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Expertise and communicating about infectious disease: a case study of uncertainty and rejection of local knowledge in discourse of experts and decision makers

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Abstract

Despite Australian horse owners being encouraged to vaccinate their horses against Hendra virus to reduce the risk of this potentially fatal virus to horses and humans, vaccine uptake has been slow. Discourse around the vaccine has been characterised by polarisation and dissenting voices. In this study we interviewed horse owners (N=15) and veterinarians (N=10), revealing how expert knowledge, disqualification of lay knowledge and inadequate handling of uncertainty impacted divisive discourse around Hendra virus. We assert that more inclusive, reflective and ultimately more effective risk communication practices will result if the legitimacy of diverse knowledge sources and the inevitability of uncertainty are acknowledged.

Keywords

Health communication; Professionalism, professional development and training in science communication; Risk communication

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Introduction

Expert knowledge is neither generated nor received by its intended audience in a neutral, value-free context [Connor and Siegrist, 2010; Mogendorff, te Molder, van Woerkum et al., 2016; Yearley, 2000]. When scientific knowledge is used in communication strategies around risk situations such as disease outbreaks, the underlying purpose driving such communication is usually compliance and reduction of uncertainty [Brashers, 2001; Davis, Stephenson and Flowers, 2011]. This influences both the message and its distribution, and dictates the measurement of successful communication [Davis, Stephenson and Flowers, 2011; Fischhoff, Slovic and Lichtenstein, 1982]. If a compliant response to a communication strategy is considered the only 'correct' response, the nuances of actual responses may be misunderstood or ignored [Davis, Stephenson, Lohm et al., 2015]. Likewise, if the default communication paradigm is uncertainty reduction, then opportunities to manage the complexity of uncertainty will be limited [Brashers, 2001]. This can result in frustration for stakeholders, especially for those with training in risk

decision making and decision makers considered at risk [Garvin, 2001; Kung et al., 2013; Manyweathers, Field, Longnecker et al., 2017; Slovic, 1999].

The selection of what constitutes legitimate responses to communication strategies is underpinned by institutional cultures that surrounds scientific research, particularly involving expertise [Mogendorff, te Molder, Gremmen et al., 2012; Wynne, 1998] and management of uncertainty [Brashers, 2001; Han, 2016; Priest, 2006]. Institutional cultures inform an often prescriptive approach to risk communication that disqualifies reflection about how local knowledge and uncertainty may impact responses to risk and decision making [Brashers, Goldsmith and Hsieh, 2002; Horst, 2008; Metcalfe, 2019; Wynne, 1998]. This lack of reflection may result in decreased trust between stakeholders and hinder participatory communication around risk and response to disease outbreaks.

Risk communication strategies addressing newly emerging diseases are complex. Risk mitigation strategies are not initially available and the scope of uncertainty is vast for all involved [Bangerter, Green and Gilles, 2011; Christley et al., 2013; Holland et al., 2012]. Nor is expertise the sole prerequisite on which risk communication messengers can claim credibility [Fiske and Dupree, 2014]. With communicator credibility found to be a shortcut for audience acceptance of scientific messages [Brewer and Ley, 2013], understanding the role of trust in establishing messenger credibility is important for effective risk management strategies and the control of disease outbreaks.

When risk communication involves diseases in domestic animals, the human-animal bond creates an added complexity to the communication and management of outbreaks [Anderson, 1997; Enticott and Vanclay, 2011]. If this bond is underestimated, or owner expertise is not considered legitimate, serious negative consequences can arise [Convery et al., 2005; Franklin, 2001; Rogers, 2016; Taylor, Lynch et al., 2015]. Without consultation and collaboration, disease management protocols may be misunderstood, mocked or ignored [Bangerter, Green and Gilles, 2011; Hernández-Jover, Taylor et al., 2012; Jensen, 2004; Manyweathers, Field, Longnecker et al., 2017].

