hives, swollen legs, cough, white spots on coat, temperament changes, loss of growth, and problems putting head down. A small number of respondents (not included in the above listing) mentioned additional treatments given at the time of the vaccination, such as 2 in 1, dental work, sedation, or specific issues

about the horse, such as it being pregnant or sensitive, and most commented that they couldn't determine the cause of the reaction, i.e. not attributing the reaction to the HeV vaccine necessarily.

Comparing the HHALTER data to the published APVMA adverse experiences data, our study participants reported a subset of the full list of presenting signs noted by APVMA. APVMA reported that a total of 977 equine reports were made to them between 2012 (Nov) and 2015 (June), of which the effect of the vaccine as a cause of the adverse experiences was classified as 'probable' in 140 and 'possible' in 677. It is difficult to compare APVMA and HHALTER adverse reactions data directly, as the APVMA presenting signs are recorded in more precise and extensive veterinary terminology (n=83), whereas the HHALTER study used lay terms and could potentially include a number of APVMA terms, e.g. the lay term 'depression' might cover APVMA listed terms lethargy, depression and listlessness. However, HHALTER reported reactions (prompted in the survey question) also reflected some of the most frequently reported presenting signs by APVMA. Table A1.1 provides comparisons of APVMA and HHALTER data.

Table A1.1. Comparison of HHALTER data with APVMA adverse experiences reporting.

HHALTER reporting		APVMA reporting	
(Ranked by % severe reaction - see Fig A1.2.)		(Ranked by reported reaction incidence %)	
Rank	Term	Rank	Term (incidence %)
1	Muscle stiffness	7=	Stiffness (0.03)
2	General depression	3	Lethargy (0.1)
3	Fever/high temperature	5	Pyrexia (0.06)
4	Swelling at the site of vaccine injection	1	Injection site reaction (0.18)
		2	Oedema (0.11)
5	Muscle twitches/shakiness	-	Shaking (0.001),
		-	Fasciculation (<0.001)
6	Signs of colic	12=	Colic (0.01)

Respondents in the HHALTER study were asked if they had reported the reactions noted above, either formally or informally, and if so, to whom. Just over half (56%, n=42) said they reported all reactions, 15% (n=11) reported some, and 29% (n=22) didn't report any. Again, respondents were able to provide comments and many who didn't report felt that the reactions were minor or not unexpected, others said that they mentioned reactions to their vets, and some provided more information about the duration of effects or of giving Bute at the time of vaccination.

Owners were asked who they reported the adverse reactions to, these data are summarised in Figure A1.3.

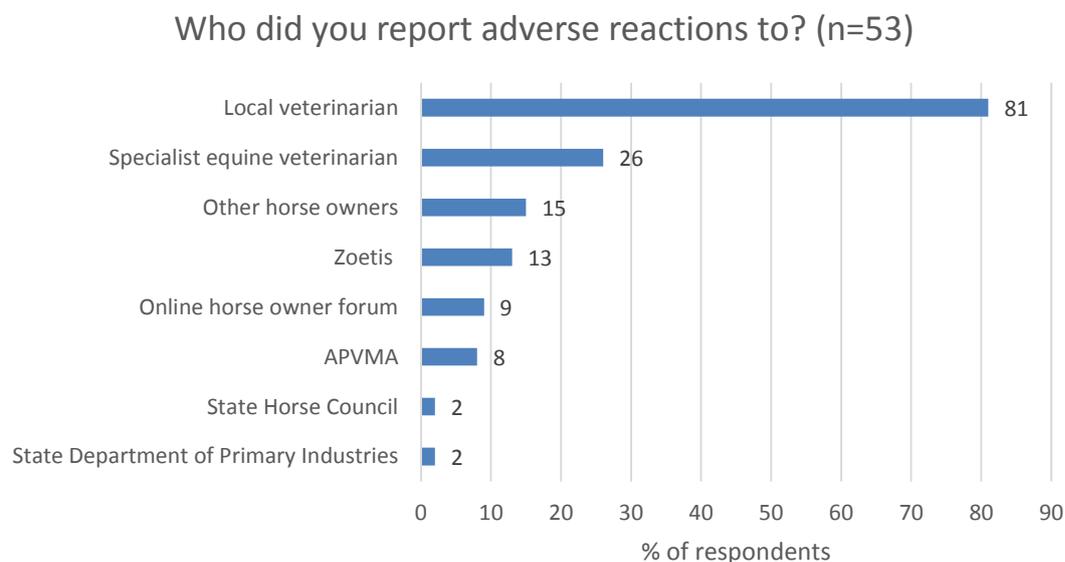


Figure A1.3. Who horse owners reported adverse reactions to (multiple responses allowed).

Most reported reactions to their local veterinarian. Respondents were asked (in an open question) whether any action occurred as a result of their report. A total of 42 respondents commented and 23 explicitly replied 'no' (no further action). Five respondents mentioned that vets monitored their horses and some also said that they (owner) monitored their horse and kept the vet informed. Four mentioned that their vets attended their horse, two were contacted by Zoetis, two mentioned that Bute (phenylbutazone – anti-inflammatory) was administered ahead of subsequent vaccine boosters as a precaution, and one commented that his/her (elderly and unwell) horse was euthanised as the owner and vet felt that the horse wouldn't tolerate a further booster. A couple of respondents mentioned that their vets refused to report the reactions, saying that the reaction was normal/to be expected or was a reaction that was not expected and therefore dismissed as not being related to vaccination.

Pressure to vaccinate

During the second year of the HHALTER project research team members noted that there was an increasing sense in some owners that they were feeling pressured to vaccinate their horses against HeV. In S5 (Nov 2015) we asked respondents if they felt pressure to vaccinate. Just under a quarter (22%) said ‘yes, definitely’, 33% said ‘yes, somewhat’, and 45% said ‘no’. We then asked respondents where they felt the main pressure to vaccinate came from. Figure A1.4 summarises these data.

Where do you feel the main pressure to vaccinate your horse/s has come from? (n=195)

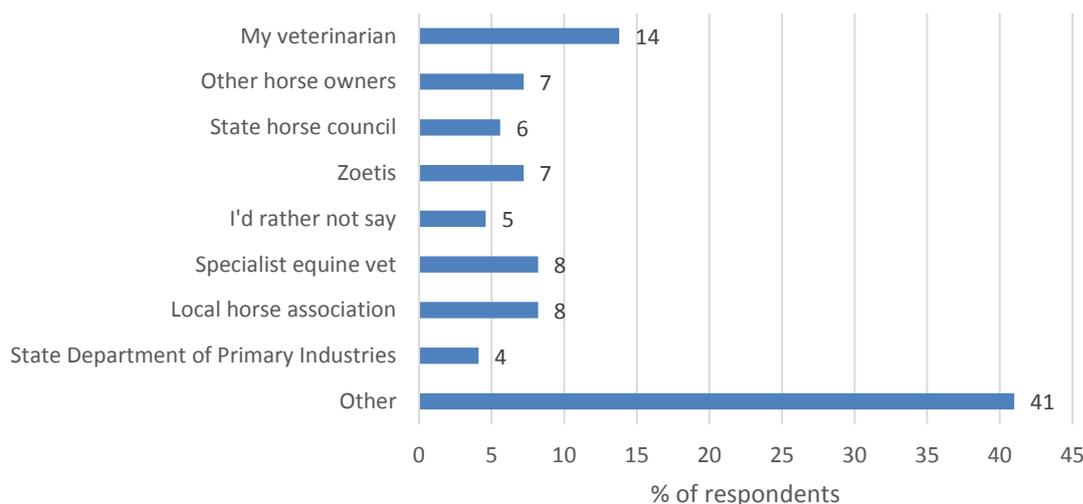


Figure A1.4. Sources of pressure to vaccinate.

Veterinarians were most frequently chosen from the list of possibly sources provided, however 41% (n=75) said ‘other’. Analysis of these responses indicated that organisations such as Equestrian Australia (n=9), RASQ, Pony Club, and Equine Veterinarians Australia (EVA) were mentioned specifically, and more generally farriers, media, agistment owners, competition organisations and show societies were also listed. Eleven respondents said that they had made the decision themselves, and four mentioned family members, and a couple suggested their professional roles (agistment owner and vet) meant that they needed to be seen to vaccinate. A few mentioned large local bat populations as being responsible for the pressure to vaccinate!

In S5 29% of respondents reported that Hendra virus vaccination was a requirement for them to maintain horse-related activity.

Implications of vaccination

A final set of three questions about vaccination in S5 related to beliefs and practices and responses to these questions are summarised in Figure A1.5. Respondents were asked:

Now that your horses are vaccinated for Hendra virus...