Communication around zoonoses (diseases that spread from animals to humans) are even more complex because of the added risk for owners and veterinarians [Jensen, 2004; Ochieng' and Hobbs, 2016; Triezenberg et al., 2014]. Veterinarians are often identified as trusted sources of information around biosecurity generally [Brennan and Christley, 2013; Hernández-Jover, Higgins et al., 2016]. Yet there are many factors that influence whether people engage with new information and whether they act on it [Longnecker, 2016] and veterinarians, like many experts, may not have a deep understanding of science communication. When both humans and animals are at risk of disease, veterinarians can be required to undertake a significant public health role for which they may not be well rehearsed, while also needing to protect themselves [Mendez, Judd and Speare, 2012]. This new role, with its required communication skills, needs to be better understood to facilitate preparation by the profession for future zoonotic disease outbreaks [Dowd et al., 2013; Manyweathers, Field, Jordan et al., 2017]. The lessons learned are valuable for various experts in different contexts of risk communication.

Hendra virus and the development of a vaccine for horses

Hendra virus is a zoonosis that has caused fatal infections in both horses and humans, with humans being infected from direct contact with sick horses. [Field, 2016; Mahalingam et al., 2012]. The natural hosts, characterised by subclinical infections, are pteropid bats (flying-foxes) [Edson et al., 2015; Field et al., 2015; Halpin et al., 2000]. To date, there have been seven humans cases, of which four (57%) have been fatal [Goldspink et al., 2015]. Of these human cases, five have been veterinarians, or para-veterinary staff.

A vaccine against Hendra virus for use in horses, and consequently providing protection for humans, was developed in 2011 after an unprecedented number of 23 horse cases, over a wide geographic area [Broder, Weir and Reid, 2016; Middleton et al., 2014]. The vaccine was released under restricted permit use in November 2012. This initial release was pending full registration with the Australian Pesticides and Veterinary Medicines Association (APVMA), the Australian Government body responsible for the registration of agricultural and veterinary chemicals. The vaccine could be used under strict conditions including administration by an accredited veterinarian, and the microchipping of inoculated horses. Since 2012, the permit for the Hendra virus vaccine has undergone several iterations, including instructions for six-monthly boosters. In August 2015, the vaccine became fully registered, with 12 monthly boosters being recommended from May 2016. To date, no vaccinated horses have been diagnosed with Hendra virus, despite periodic cases in unvaccinated horses.

The state government agencies responsible for Hendra virus policy are the Queensland Department for Agriculture and Fisheries (QDAF) and New South Wales Department of Primary Industries (NSW DPI). They recommend vaccination as *'the single most effective way of reducing the risk of Hendra virus infection in horses'* [Queensland Government, 2013]. However, horse owners have been hesitant in their uptake of the vaccine [Middleton et al., 2014]. Whilst there is no national registry of horses in Australia, it is estimated that the majority of horses remain unvaccinated, with rates as low as 11% in New South Wales and 17% in Queensland [Taylor, Dhand et al., 2016].

Communication challenges

During the first ever Australian outbreak of Equine influenza in 2007, horse owners identified information coming from veterinarians as significantly more efficacious than information from other sources [Schemann et al., 2011]. Veterinarians are still identified as one of the most preferred and used sources of information around Hendra virus [Hii et al., 2020]. However, since the vaccine release, discourse among some horse owners and veterinarians around Hendra virus and the vaccine has become divisive. Divisiveness has been exacerbated by several factors, including the exclusion of unvaccinated horses from veterinary care by some veterinary practices and prosecution by Work Health and Safety officers of veterinarians for failure of duty of care around management of suspected Hendra virus cases. Equine veterinarians have left the profession as a result [Mendez, Judd and Speare, 2012] and a state government enquiry around the handling of the vaccine has added to discourse complexity [Queensland Government, 2016].

A project was launched to facilitate a deeper understanding of the factors involved in uptake of Hendra virus risk mitigation strategies. The *Hendra Virus Infection and Transmission Dynamics — Conversation with Industry* project was commissioned in Australia by an intergovernmental Hendra Virus Taskforce [Australian Government, 2016; Taylor, Dhand et al., 2016]. Overall, the project was directed to assess the level of uptake of government-recommended Hendra virus risk mitigation practices and to investigate the barriers and enablers that influence this uptake.

This study builds on findings from that project. Designed in two stages, the first part of this study involved an online survey targeted towards horse owners living in areas near previous Hendra virus cases, who had elected not to vaccinate any or all of their horses. The survey was designed to examine risk mitigation practices, risk perception, and horse owners' attitudes towards the risk of Hendra virus, with results being reported elsewhere [Manyweathers, Field, Jordan et al., 2017; Manyweathers, Field, Longnecker et al., 2017]. This paper focuses on the second stage of the study, using in-depth interviews to explore the nature of engagement around Hendra virus among veterinarians and horse owners who had elected not to vaccinate their horses. The aim of the study was to explore the perspectives of those considered to be non-compliant with a recommended practice and the experts tasked with providing both information and the vaccinations. The results can be used to inform future risk communication strategies and management of infectious diseases, both emerging and re-emerging.

Methodology

In-depth interviews were conducted with a subsample of survey respondents (horse owners who had elected not to vaccinate some or all of their horses) and practising veterinarians in areas known to be at risk of Hendra virus. Table 1 provides information regarding interview participants. The majority of respondents identified as female. This apparent gender bias is in fact representative of the Australian horse owning population [Hii et al., 2020; Taylor, Dhand et al., 2016].

Overall 25 in depth interviews lasting 60 to 120 minutes were carried out by the first author: 23 face to face and two by phone. There were 10 interviews with veterinarians, including four interviews with equine veterinarians and pathologists from the James Cook University veterinary school in Townsville, Queensland. Interviews were conducted with 15 horse owners. Interviews were carried out in 2015, one month before the Hendra virus vaccine for horses was fully registered.

Non-vaccinating horse owners were identified from an online survey carried out between January and March 2015. All respondent data from the survey were collected from SurveyMonkey™ into Excel™ files. The only respondents considered for interviews were those who had completed the survey, consented to further contact, included their contact details and were located near areas of previous Hendra virus cases.

In order to ensure good coverage of locations, a small interview sample size for each location was required. The strength of this methodology lies with the 'thick description' that comes with the semi-structured nature of the data collection [Holliday, 2002, p. 77]. However, the sample may not represent all horse owners in each area visited. The representativeness of this sample can be considered in the light of other Hendra virus studies that suggests that these experiences and

Table 1. Interviewee characteristics.

ID	Location	Gender	Role	Number of Horses	Vaccination status**
O01	Southern QLD	F	Horse owner	4	some
O02	Southern QLD	F	Horse owner	6	none
O03	Southern QLD	F	Horse owner	5	none
O04	Southern QLD	F	Horse owner	12	some
O05A	Southern QLD	M	Horse owner	18	none
O05B		F	Horse owner		
O06	Northern NSW	F	Horse owner	4	none
O07	Northern NSW	F	Horse owner	11	some
O08	Northern NSW	F	Horse owner	12	some
O09	Southern QLD	F	Horse owner	2	start/stop
O10	Southern QLD	F	Horse owner	3	some
O11	Central QLD	F	Horse owner	17	some
O12	Northern NSW	F	Horse owner	8	some
O13	Northern NSW	F	Horse owner	10	none
O14	Southern QLD	F	Horse owner*	6	some
O15	Far North QLD	F	Horse owner*	2	start/stop
V01	Southern QLD	M	Veterinarian	0	—
V02	Southern QLD	M	Veterinarian	N/A	—
V03	Northern NSW	F	Veterinarian	3	all
V04	Southern QLD	F	Veterinarian	2	none
V05	Central QLD	F	Veterinarian	0	—
V06	Northern QLD	F	Veterinarian	0	—
V07	Northern QLD	M	Veterinarian	0	—
V08	Northern QLD	F	Vet. Pathologist	0	—
V09	Northern QLD	F	Veterinary Nurse	N/A	—
V10	Northern QLD	M	Veterinarian	0	—

New South Wales (NSW), Queensland (QLD), N/A — data were not available. *Phone interviews. **All/some/none horses vaccinated. Start/stop — The vaccine protocol was started but then stopped.

opinions are consistent with those reported by the horse owning community in areas where Hendra virus cases have been reported [Hii et al., 2020; Mendez, Büttner et al., 2016; Wiethoelter et al., 2017].