- ...do you think there is any possibility that your horses could still become infected with Hendra virus?
- ...if your horses became sick, would you consider Hendra virus as a possible cause?
- ...are you likely to relax your property management practices (e.g. not cover water containers, not keep horses away from trees, or not consider taking these sorts of actions)?

Now that your horses are vaccinated for Hendra virus...

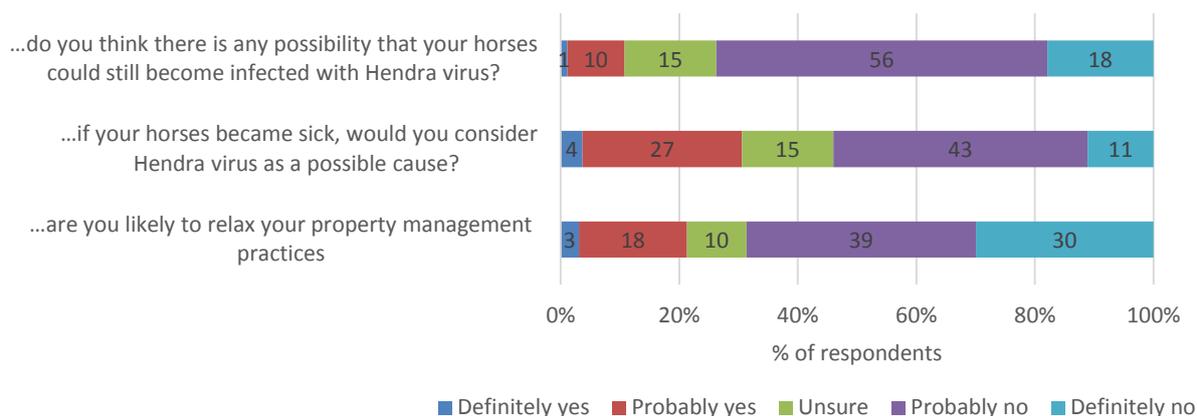


Figure A1.5. Beliefs and practices in response to HeV vaccination.

Although the majority of horse owners appear to trust the efficacy of the HeV vaccine, it is interesting to note that around a quarter have doubts; with 11% reporting that they still believe that their vaccinated horses could become infected with HeV, and a further 15% are unsure. A larger proportion, just under half, suggest that they might still consider HeV as a possible cause of illness in their vaccinated horses. Although responses to the final question are likely to contain a level of ‘social desirability’, it is still interesting that around a third of respondents (31%) indicate that they might consider relaxing their property management practices now that their horses are vaccinated.

Summary

Data presented in this Appendix are from supplementary question content included mostly in the last HHALTER survey (S5) collected during November 2014 to January 2015 from the 354 respondents who had vaccinated their horses at this time point. Data provide some insight into the concerns of horse owners about the vaccine; the factors that are influencing decisions to continue with 6-monthly boosters and concerns about adverse reactions and reporting.

Decisions to delay or withdraw from the vaccination regime appear to be based on a combination of cost and risk factors linked to individual circumstances. With respect to adverse reactions, a fairly stable and not insignificant minority reports adverse reactions; reactions that veterinarians and other professionals may regard as ‘normal’, but horse owners feel to some extent are unacceptable. The purpose of mentioning these findings here is not to suggest that this level of adverse reactions is typical or representative of the population, or objectively verifiable, but simply to raise the issue that the perception of severe adverse reactions is real to a fairly significant proportion of respondents in this sample and that these perceptions will guide subsequent decisions, actions, and communications with others. It is also interesting to note that some vaccinating horse owners still feel their horses could become infected and would still consider HeV in a sick vaccinated horse.

Finally, the issue of pressure to vaccinate is more complex to assess. Although it is clear that for many a ‘pressure’ to vaccinate is a negative, unpleasant experience, less extreme contexts may be interpreted as potential levers or motivating influences to vaccinate. In general, and without prejudice, larger organisationally-driven actions (for example here to mandate vaccination) have the potential to disenfranchise individuals who have good interconnectedness through their association with the organisation, and thus enable easily-mobilised and coordinated resistance and strong counter-argument. Smaller-scale and more individualised approaches, such as encouragement to consider vaccination from a trusted veterinarian or friend, are likely to be less confronting or adversarial and more acceptable in this context.

Appendix 2. HHALTER Dissemination activities

Journal articles

Sawford K, Dhand NK, Toribio J-A LML, and Taylor MR, 2014. The use of a modified Delphi approach to engage stakeholders in zoonotic disease research priority setting. *BMC Public Health*, 14:182

Conferences

Wiethoelter A, Sawford K, Schembri N, Taylor M, Dhand N, Kung N, Moloney B, Wright T, Field H, Toribio J-A LML. Have your say about Hendra – a qualitative study to explore horse owners' knowledge and perception of Hendra virus. 14th International Symposium on Veterinary Epidemiology and Economics (ISVEE), Yucatan, Mexico. (3-7 November, 2015)

Schembri N, Dhand N, Wiethoelter A, Toribio J-A LML, Field H, Moloney B, Sawford K, Kung N, Wright T, Taylor M. Combating Hendra - Biosecurity practices and risk perceptions of Australian horse owners. 14th International Symposium on Veterinary Epidemiology and Economics (ISVEE), Yucatan, Mexico. (3-7 November, 2015)

Dhand N, Schembri N, Wiethoelter A, Toribio J-A LML, Kung N, Moloney B, Sawford K, Wright T, Field H, Taylor M. Drivers and barriers for the uptake of a new Hendra virus vaccine for horses in Australia. 14th International Symposium on Veterinary Epidemiology and Economics (ISVEE), Yucatan, Mexico. (3-7 November, 2015)

Taylor M, Schembri N, Wiethoelter A, Toribio J-A, Dhand N, Kung N, Moloney B, Wright T Field H. The HHALTER project: An interdisciplinary One Health collaboration in action. 3rd GRF One Health Summit, Davos, Switzerland. (4-7 October, 2015)

McDonald E, Wiethoelter A, Taylor M, Schembri N, Dhand N, Kung N, Moloney B, Wright T, Field H, Toribio J-A LML. “As long as we’ve had bats, we’ve had Hendra” – Horse owners’ knowledge and risk perception of flying foxes in regards to Hendra virus. 64th Annual International Conference of the Wildlife Disease Association, Queensland Sunshine Coast, Queensland, Australia. (26-30 July, 2015)

Schembri N, Dhand N Wiethoelter A, Toribio J-A LML, , Kung N, Wright T, Sawford K, Field H, Moloney B, Taylor M. Hendra virus risk perceptions and prevention protocols among horse owners: A HHALTER Study. Australian and New Zealand College of Veterinary Scientists Science week, Gold Coast, Queensland. (9- 11 July 2015)

Schembri N, Dhand N Wiethoelter A, Toribio J-A LML, Field H, Moloney B, Sawford K, Kung N, Wright T, Taylor M. Horse owners’ attitudes and behaviours regarding Hendra virus vaccination uptake. Australian and New Zealand College of Veterinary Scientists, Science Week, Gold Coast, Queensland. (9- 11 July 2015)

Taylor M, Wiethoelter A, Schembri N, Toribio J-A, Dhand N, Kung N, Moloney B, Wright T, Field H. Novel vaccine acceptance in emerging infectious diseases: a case study of Hendra virus vaccine uptake in Australia. 3rd International One Health Congress, Amsterdam, The Netherlands. (15-18 March 2015)

Wiethoelter A, Taylor M, Schembri N, Moloney B, Wright T, Kung N, Field H, Sawford K, Dhand N, Toribio J-A. Horse owners and Hendra virus: A longitudinal cohort study to evaluate risk. Research in Veterinary Science Conference – This is why we measure up! Sydney, New South Wales. (4 - 5 February 2015)

Schembri N, Taylor M, Sawford K, Wiethoelter A, Toribio J-A LML, Dhand N, Kung N, Field H, Moloney B, Wright T. Biosecurity practices of horse owners to prevent Hendra Virus (HeV)

transmission: The HHALTER project. Marie Bashir Institute (MBI) Colloquium: “tackling infection, locally and globally, The University of Sydney. (25th November 2014)

Taylor M, Sawford K, Toribio J-ALML, Schembri N, Kung N, Field H, Moloney B, Wright T, Dhand N. Tracking horse owner uptake of Hendra virus risk mitigation practices: Data from the HHALTER study. Zoonoses 2014. Australasian Society for Infectious Diseases. Brisbane, Queensland. (25-26 July 2014).

Taylor M, Sawford K, Dhand N, Toribio J-A, Wright T, Moloney B, Kung N, Field H. (2013). The HHALTER project – unravelling horse owners’ decisions to vaccinate their horses against Hendra virus. Ingham Institute 8th Annual Research and Teaching Showcase. Sydney, New South Wales. (29 November 2013)

Schembri N, Sawford K, Toribio J-A LML, Dhand N, Kung N, Field H, Moloney B, Wright T, Taylor M. Risk awareness and the uptake of on-farm biosecurity and management practices by horse owners to prevent Hendra Virus (HeV) transmission - The HHALTER project. Marie Bashir Institute (MBI) Colloquium, The University of Sydney, Australia. (5th December 2013)

Sawford, K., Taylor, M., Dhand, N., Toribio, J. (2013). Engaging different stakeholder groups in a consultation process to guide research into Hendra virus risk perception and risk mitigation. Australian and New Zealand College of Veterinary Scientists Science week. Gold Coast, July 2013

Taylor M, Sawford K, Dhand N, Toribio J-A, Kung N, Field H, Moloney B, Wright B. (2012) The HHALTER project: Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk. Emerging Infectious Diseases Symposium. Geelong, Victoria. (22-23 October 2012)

Taylor M, Toribio J-A, Dhand N, Kung N, Field H, Moloney B, Wright T. Horse Owners and Hendra Virus; a longitudinal cohort study to evaluate risk. Zoonoses 2012. Australasian Society for Infectious Diseases. Sydney. New South Wales. (27-28 July 2012).

Presentations

Taylor M, Schembri N, Sawford K, Dhand N, Toribio J-A, Kung N, Field H, Moloney B, Wright T. (2015) The HHALTER Project: An overview of the final results ahead of final reporting. Presentation to New South Wales Department of Primary Industries. Orange, New South Wales. (29 October 2015)

Taylor M, Schembri N, Sawford K, Dhand N, Toribio J-A, Kung N, Field H, Moloney B, Wright T. (2014) Preliminary results from HHALTER. Presentation to the Horse Biosecurity and Market Access Liaison Group, University of Queensland Gatton Campus. (13 February 2014)

Taylor M, Schembri N, Sawford K, Dhand N, Toribio J-A, Kung N, Field H, Moloney B, Wright T. (2014) Preliminary results from HHALTER. Presentation to New South Wales Department of Primary Industries. Orange, New South Wales. (8 April 2014)

Student reports

Eliza McDonald, Anke Wiethoelter, Melanie Taylor, Nicole Schembri, Navneet Dhand, Nina Kung, Barbara Moloney, Therese Wright, Hume Field, Jenny-Ann Toribio. (2015) *Attitudes and risk perception of horse owners towards flying foxes in relation to Hendra virus*. Honours Thesis. University of Sydney, Faculty of Veterinary Science.

Appendix 3. HHALTER Posters

During the period July 2012 – Nov 2015 the project team presented seven posters at conferences. These were referenced in Appendix 2 in full and are reproduced in the following section along with their accompanying abstracts.

1. Horse Owners and Hendra Virus; a longitudinal cohort study to evaluate risk. *Zoonoses*. July 2012

Background: The trajectory of Hendra Virus (HeV) is uncertain. To date in Australia there have been 33 known occasions when HeV has spilled from its natural fruit-bat host to horses; 14 pre-2011 and 19 since June 2011. The recent 2011 super-cluster of HeV cases and evidence of HeV transmission to a dog has caused widespread concern in horse owners, government agencies, and the general public more broadly.

Overview: The project provides both a research platform and a resource to track the dynamic nature of horse owner risk awareness, mitigation practices, and the effectiveness and reach of government agency-directed communication and guidance in the context of an evolving and uncertain threat. The research program will commence in June 2012 with the recruitment of a large and inclusive longitudinal cohort of horse owners from across all industry sectors that will be followed over a two year period. The study comprises five surveys conducted at six-monthly intervals over what is anticipated to be three consecutive peak HeV outbreak periods and two ‘quieter’ intervening periods. Each survey will comprise consistent (core) questions as well as supplementary questions in areas of emerging priority or interest, e.g. implementation of vaccination, research/treatment break-throughs, education and communication campaigns, and the impact of the media.

This project is being funded by the National Hendra Virus Research Program (NHVRP). Additional collaboration is planned with NHVRP research programs to incorporate small ad hoc question modules that will support the research aims of these projects.

Expected outcomes and deliverables: The research program will support the communications strategies of both government and the horse industry providing a regular research ‘tracker’ publication following changes in core areas over time and reporting summaries of supplementary studies.

Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk (HHALTER)

Melanie Taylor¹, Jenny-Ann Toribio², Navneet Dhand², Nina Kung³, Hume Field³, Barbara Moloney⁴, Therese Wright⁴

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Overview

This research project provides a flexible and responsive research methodology for the study of factors influencing Hendra virus (HeV) risk awareness and the uptake of risk mitigation practices by horse owners to prevent transmission.

The research will focus on a large and inclusive cohort of horse owners followed over a two year period. The project is largely survey-based, but includes provision for an in-depth group study and a randomised control trial in year two.

The project provides both a research platform and a resource to track the dynamic nature of horse owner risk awareness, mitigation practices, and the effectiveness and reach of government agency-directed communication and guidance in the context of an evolving and uncertain threat.

This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program, and contracted by the Rural Industries Research and Development Corporation (RIRDC).

Aims

- To investigate interrelationships between HeV risk awareness and understanding and risk mitigation practices.
- To identify factors influencing changes in perceptions and practice over time, and in the context of a dynamic threat.
- To assess the effectiveness of recommended strategies and interventions.
- To investigate the impacts on risk awareness and uptake of risk mitigation practices of emerging issues as they arise, e.g. vaccination implementation and uptake, media stories and issues around trust and confidence, or new host species.
- To support stakeholder decisions on policy, advice, and action to reduce the risk of HeV transmission to horses and humans.

Methodology

This research program is, principally, a longitudinal cohort study. A cohort of at least 2400 horse owners will be recruited

- from all industry sectors,
- across all states and territories, and
- with a minimum two thirds from Queensland and New South Wales.

Horse owners outside current HeV risk areas will form a valuable reference group and provide research flexibility should future HeV cases occur outside current risk regions.

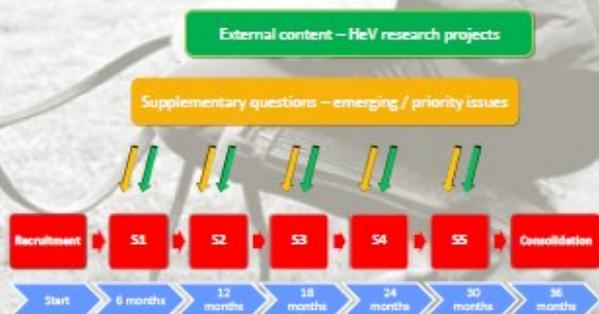
The Surveys

The main study comprises five surveys (S1-S5) conducted at six-monthly intervals over what is anticipated to be three consecutive peak HeV outbreak periods and two 'quieter' intervening periods.

Each survey will include up to three categories of content (see schematic)

- a consistent (core) set of questions; used to track changes over time, e.g. risk perception, risk mitigation practices, intentions to vaccinate, attitudes to response management, trust in agencies
- supplementary questions in areas of emerging priority or interest, e.g. vaccination strategy, flying fox control
- external content modules; small sets of questions hosted on the survey for other researchers.

The first survey will be administered in October/November 2012.



Stakeholder consultation: horse associations and groups, government agencies, and academics



The project team will be seeking input from a range of stakeholders during August and September 2012. If you would like to be included, please contact the team at

hhalter@uws.edu.au



2. Risk awareness and the uptake of on-farm biosecurity and management practices by horse owners to prevent Hendra Virus (HeV) transmission - The HHALTER project. Marie Bashir Institute (MBI) Colloquium. December 2013.

Study rationale

Hendra virus (HeV) is a zoonotic disease caused by spillover of the virus from flying foxes to horses, and then to people. To date there have been 69 confirmed equine cases in Queensland and New South Wales, seven human cases, and two in dogs. Little is known of the perceived risks associated with HeV and attitudes and practices surrounding the implementation of on-farm biosecurity practices among at risk horse owners and the general industry.

Methods

The data presented is part of a three year longitudinal study which is focused on a national cohort of horse owners that will be followed over a two year period via five self-administered online surveys at six-monthly intervals (S1-S5 from 2012 – 2014). Stakeholder consultation was initially undertaken to guide the research and ensure the relevance of project outcomes. Quantitative (univariable logistic regression) and qualitative (thematic content) analysis is being undertaken to identify attitudes, behaviours and practices involving HeV awareness; and property management and biosecurity practices associated with horse and personal health and safety.