Interview protocol

Different interview questions were developed, after multiple iterations, for horse owners and veterinarians [Manyweathers, 2017]. Interviews were semi-structured, adopting a conversational approach with questions used as prompts [Brinkmann and Kvale, 2015]. The interview protocols for both horse owners and veterinarians are provided as supplementary material.

Ethics approval for the study was provided by the Human Research Ethics Committee of the University of Western Sydney (Protocol No. H10643).

Data Analysis

Each interview was digitally recorded, transcribed and downloaded into NVivo™. Comments from individual horse owners were identified with an 'O' and numbered. Veterinarians were identified with a 'V'. Any words deemed necessary for clarification have been added to reported quotes in bold square brackets.

Interviews were coded initially based on the interview questions. From the initial data-derived coding [Braun and Clarke, 2013], a deeper iterative examination was undertaken of interviewees' reflection around Hendra virus, including: How were the horse owners and veterinarians making sense of their experiences and why? What assumptions may underpin these considerations? The coding manual was developed by the first and third author, based on a latent coding approach [Braun and Clarke, 2013], with the themes being developed by all three authors. The final manual is found in Table 2.

The principles of inductive thematic analysis [Braun and Clarke, 2013], and interaction between data and existing research around expertise, uncertainty, risk and trust [Cairns, de Andrade and MacDonald, 2013; H. Collins and Evans, 2007; Douglas, 1986; Dunwoody, 1993; Engdahl and Lidskog, 2014], informed the development of the main themes [Davis, Stephenson, Lohm et al., 2015; Flyvbjerg, 2001] reported in this paper. Development of the themes was also informed by previous research into risk perception and uptake of suggested risk mitigation strategies for Hendra virus [Kung et al., 2013; Manyweathers, Field, Jordan et al., 2017; Manyweathers, Field, Longnecker et al., 2017; Taylor, Dhand et al., 2016].

Results

Communication between veterinarians and horse owners around the issue of Hendra virus and the release of the vaccine for horses has been characterised by dissent and complexity. This quote provides a snapshot of the communication challenges for all participants in the discourse.

> *One guy said to me, "How many people have died?" And I said, "Four people have died." "How many horses?" And I couldn't remember how many, so I said, "A hundred." And he said, "Well, when 20 people have died and 2,000 horses have had Hendra, I will vaccinate my horses."… I said, "So you're happy if your 13-year-old daughter is one of the 16 more people who've got to die before you vaccinate your horses?" And I didn't vaccinate his horse…The next day, he rang and said, "I don't want that vet back on my property."* **(V10)**

Two main but interwoven themes around expertise were identified from the interview data obtained in this study — firstly, the management of uncertainty and its effects on trust, and secondly, how perception of expertise influenced inclusion in discussions.

Trust in times of uncertainty

The management of uncertainty and the impact this has on the development of trust between participants was identified as a significant contributor to the divisive

Table 2. Interview coding manual.