Results

Findings from the first two surveys (S1: N=1132; and S2: N=745) will be presented. Preliminary results indicate that the majority of horse owners understand the HeV transmission pathway and feel they have a good standard of on-farm biosecurity. However, some discrepancies exist between best practice and actual risk mitigation practices. Further detailed analysis will be presented.

Conclusion

Findings from this study will be used to assist government departments, veterinarians, and horse industry groups to develop targeted communication strategies to horse owners.

Risk awareness and the uptake of on-farm biosecurity and management practices by horse owners to prevent Hendra virus transmission - The HHALTER* project



*(Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk)

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Hendra virus

Hendra virus (HeV) is a zoonotic disease with high case fatality rates. It is caused by spill-over of the virus from flying foxes to horses, and then to people. There have been 69 confirmed equine cases in Queensland (QLD) and New South Wales (NSW), seven human cases, and two cases in dogs.

Aim

To explore and track changes in horse owners' perceptions of risk associated with HeV, and the uptake of risk mitigation practices, such as the implementation of on-farm biosecurity, availability and use of personal protective equipment and safe approaches to animal health management.

Methodology

Data presented are part of a three year longitudinal study guided by stakeholder consultation and consisting of

- A national cohort of horse owners
- Five self-administered online surveys at six-monthly intervals
 - S1-S5 from Nov 2012 – Nov 2014 (see right)
 - Sets of core (repeated) questions to track changes
 - Supplementary content to respond to current issues

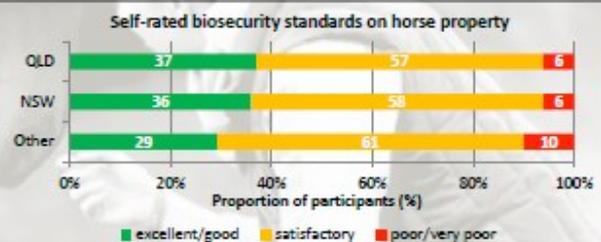
Quantitative (logistic regression) and qualitative (thematic content) analysis is being undertaken to explore and track changes in knowledge, attitudes, and practices.



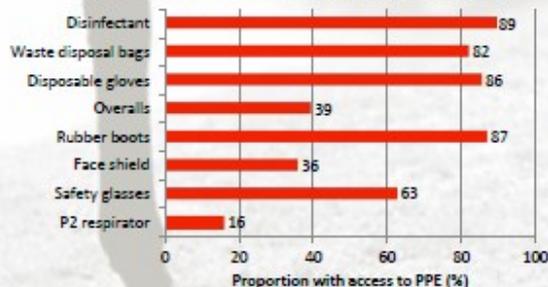
Results

Participants in QLD were more likely to report that a HeV case was likely to occur in their area; 41% reporting it as 'extremely' or 'very' likely, compared to 14% in NSW and 2% overall in other states. However, if they had a sick horse showing non-specific symptoms, only 28% of participants in QLD reported they would be 'extremely' or 'very' likely to suspect it could be HeV, compared to 9% in NSW, and 2% elsewhere.

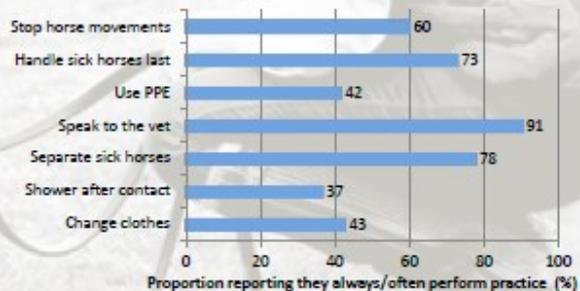
Overall, just over a third of horse owners (35%) rated the standard of biosecurity on their horse property as 'excellent' or 'good' compared to others, whilst 7% rated their standard as 'poor' or 'very poor'.



Accessibility of personal protective equipment (PPE)



Biosecurity practices around a sick horse



Conclusions

Although reported biosecurity standards and practices appear satisfactory, in general, relatively few horse owners would suspect Hendra virus infection in a sick horse. This finding underlines the need to exercise caution and stringent biosecurity practice around sick horses to minimise risk. Our data suggest that PPE use and personal hygiene practices following contact with sick horses could be improved. Further analysis is underway.



The University of Western Sydney was contracted by the Rural Industries Research and Development Corporation to undertake this research project. This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program.

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3. Tracking horse owner uptake of Hendra virus risk mitigation practices: Data from the HHALTER study. *Zoonoses*. July 2014.

Introduction

Hendra virus (HeV) is a zoonotic disease transmitted from flying foxes to horses, horses to horses, and horses to people. It has a high case fatality rate (75% in equines, 57% in humans). Seventy confirmed equine cases and seven human cases have occurred in Queensland and New South Wales. In November 2012 a horse vaccine against HeV became available, making it possible to break the virus transmission pathway to horses and people. However, uptake of vaccination has been slow and the majority of horses remain unvaccinated. Minimising horse exposure to flying foxes remains a fundamental risk management strategy and understanding the uptake of recommended practices over time is important for those involved in horse owner communication and engagement.

Methods

Data from the HHALTER study (Horse owners and Hendra virus: A Longitudinal study To Evaluate Risk) are presented. This is a longitudinal study of a cohort of horse owners over a two year period. Data are collected via five six-monthly online surveys. Four waves of data will be presented (Nov 2012 to May/June 2014).

Results

Vaccine uptake in the cohort (n=468) has increased from 13% to 57%. However, uptake of property management practices has remained static with access to uncovered sources of water and feed remaining high, around 79% and 47% respectively. Although some action has been taken to prevent horses having access to areas under trees, the proportion with permanent access has also remained steady, around 71% in the day and 61% at night.

Conclusion

This research is still underway and data collection will be completed at the end of 2014. Uptake of vaccination in the cohort has increased dramatically over an 18 month period and is much higher than the broader horse-owning population, suggesting that the HHALTER cohort provides an insight into 'best case' HeV risk mitigation practice.

TRACKING HORSE OWNER UPTAKE OF HENDRA VIRUS RISK MITIGATION PRACTICES: DATA FROM THE HHALTER STUDY



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Hendra virus

Hendra virus (HeV) is a zoonotic disease with high case fatality rates (75% in equines and 57% in humans). It is caused by spill-over of the virus from flying foxes to horses, and then to people. There have been 70 confirmed equine cases in Queensland (QLD) and New South Wales (NSW) and seven human cases. A vaccine for horses was released in November 2012.

Aim

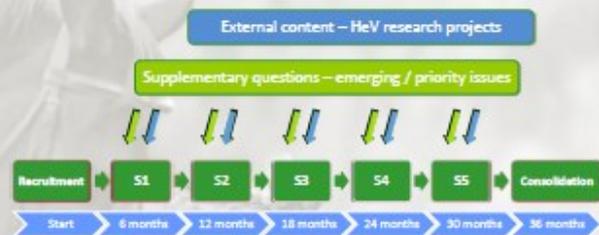
Data presented here are part of the 'Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk' (HHALTER) project. This project is tracking changes in horse owners' perceptions of HeV risk and their risk mitigation practices; including their uptake of vaccination and property management practices.

Methodology

The HHALTER project is guided by stakeholder consultation and consists of

- A national cohort of horse owners
- Five self-administered online surveys at six-monthly intervals
 - S1-S5 from Nov 2012 – Nov 2014 (see right)
 - Sets of core (repeated) questions to track changes
 - Supplementary content to respond to current issues

Quantitative (logistic regression) and qualitative (thematic content) analysis is being undertaken to explore and track changes in knowledge, attitudes, and practices.



Results

Although to date 1373 horse owners have completed one or more HHALTER surveys, a cohort of 468 horse owners has completed all three. Data presented here are for this cohort group only.

Risk mitigation options

In general, horse owners have three main options to reduce the risk of HeV in their horses:

- Have their horses vaccinated.
- Follow property management recommendations to keep horses away from flying foxes and possible contamination.
- Employ good biosecurity practices, especially around sick horses.

The graph below show changes in uptake of vaccination over the three waves of HHALTER data collection.

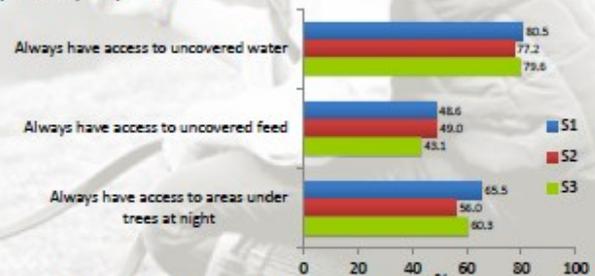
Uptake of vaccination



Uptake of property management recommendations

Three of the main property management recommendations to horse owners are for them to cover water sources and feed containers and keep horses away from areas under trees at night, where flying foxes may stop to feed or roost.

The graph below shows the proportion of the cohort that is not adopting these recommendations and whose horses are *always* exposed to these potentially risky situations.



Overall around 44% of the cohort felt that these property management recommendations would be *extremely/very* effective at reducing risk of HeV, however, only around 27% felt it would be easy for them to make changes.

Conclusions

Uptake of vaccination by the cohort has increased dramatically over an 18 month period and is much higher than the broader horse-owning population; which is estimated to be around 10%. This suggests that the HHALTER cohort may provide an insight into 'best case' HeV risk mitigation practice, and as a group they could reasonably be assumed to be more engaged, generally. With this in mind, it is surprising not to see changes in uptake of recommended property management practices to reduce HeV risk. Further research is required to understand the barriers to non vaccination-based risk mitigation practices.



The University of Western Sydney was contracted by the Rural Industries Research and Development Corporation to undertake this research project. This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program.

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4. Biosecurity practices of horse owners to prevent Hendra Virus (HeV) transmission. *Marie Bashir Institute (MBI) Colloquium. December 2014.*

Study Rationale: Hendra virus (HeV) is a zoonotic disease caused by spillover of the virus from flying foxes to horses (and people). In November 2012 a HeV vaccine for horses became available, making it possible to break the virus transmission pathway to horses and people. Initial uncertainty surrounding the vaccine's safety and efficacy, highlights the importance of sound horse and property biosecurity practices.

Methods: The data presented is part of a longitudinal study that focused on a national cohort of horse owners followed over a two-year period via five self-administered online surveys at six-monthly intervals. Uni- and multi-variable logistic regression was undertaken on the second survey to identify attitudes, behaviours and practices involving HeV awareness; property management and biosecurity practices are presented.

Results: Respondents (N=715) were classified as having low (24.9%), medium (44.4%) or high (27.7%) biosecurity practices based on their reported management practices around healthy and sick horses. Those with higher levels of biosecurity practices, including preventing access to areas where flying foxes could roost or drop half-eaten fruit, were more likely to suspect HeV in a sick horse, contacting their veterinarian to discuss or examine changes in their horse(s) and had access to a greater range of personal protective equipment (PPE).

Conclusions: These findings will be used to assist government, veterinarians, and horse industry groups in developing targeted communication strategies to protect horse owners and the general public via best practice horse biosecurity.

Biosecurity practices of horse owners to prevent Hendra Virus (HeV) transmission

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Hendra virus

Hendra virus (HeV) is a zoonotic disease caused by spillover of the virus from flying foxes to horses (and people). In November 2012 a HeV vaccine for horses became available, breaking the virus transmission pathway to horses and people. Initial uncertainty surrounding the vaccine's safety and efficacy highlighted the importance of sound biosecurity practices.

Aim

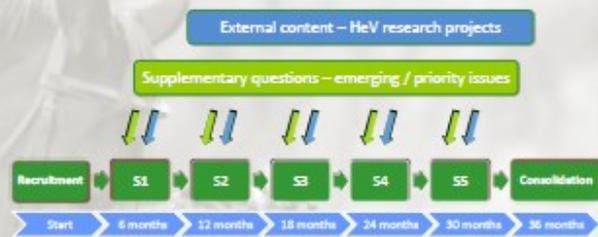
Data presented here are part of the 'Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk' (HHALTER) project (survey 2). The aim of this component of the broader study was to identify attitudes, behaviours and practices involving HeV awareness; property management and biosecurity practices.

Methodology

The HHALTER project is guided by stakeholder consultation and consists of

- A national cohort of horse owners
- Five self-administered online surveys at six-monthly intervals
 - S1-S5 from Nov 2012 – Nov 2014 (see right)
 - Sets of core (repeated) questions to track changes
 - Supplementary content to respond to current issues

Quantitative (logistic regression) and qualitative (thematic content) analysis is being undertaken to explore and track changes in knowledge, attitudes, and practices.



Results

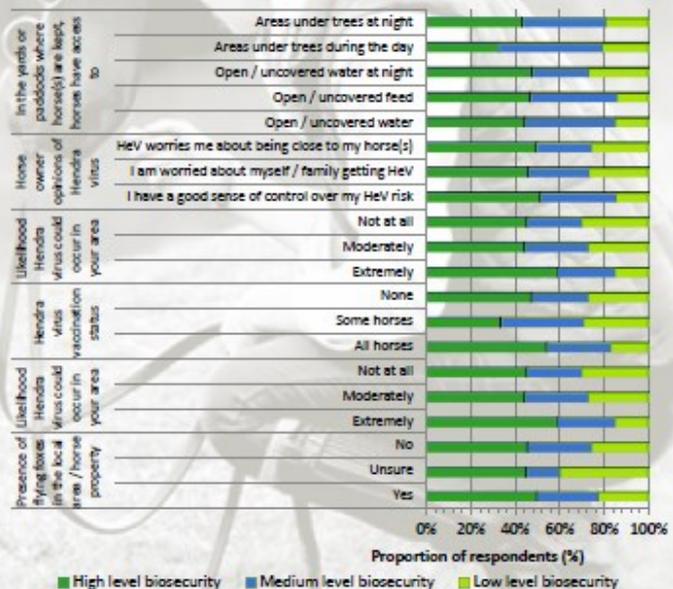
Respondents of the second HHALTER survey, (May-July 2013; N=715), were classified as having low (24.9%), medium (44.4%) or high (27.7%) levels of biosecurity practices based on their reported management practices around healthy and sick horses. These practices included personal hygiene, quarantine of sick horses, seeking veterinary advice and limiting contact with people or other animals.

Those with high levels of biosecurity practices prevented horse access to areas where flying foxes could roost or drop half-eaten fruit, were more likely to suspect HeV in a sick horse, and were more likely to contact their veterinarian to discuss or examine changes in their horse(s) if they saw anything unusual, compared to those horse owners with medium or low levels of biosecurity. Moreover, horse owners with high levels of biosecurity had access to a significantly greater range of personal protective equipment (PPE) such as a P2 respirator (43.4%); face shield (43.3%); overalls and gloves (45.9 and 49.2% respectively; $P < 0.05$).

Interestingly, significantly fewer horse owners with high biosecurity practices lived within 50km and 50-100km of a previously confirmed HeV case, compared with those undertaking medium and low-level biosecurity practices ($P = 0.005$).

The graph on the right shows the relationship between opinions of Hendra virus and on-property biosecurity management practices.

Opinions of Hendra virus and on-property biosecurity and management practices (by horse owners with high, medium and low levels of biosecurity practices)



Conclusions

These findings will be used to assist government, veterinarians, and horse industry groups in developing targeted communication strategies to protect horse owners and the general public via best practice horse biosecurity.



The University of Western Sydney was contracted by the Rural Industries Research and Development Corporation to undertake this research project. This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program.

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5. Novel vaccine acceptance in emerging infectious diseases: a case study of Hendra virus vaccine uptake in Australia. *3rd International One Health Congress. March 2015.*

Background

The development of a horse vaccine against Hendra virus has been hailed as a good example of a One Health approach to the control of human disease. Although there is little doubt that this is true, it is clear from the underwhelming uptake of the vaccine by horse owners to date (approximately 10%) that realisation of a One Health approach requires more than just a scientific solution. As emerging infectious diseases may often be linked to the development and implementation of novel vaccines this presentation will discuss factors influencing their uptake; using Hendra virus in Australia as a case study.

Methods

This presentation will draw on data collected from the Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk (HHALTER) study. The HHALTER study is a mixed methods research study comprising a two-year survey-based longitudinal cohort study and qualitative interview study with horse owners in Australia. The HHALTER study has investigated and tracked changes in a broad range of issues around early uptake of vaccination, horse owner uptake of other recommended disease risk mitigation strategies, and attitudes to government policy and disease response. Interviews provide further insights into attitudes towards risk and decision-making in relation to vaccine uptake. A combination of quantitative and qualitative data analysis will be reported.

Results

Data collected from more than 1100 horse owners shortly after vaccine introduction indicated that vaccine uptake and intention to vaccinate was associated with a number of risk perception factors and financial cost factors. In addition, concerns about side effects and veterinarians refusing to treat unvaccinated horses were linked to uptake. Across the study period vaccine uptake in the study cohort increased to more than 50%, however, concerns around side effects, equine performance and breeding impacts, delays to full vaccine approvals, and attempts to mandate vaccination by horse associations and event organisers have all impacted acceptance.