Codes	Description	Example comments
Information sources	Descriptions of where people are going to for information about Hendra virus and the vaccine, what sources do they trust?	I mean if I'm going to look on the internet, I would — yes, try and look up on vet pages and things like that rather than Facebook or something like that, which I have very — absolutely no faith in whatsoever (O11)
Questions around what is not yet known	Descriptions of what is not known, or where uncertainty might lie	Because there's still a very low incidents so I think the evidence of Hendra is that the virus has probably been around for decades and there's still less than a handful like less than six people have died from it so it's — there's still a lot of questions about it. I think about how much an infected load whether they can adequately identify an infected animal that's going to potentially pass it on to themselves (O07)
Us and them	Evidence of division between vets and horse owners in veterinary/horse owner interviews	All I've tried to do is spread information not lies. We ran a Hendra virus plan information evening down the Gold Coast for our clients down there — opened it up, had an amazing turn out, and amazing response and — yeah. I've just tried to be vehemently defensive of the veterinary profession (V07)
Reasons for not vaccinating	Descriptions of reasons for not vaccinating any or some horses.	Our horses are breeding stock. It's not approved or recommended for breeding stock. So on any other grounds that he or I might personally have against vaccinations or Hendra vaccination in particular, it's not recommended for our stock. (O05B)
Reasons for vaccinating some and not others	Description of reasons why some or all horses were vaccinated	I feel much more comfortable that I can call the vet out and know that they'll attend, so that was a big thing for me. Although I can cope with a lot of stuff, I did want to feel that I would be able to call my vet and they would — it's very important that my horses don't suffer when they're sick. So I need to feel that I have access to a vet in an emergency that I can't cope with. (O09)
Hendra virus versus the vaccine	Consideration of the risk of Hendra virus and the risk of using the vaccine	For me, Hendra vaccine is more damaging than Hendra virus. Hendra virus is nothing. (O05A)
Suggestions for better management	Comments highlighting what approaches might be done better	I think honesty and integrity are two words that are completely missing from this (O01)

nature of the communication among veterinarians and horse owners in this study. Management of the restricted permit for use of the vaccine played a particular role

in undermining trust, as highlighted in this comment by a horse owner.

> *So in the first two years, they **[vaccine manufacturer]** changed their permit fractionally five times…But there's no data added saying "We've tested now the 100,000 horses…and we've blood tested them, and we know that horses who have had a shot every six months have a titre of over whatever."* **(O09)**

The desire for evidence to support vaccine safety and efficacy was reflected in many of the interviews (n=6). Two respondents also commented about how changes were made to the permit without supporting information and how they considered this process very unsettling (n=2). This uncertainty contributed to the decision of two respondents who had started vaccinating their horses to discontinue the vaccine protocol. These comments included calls for transparency of data, and frustration with how requests for more information were dealt with. This perceived lack of transparency appears to have added to the general feeling that secrets were being kept and that horse and human welfare were not a priority.

The following comment from a veterinarian highlights the importance of transparency about what facts are known and what is still unknown.

> *This has been touted as much safer than what it actually is. I think people need to be given all the details. They need to know about Freedom of Information Act. We need to know what's really going on and then it should be up to the individual.* **(V04)**

A common theme was the desire for openness around what information is available to those who need to make decisions around the risk event (n=5). The ongoing silence or discordant interactions with pharmaceutical company representatives and veterinarians appeared to validate participants' increasing fear around the vaccine and added to the sense that there was a conspiracy between veterinarians, the veterinary professional body, the pharmaceutical company and the vaccine registration body (AVPMA).

The type of interactions between horse owners and veterinarians were generally reported as being negative, but there were examples of positive participatory conversations. The following comment illustrates how trust can co-exist with uncertainty.

> *The anti-vaccination people say, "Well, there's no guarantee that your horse is protected if it's vaccinated." But having spoken to my vets, I'm fairly comfortable with the fact that my horses are highly unlikely to contract Hendra virus after vaccination, and I have a bit more faith in them than I do the Facebook page.* **(O04)**

In this situation, the negativity surrounding the uncertainty of the vaccine had been addressed openly within the veterinarian/horse owner relationship, resulting in some of the owner's more at-risk animals being vaccinated. The language used by this horse owner allows for uncertainty around the extent of vaccine protection and a continuation of collaborative discourse.

When faced with people whose decisions differ to those supported by current scientific research, the common response by many of the veterinary participants

was to assume that more information, or the right information would change people's minds. This illustrates the prevalence of the deficit approach within science communication, that receivers of scientific information, in this case horse owners, are passive, empty vessels waiting to be filled, and that uncertainty needs to be eliminated.

> *I think we just need to get as much data as we can out there regarding safety and efficacies. You can try and convince people and that may not even be enough.* **(V06)**

This approach to uncertainty and communication seemed to create a larger gap in the conversation and contributed to another issue around science communication and expertise — the need for a more participatory, two-way approach to science communication.