Conclusion

Despite being provided with a safe and effective vaccine for Hendra virus that can protect horses and break the transmission cycle of the virus to humans, Australian horse owners have been reluctant to commit to it. General issues pertinent to novel vaccines, combined with challenges in the implementation of the vaccine have led to issues of mistrust and misconception with some horse owners. Moreover, factors such as cost, booster dose schedules, complexities around perceived risk, and ulterior motives attributed to veterinarians have only served to polarise attitudes to vaccine acceptance.

Novel vaccine acceptance in emerging infectious diseases: a case study of Hendra virus vaccine uptake in Australia

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¹University of Western Sydney, Centre for Health Research, ²The University of Sydney, Faculty of Veterinary Science, ³Queensland Department of Agriculture and Fisheries, ⁴NSW Department of Primary Industries, ⁵Ecohealth Alliance.



Hendra virus background

- Hendra virus (HeV): zoonotic disease of sporadic occurrence in Australia
- caused by HeV spill over from flying foxes to horses and from horses to people
- since 1994 71 confirmed equine and seven human cases with the five most recent human cases all occurring in veterinary health professionals
- high case fatality rate (75% in equines, 57% in humans)

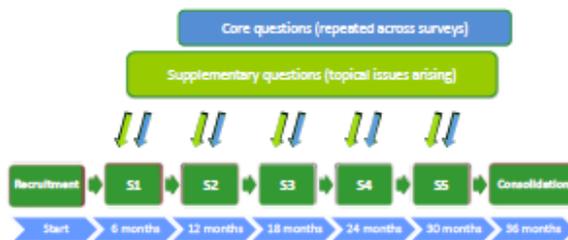
Hendra virus vaccine

A super cluster of HeV cases in New South Wales and Queensland in 2011 triggered public outcry. This was followed by funding which enabled the fast-tracking of HeV research, including the development of a novel vaccine for horses. In November 2012 the vaccine became available, providing a tool to break the transmission pathway to horses and people.



Methodology

Data presented here are part of the 'Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk' (HHALTER) project. This study aims to explore and track changes in knowledge, attitudes, and practices of a national cohort of horse owners followed over a two-year period (from Nov 2012 – Nov 2014) via five self-administered online surveys at six-monthly intervals (see study structure below). The HHALTER study also includes a series of in-depth interviews with horse owners.



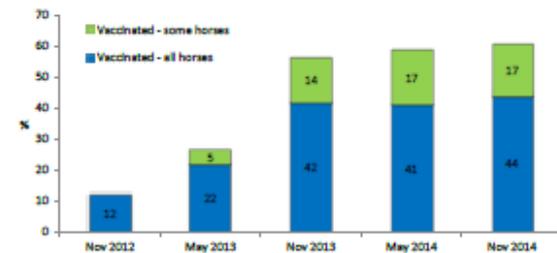
Vaccine implementation

The vaccine was launched ahead of schedule and without pre-launch consultation with the Australian horse industry. Instead of being registered as a chemical product, it was released under a 'Minor Use Permit' due to limited time for testing. This necessitated a number of restrictions, most notably, that the vaccine must be administered by a registered and accredited veterinarian. The vaccine schedule requires an initial dose, followed by a second dose 21-42 days later, and then a booster every six months. Vaccinated horses have to be microchipped for identification and their vaccination status is recorded on a national database. The booster schedule must be maintained for horse owners to hold a valid vaccination certificate – mandatory for some equine events in Australia.

Vaccine uptake and barriers to uptake

In total 1,449 horse owners have taken part in one or more surveys, with a cohort of 341 completing all five surveys. Data presented are from this cohort group only.

The figure below shows the vaccine uptake in the cohort over the two year study period. Uptake rose from around 12% shortly after launch to over 60% two years later.



Horse owners, who decided not to vaccinate, reported that their decision was very much or extremely affected by the high cost of vaccination (60%), a perceived low HeV risk in their area (49%), for their horses (44%) and for themselves/their families (40%) as well as concerns about adverse reactions of the vaccine (28%). As one survey respondent commented:

"The decision came down to the risk to our area being affected. As the vaccine was rushed to market without proper testing, I felt that the risk of side effects was greater than the risk of Hendra."

Conclusions

Although vaccine uptake in the HHALTER study cohort group has risen steadily over the two year period, the overall national rate of HeV vaccination uptake is estimated to be less than 10%. Despite being provided with a safe and effective vaccine for Hendra virus that can protect horses and break the transmission cycle of the virus to humans, many Australian horse owners have been reluctant to commit to it. General issues pertinent to novel vaccines, combined with challenges in the implementation of the vaccine have led to issues of mistrust and misconception with some horse owners. Moreover, factors such as cost, booster dose schedules, complexities around perceived risk, and ulterior motives attributed to veterinarians have only served to polarise attitudes to vaccine acceptance.

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6. “As long as we’ve had bats, we’ve had Hendra” – Horse owners’ knowledge and risk perception of flying foxes in regards to Hendra virus. *64th Annual International Conference of the Wildlife Disease Association. July 2015.*

Hendra virus (HeV) is a zoonotic paramyxovirus causing neurological and respiratory disease with high mortality rates in horses (75%) and humans (57%). Discovered in Queensland, Australia in 1994, it sporadically spills over from flying foxes (*Pteropus* spp.) to horses and from horses to humans. While outbreaks significantly impact the equine industry, they additionally propagate fear and misinformation amongst horse owners about flying foxes, leading to calls for more radical flying fox management approaches, including dispersal and culling. This study investigates the knowledge, risk perception and attitudes of horse owners towards flying foxes as reservoirs of HeV to identify knowledge gaps and misconceptions, while informing effective communication strategies and policy development.

Data presented here are part of the ‘Horse owners and Hendra virus: a longitudinal cohort study to evaluate risk’ (HHALTER) project. Five online surveys at six-monthly intervals were administered to horse owners between November 2012 and December 2014 to assess changes in their knowledge, perceptions and attitudes on a range of HeV related topics, including flying foxes and their management. Additionally, the study monitored changes in risk mitigation practices, including uptake of horse HeV vaccination.

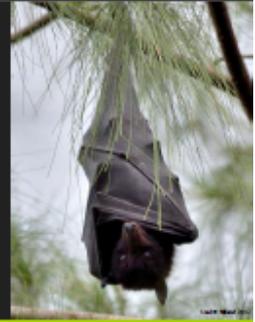
Overall, 1,449 horse owners participated in at least one survey. Over half (57%) of the respondents of the fifth survey (N= 580) reported seeing flying foxes nearby or on their horse property, but only 30% of these perceived them as a current health threat to their horses. Furthermore, the majority of respondents (73%) agreed that flying foxes play an important role in the environment. Further ongoing descriptive and regression analysis will be presented that explore relationships between these perceptions, demographic information and the subsequent uptake of biosecurity practices and vaccination.

The findings of this study will be used to advocate sustainable flying fox camp management strategies and to ensure protection of these endangered species.

“As long as we’ve had bats, we’ve had Hendra” – Horse owners’ knowledge and risk perception of flying foxes in regards to Hendra virus

Eliza McDonald¹, Anke Wiethoelter^{1,2}, Melanie Taylor², Nicole Schembri², Navneet Dhand¹, Nina Kung³, Barbara Moloney⁴, Therese Wright⁴, Hume Field^{3,5} and Jenny-Ann Toribio¹

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HENDRA VIRUS BACKGROUND

- Hendra virus (HeV) – zoonosis of public health concern in Australia
- Spills over from flying foxes (*Pteropus* spp.) to horses and from horses to humans
- High fatality rate – 75% in horses and 57% in humans (Kung et al. 2013)
- 53 spillover events since identification in Hendra, Queensland in 1994 – all spillover locations overlap with distribution of flying fox species (see Figure 1) (DAFF 2014; NSW DPI 2015)

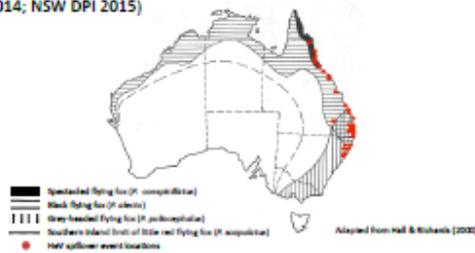


Figure 1: Locations of HeV cases overlapping with the distribution of flying fox populations

STUDY OBJECTIVES

1. Identify horse owners’ attitudes towards flying foxes in regards to HeV and their management
2. Evaluate factors influencing horse owners’ risk perception of flying foxes and how these may impact subsequent uptake of risk mitigation strategies

METHODS

This study is part of the Horse owners and Hendra virus: A Longitudinal cohort study To Evaluate Risk (HHALTER) project and focuses on the knowledge, risk perception and attitudes of horse owners towards flying foxes as the reservoir hosts of HeV. Data presented here are based on responses of the 577 participating horse owners in a self-administered online survey in December 2014. Ordinal logistic regression was conducted to evaluate the influence of various factors on horse owners’ risk perception of flying foxes as a current threat to the health of horse(s) on their properties, categorized as ‘yes’, ‘unsure’ and ‘no’.