Consideration of local knowledge

The second theme to emerge in interviews involves how people and their expertise might be accepted into or rejected from the discourse, based on how their knowledge and experience was valued. The following comment from a veterinarian highlights the potential for exclusion of people who have differing opinions.

> *I don't understand why people won't vaccinate their horse. Why would you not? It's almost a perfect vaccine…Causes some slight reactions, but has been shown to be 100 percent protective with very minimal side effects, bit of a sore neck for once in a while, if you need to have… a dose of bute* ***[anti-inflammatory for horses]****. There's those that refuse to have it done that are probably the same tree-hugging hippies from Byron that refuse to have their kids vaccinated, and their kids are dying of meningococcal. But decisions are being made on political, financial, and public relations matters, not sound medical basis or sound medical decisions. It's ridiculous.* **(V07)**

At least two veterinary respondents appeared to disqualify the possibility of anything going wrong with the administration of the vaccine, and discussed the vaccine as though it was infallible. Yet regarding any vaccine as "almost perfect" is potentially blinding to the possibility of side effects and misses opportunities for further critical thinking and participatory discussion about vaccine efficacy.

The following comment offers an alternative approach to communication.

> *I just think that they came in and told us the best thing was for everybody* ***[to vaccinate]*** *without consultation. It was like all of a sudden the vaccination is here and you must do it and I think that was the driving force for a number of people to really take offence. And it really is a sense at being told that this is what they have to do regardless of their own management with their horses. I think that people would accept it a lot better if they weren't forced. I just think that possibly people just need it to be done in a more softly, softly approach. And not being treated like idiots. I think we were treated like idiots to begin with.* ***(O14)***

This comment illustrates the consequences of a lack of inclusion of horse owners' opinions, knowledge and expertise in the communication around the management of their animals, the vaccine launch and uptake of the Hendra vaccine for horses. The fact that many horse events were making vaccination a prerequisite for competition also contributed to a sense that some horses owners felt they were being forced to vaccinate. The majority of participants in this study who had vaccinated some of their animals (n=7) had done so in order to compete.

The following comment is from a horse owner who found herself on the receiving end of disbelief around her horse's vaccine injury experience.

> *If you tell the average person you've got a problem with the vaccine, they look at you like you've just said "I've got syphilis." Or "I'm still breastfeeding my teenager."* ***(O09)***

Many horse owners spoke about their own experiences of vaccine side effects, or of those they knew about, with seven comments reflecting this. The perception was that the official communication arena excluded the possibility of side effects, and this contributed to the sense by horse owners of being ignored. This appeared to further undermine some owners' trust in their veterinarian, the pharmaceutical company and the vaccine regulatory body. Some respondents reported feeling initially shocked by their experience of the vaccine side effects, then ostracised by their veterinarian when their concerns were raised, and then afraid to vaccinate again, or to vaccinate new horses. All this appeared to contribute to the perception that there was a conspiracy to protect the vaccine and its associated profits. The sense for some participants was that there was no one who would listen to or believe them.

The theme of inclusivity also reflects on who has the power or legitimacy to ask questions and interrogate scientific information. The following comment highlights the approach one horse owner took to consider the number of boosters required.

> *It's not the vaccine I'm querying. It's the amount of boosters we have to give…I would recommend everybody in the risk area vaccinate their horses as per permit. I've never been somebody who's not trusting of authority. I've never been anyone to question that we should vaccinate…If you'd said to me "I don't like vaccinations." I would have said. "Oh, one of those crazy people."* **(O09)**

That comment reflects the exclusion some horse owners perceived when they did question aspects of the vaccine and protocol, even when those questions appeared to be scientifically robust and appropriate in the field of vaccine science.

Indeed, scientific thinking underpinned some of questions horse owners had about Hendra virus generally, as illustrated by this quote.