Such factors included:

1. Demographics
2. HeV risk awareness and risk mitigation strategies, including vaccination and property management
3. Attitudes and perception towards flying foxes and camp management



ATTITUDES & RISK PERCEPTION TOWARDS FLYING FOXES

Horse owners displayed various attitudes towards flying foxes in regards to HeV and their management (see Figure 2):

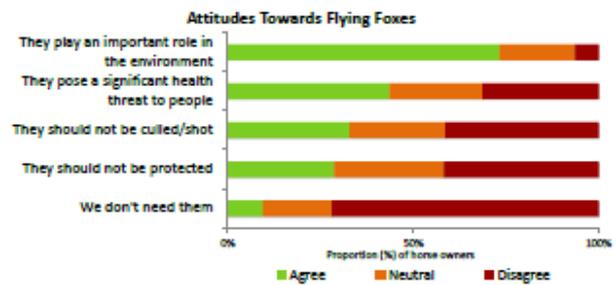


Figure 2: Horse owners’ attitudes towards flying foxes and their management in regards to HeV. Each bar represents the proportion (%) of the 577 respondents for each response

Flying foxes were perceived as a current threat to the health of horse(s) on their property by 18% of horse owners and not viewed as a threat by 71%, with the remainder of horse owners ‘unsure’.

Out of the 104 respondents who did perceive flying foxes as a threat:

- 84% had vaccinated either all or some of their horses
- 96% lived in Queensland or New South Wales
- 52% lived less than 50km from the nearest HeV case in a horse

Furthermore, horse owners who saw flying foxes either nearby or on their horse property were 11 times more likely to perceive them as a threat compared to those who did not see them ($P < 0.001$). Additionally, those who believed a HeV case was very likely to occur in their area were 28 times more likely to perceive them as a threat compared to those who believed it was not at all likely to occur ($P < 0.001$) (see Figure 3).

Factors Influencing Horse Owners’ Risk Perception of Flying Foxes to Horse Health

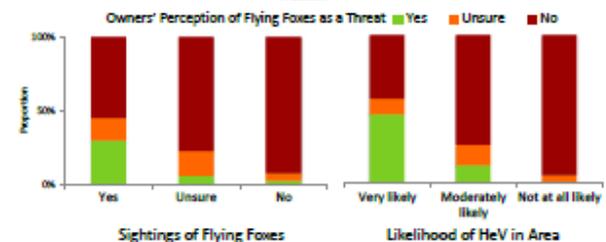


Figure 3: Influence of sightings of flying foxes nearby or on horse properties reported by horse owners and the likelihood of a HeV case in area perceived by horse owners on their risk perception of flying foxes

CONCLUSIONS

- Most horse owners did not perceive flying foxes as a current threat to the health of horse(s) on their properties
- However, the majority of those who did perceive flying foxes as a threat kept horses in or close to HeV affected regions and had implemented risk mitigation measures by vaccinating some or all of their horse(s)
- Sightings of flying foxes and a belief that a HeV case is likely to occur in their area are among the most influential factors on owners’ risk perception of flying foxes
- The majority of horse owners recognised the need for flying foxes, particularly in respect to the important role they play in the environment
- These findings will inform government agencies and the equine industry on attitudes of horse owners towards flying foxes in regards to HeV and could be used to enhance communication around risk mitigation strategies

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The University of Western Sydney was contracted by the Rural Industries Research and Development Corporation to undertake this research project. This research was funded by the Commonwealth of Australia, the State of New South Wales and the State of Queensland under the National Hendra Virus Research Program.



7. Have your say about Hendra – a qualitative study to explore horse owners’ knowledge and perception of Hendra virus. 14th International Symposium on Veterinary Epidemiology and Economics (ISVEE). November 2015.

Purpose

Hendra virus (HeV) is a zoonotic disease of sporadic occurrence in Australia caused by spillover from flying foxes to horses, and from horses to people. HeV vaccination of horses and property management measures are highly recommended and publicised to prevent spillover events. Since health behaviour models have shown that uptake of such risk mitigation strategies is largely influenced by risk perception, we investigated horse owners’ knowledge and attitudes on a range of HeV related topics.

Methods

Our mixed methods research study comprised a qualitative interview study with horse owners from various horse industry backgrounds in Australia. Semi-structured face-to-face interviews were conducted in high HeV risk areas, covering experience with HeV, risk perception and mitigation, as well as HeV information-seeking behaviour. Interviews were recorded and transcribed verbatim. Transcripts were analysed with NVivo using thematic analysis.

Results

Several main themes emerged from the 24 interviews with 27 horse owners (24-84 years old, 59% female). All interviewees were aware of HeV outbreaks in their area, common clinical signs in horses, and recommended management practices. Attitudes towards HeV vaccination were mostly polarised; ranging from “*a relief to have*”, “*the right thing to do*” and “*duty of care*”, to resentment and mistrust largely driven by factors such as safety concerns (“*still in its trial stages*”), cost (“*can’t afford it*”), booster schedules, and compulsory horse vaccination for attendance of some events. Veterinarians play a central role in HeV communication pathways as one interviewee described: “*We have the vet out every few months for something, so we can always ask them questions about the Hendra as well. They have been very forthcoming with any information they have. They’re vets, so I suppose we trust them.*”

Conclusion & Relevance

Despite the broad awareness of HeV, the attitude polarisation towards the vaccination potentially threatens effective HeV risk management. The results of this study will help to inform targeted communication strategies and HeV policy development for this zoonosis of great veterinary and public health significance.

Appendix 4. HHALTER Further analysis and research publications in preparation

This section provides details of analyses and manuscripts being completed from the HHALTER data. It is anticipated that these will all be completed for submission in the first half of 2016.

Drivers and barriers for the uptake of a new Hendra virus vaccine

This analysis has been led by Navneet Dhand and identifies trends in vaccine uptake across the set of five surveys, looking to identify the factors associated with uptake/lack of uptake over the survey period. Generalized linear mixed models have been used to evaluate associations of demographic, management and behavioural variables with the outcome (vaccination status).

An abstract outlining this analysis is included below. This was submitted in mid-2015 to ISVEE and Navneet delivered the presentation in November 2015. The manuscript should be completed and ready for submission in the first half of 2016.

ABSTRACT

Purpose

Hendra is an emerging zoonotic disease transmitted from flying foxes to horses and from horses to humans. This study was conducted to identify trends, drivers and barriers for the uptake of a new Hendra vaccine for horses since its launch in November 2012.

Methods

Five online surveys were administered to horse owners at six monthly intervals between November 2012 and December 2014. Data from each survey were stacked and a binary outcome variable created based on the question 'Have any of your horse(s) been vaccinated against Hendra virus?' Respondents who were not responsible for making decisions regarding vaccination were excluded. Generalized linear mixed models were built to evaluate association of demographic, management and behavioural variables with the outcome, after including respondent ID as a random effect to adjust for multiple observations for some respondents over time.

Results

The numbers of participants in the five online surveys ranged from 720 to 1195, including 341 respondents who participated in each survey. Overall, 56% of them were aged between 35 and 54 years and 90% were female. Proportion of respondents who had vaccinated their horses increased from 11% at the first to 28% at the second and 56% at the third survey and then hovered around this value. Respondents who thought that a Hendra case was 'moderately' and 'very/extremely' likely in their area had 2.7 and 8.2 times odds of getting their horses vaccinated than those who thought that a case was not likely to occur ($p < 0.001$). Respondents were more likely to get their horses vaccinated if they were worried about themselves or their family members getting Hendra virus or if they agreed with the establishment of a national horse registration system to assist with disease control and horse movements. Owners reporting a good sense of control over the risk of Hendra virus were also more likely to have vaccinated their horses.

Conclusions and relevance

Horse owners made their decisions by considering both threat appraisal (severity and vulnerability) and coping appraisal (response efficacy and self-efficacy). The study has implications for making policy decisions about encouraging uptake of the vaccine.