> *One thing I would like to find out…all the horses that contracted Hendra, I'd like to know what sort of condition they were in, how their immune system was, because most of them seem to be old or pregnant brood mares. I'd like to know all these sort of things and I think it should be studied to find out if the immune systems are down on most of the horses that get it naturally.* **(O04)**

Many of the horse owners interviewed gave thoughtful and considered responses that included scientific consideration to questions around the virus and the vaccine. Multiple interviewees (n=6) indicated an interest in exploring the option of antibody testing to further the scientific knowledge base of protection duration offered by the vaccine. Four respondents were interested in the questions regarding infection dynamics: one horse infected in a paddock of many horses, for example. Indeed, interviewees generally had positive things to say about the vaccine. What they appeared concerned about was a perceived lack of inclusivity — that their opinions and knowledge were not valued, and that their questions were not adequately dealt with. If considered appropriately, these comments could contribute to more inclusive and participatory relationships and stakeholder-inclusive research.

An example of when inclusion of local knowledge and experience in communication strategies may have acted as a conduit to participatory communication and trust, but resulted in failure is highlighted in the next comment.

> *I thought… the vaccine's all right. But then one of the fellas* ***[pharmaceutical representatives]****… spoke up and said, "Well as far as we know, bats don't defecate while they're flying." And everyone around here has had their cars splattered by bats. It was just off putting to have somebody make a silly statement like that when they were supposed to be convincing us that what we're doing is correct. And that set me back a little bit.* **(O12)**

That comment illustrates communication impeded by perception of the vaccine manufacturer's lack of awareness of local knowledge and bat physiology. It is not difficult to see how this interaction would seriously damage any existing trust in the pharmaceutical company and thus their ability to produce a product that can also be trusted. Many other respondents reported feeling that their knowledge around horse management and bat interactions were disregarded in the conversation. Interview data reflected how this lack of local context undermined the legitimacy with which the information and data from veterinarians and pharmaceutical representatives were received by horse owners in the study.

The veterinary profession as a whole, together with the national professional organisation, the Australian Veterinary Association (AVA), were also mentioned for their perceived lack of reflexive practice around how the vaccine was used and promoted (n=5). Some comments highlighted the damage this approach did to the veterinary profession generally and that it contributed to the divisive nature of communication around the vaccine.

> *I think the veterinary profession is doing a lot of damage to itself. When you get the president of the AVA touting online about special offers… the dental, Hendra/tetanus* ***[vaccine for horses]*** *package. Tetanus and Hendra and strangles* ***[vaccine for horses]*** *at the same time as having a sedation in dental. It's not supposed to be like that. They're not reading the interactions. They're not reading the recommendations. I mean they've made themselves look like idiots.* **(V04)**

Examples of where the vaccine permit guidelines were openly ignored were highlighted by interviewees, contributing to the underlying concern that the drive

to vaccinate horses was driven less by welfare and horse/human health issues and more by profit or other interests.

The themes of uncertainty management and consideration of local knowledge were developed from the interview data. Their contribution to the divisive communication around Hendra virus and the vaccine for horse are discussed here.

Discussion

The value of open and frank communication around potentially controversial scientific issues cannot be underestimated [Davis, Stephenson, Lohm et al., 2015; Leiss and Powell, 2004; Manyweathers, Field, Longnecker et al., 2017]. However, for such communication to be possible, an arena where multiple voices can be heard is needed [Wynne, 1998], and the role of uncertainty understood [Brashers, 2001]. An issue which may appear clear and resolved to some stakeholders, may still be controversial and uncertain for others. Awareness of this possibility would provide scope for differing viewpoints within discussions [Han, Klein and Arora, 2011; Wynne, 1991].

The assumption that data arising from scientific research that informs communication strategies is unbiased and neutral is implicit within scientific training [H. M. Collins and Evans, 2002; Mogendorff, te Molder, van Woerkum et al., 2016; Wynne, 2006]. Wynne [1993] has suggested that self-awareness or reflexivity of how information is generated and used by those with expertise in risk decision making is vital. This should extend to management of uncertainty [Brashers, 2001]. Without such reflexivity, experts may consider their conclusions about risk are neutral, unbiased and free from any social and cultural context, with serious negative consequences for participatory communication [Metcalfe, 2019; Turner, 2001]. Scientific research is still firmly embedded in a positivist approach to knowledge [Seethaler et al., 2019], despite decades of research demonstrating the value of other ways of knowing [Douglas, 1986; Freudenburg, 1988; Slovic, 1999; Wynne, 1989]. The continuing default of using the deficit model of science communication corroborates this [Mogendorff, te Molder, Gremmen et al., 2012; Raps, 2016; Seethaler et al., 2019]. Appropriate consideration needs to be given to increasing the transparency of assumptions about neutrality in scientific research and the impact of those assumptions on risk communication.

The opaque nature of the scientific process also contributes to the apparent clash of paradigms around the development and adoption of new technology, including novel vaccines [Seethaler et al., 2019]. Clinical trials are not able to cover every biological, environmental, social and epidemiological variable and no vaccine is 100% protective nor risk free. A positivist approach to vaccine science is risky because it hinders discussion beyond 100% efficacy and uptake. Increased transparency of the process by which ideas are made concrete and how uncertainty is managed within the scientific framework can facilitate discussion around what is known, not yet known or not able to be known [Frewer et al., 2002; Keohane, Lane and Oppenheimer, 2014; Pearce et al., 2015].

Assuming a one size fits all, top down, binary approach to mitigating risk around disease outbreaks, compliant or noncompliant, does not promote inclusive communication or establishment of trusting relationships [Davis, Stephenson and Flowers, 2011]. Allowances should be made for uncertainty and alternate voices so

that approaches to managing infectious diseases, based on unfolding but possibly obscured research will not continue to be plagued with fears of conspiracy and cover-up [Seethaler et al., 2019]. Without this, experts will continue to be ill-prepared for their role in the discourse.

The issues of uncertainty management and inclusivity highlighted in this study underpin greater institutional challenges around how science (in this case specifically veterinary science) is taught and evidence-based science communication practices implemented. Veterinary training in Australia excels in clinical practice, including diagnostics and surgery. What is lacking in their science training is capacity for deeper reflection of the impacts of source of expertise and of uncertainty when providing information that may facilitate or impede communication around decision making. An understanding of the complexity of the human animal bond, and the psychological impacts of disease management on animals owners, regardless of whether the animal is for production (profit) or pleasure is also important [Dashper, 2014; Mort et al., 2008]. If scientific training for veterinarians and others taught these concepts explicitly, participatory communication around risk communication may be facilitated. Future work in this area should be directed towards the development of evidence-based changes to science education aimed at improving the capacity of scientists, including veterinarians, to engage in progressive and participatory communication, especially around traditionally divisive topics.

This study was undertaken to examine perspectives of veterinarians and horse owners around Hendra virus and the release and uptake of the vaccine for horses. One aim was to inform improvements in future communication around emerging infectious zoonotic diseases. We recommend inclusion of the concepts of the roles of expertise and uncertainty in communication to improve disease management strategies in veterinary education.

We found evidence that institutional experts' disqualification of local knowledge hampered participatory communication. This disqualification contributed to dissent around the recommended disease management strategies and disengagement and alienation of some decision makers. Trusting and open relationships between veterinarians and their clients are important. The goal for any zoonotic risk communication approach or policy should include strategies that facilitate improved communication between veterinarians and their clients, avoiding a one-size-fits-all, compliance focussed approach. This goal should include approaches that enhance messenger credibility [Fiske and Dupree, 2014] and encourage communication within existing relationships with respect for and understanding of animal owner knowledge [Higgins et al., 2016]. This study has highlighted the importance of improving experts' capacity in reflexive practice and the urgent need for explicit teaching of evidence-based principles of science communication.

Our findings support the contention that how expertise of different stakeholders is valued influences the extent to which communication promotes trusting relationships that facilitate risk mitigation. Management of uncertainty that surrounds scientific research needs to be factored into communication strategies around responses to emerging diseases. This is particularly true when research is new and decisions are being made while many questions remain unanswered.

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