Biosecurity practices and risk perceptions

This analysis has been led by Nicole Schembri until she left the team in October 2015, and now will be completed by Jenny-Ann Toribio. It quantifies horse owners' level of biosecurity in association with property-based measures and looks at HeV risk perception, demographic, and other factors that are linked to differing levels of biosecurity practice (low, medium, high). Descriptive and multivariable ordinal logistic regression analyses were undertaken on data from S2 (May 2013) to determine participant level of biosecurity and associated factors.

An abstract outlining this analysis is included below. This was submitted in mid-2015 to ISVEE and the presentation was delivered by Anke Wiethoelter in November 2015. The manuscript should be completed and ready for submission in the first quarter of 2016.

ABSTRACT

Purpose

Discovered in Australia in 1994, Hendra virus (HeV) is an endemic zoonotic disease caused by spillover from flying foxes to horses and horses to people. Moderate uptake of the HeV horse vaccine reiterates the need for continued biosecurity measures. This study aims to quantify horse owner's level of biosecurity in association with property-based measures, their HeV risk perceptions and preparedness.

Methods

An online, self-administered longitudinal survey of horse owners was conducted over two years from November 2012 with five surveys distributed at six-monthly intervals. Descriptive and multivariable ordinal logistic regression analyses were undertaken on data from the second survey to determine participant level of biosecurity and associated factors. Level of biosecurity (low, medium or high) was based upon responses to 19 preventive measures involving contact with both healthy and sick horses that were carried out 'rarely', 'sometimes' or 'often'. Preventive measures were converted into binary variables, with a proportion of the 19 practices estimated for each individual giving an overall biosecurity rating. Low biosecurity individuals undertook <34% of practices, medium, up to 67% of practices and high biosecurity individuals undertook >67% of practices.

Results

Over a quarter of the 713 survey participants (N = 198) were classified as having a high biosecurity rating. Around 60% of these participants lived within 50km of a known HeV case, with 51% strongly agreeing that they had a good sense of control over *their* HeV risk. A greater proportion of high-level biosecurity participants "always" covered feed/water and limited horse access to trees at night (P<0.05), were "very likely" to suspect HeV in a sick horse, contact their veterinarian to discuss or examine changes in their horse(s); and had access to a greater range of personal protective equipment (P<0.05).

Conclusion and relevance

Gaps identified in horse owner biosecurity practices will assist government, veterinarians, and horse industry groups in prioritising and developing targeted risk and prevention communication strategies to protect horse owners and the general public against HeV.

Horse owner attitudes towards flying foxes

During 2015, Anke Wiethoelter and Jenny-Ann Toribio from the HHALTER project team supervised Eliza McDonald, an Honours student at University of Sydney, Faculty of Veterinary Science. Eliza analysed data from S2 in which a block of questions relating to horse owner attitudes to flying foxes was included.

Eliza produced an Honours thesis in October entitled “Attitudes and risk perception of horse owners towards flying foxes in relation to Hendra virus” and presented a poster at the Wildlife Disease Association conference in July 2015 (see Appendix 3). The abstract of Eliza’s thesis is reproduced below.

ABSTRACT

Hendra virus is a zoonotic paramyxovirus that causes neurological and respiratory disease with high case fatality rates in horses (75%) and humans (57%). Discovered in Queensland, Australia in 1994, it sporadically spills over from flying foxes (*Pteropus* spp.) to horses and from horses to humans. Several risk mitigation measures are recommended such as restricting horse access to fruiting/flowering trees and vaccinating horses, however research shows uptake is inconsistent. Therefore, an improved understanding of horse owner engagement and attitudes towards risk is paramount. This study investigates the knowledge, risk perception and attitudes of horse owners towards flying foxes as well as factors influencing their risk perception of flying foxes in regards to Hendra virus, utilising a Health Belief Model framework.

Data presented here are derived from an online survey administered to horse owners in December 2014 that evaluated their knowledge, attitudes and practices in relation to Hendra virus. The responses of 577 horse owners from across Australia and varying equine industry sectors were analysed. Descriptive analyses revealed 73% acknowledged the important role flying foxes play in the environment, yet 40% supported their culling if roosting in areas where they are causing a nuisance. Most (57%) had sighted flying foxes in their local area and only 18% perceived them as a current health threat to their horse(s). Factors significantly associated with horse owner risk perception towards flying foxes in ordinal logistic regression models related to horse owner perception of susceptibility to and concern for the severity of Hendra virus infection in both their horse(s) and themselves. Findings could be utilised to inform targeted communication strategies and policy development to enhance uptake of risk mitigation.

During 2016 Anke Wiethoelter will lead a further analysis of questions in this area from S5 (some were repeated from S2) and this combined analysis will form part of a manuscript for publication.

Early uptake of novel vaccine

This paper is being led by Mel Taylor. It focusses on factors associated with early uptake of vaccination and issues that influenced vaccination/non-vaccination decisions. This analysis is based on S1 data (Nov 2012) when the vaccine was first rolled out. The analysis includes consideration of demographic, risk perception, knowledge, and concerns that may drive or inhibit vaccine uptake.

The main drivers of early vaccination included higher levels of concern about the risk of HeV and its consequences, believing that the vaccine is effective and is easy to get/arrange, having horses in Queensland, having higher levels of contact with a veterinarian to gain information about HeV, and being concerned that veterinarians wouldn’t treat unvaccinated horse. Significant barriers included cost/financial status, concerns about side effects, and being in the breeding sector of the industry.

This manuscript will be submitted in the first quarter of 2016.

Qualitative research – HHALTER interview study

The interview component of the HHALTER study is being written up for submission to a peer-reviewed journal. The draft is entitled “We've learned to live with it” - A qualitative study of Australian horse owners' attitudes, perception, and practices in response to Hendra virus”.

This work is being led by Anke Wiethoelter. These data have been reported in Chapter Two of this report and further information has been supplied in Appendix 3 (poster and abstract). The full theoretical model of horse owners' approaches to HeV risk and mitigation practices will be covered in this manuscript and it is hoped that this will facilitate a better understanding of the decision-making processes of horse owners and their communication pathways.

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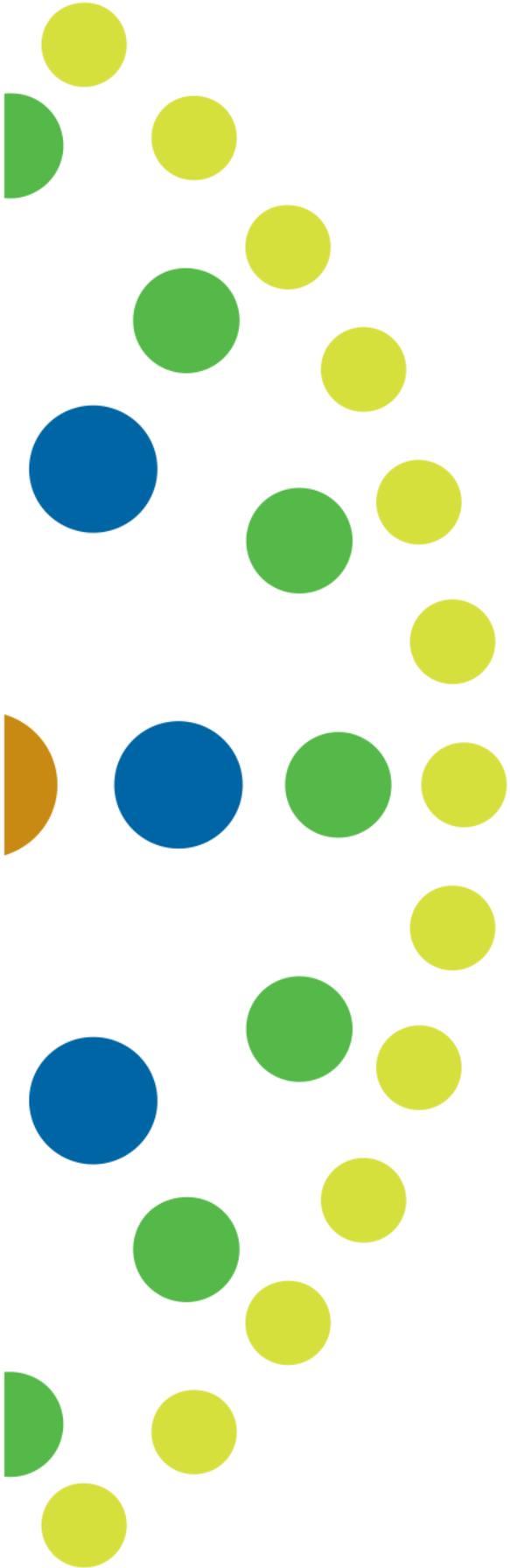
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Longitudinal Cohort Study of Horse Owners

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