Preventive Veterinary Medicine 148 (2017) 28–36

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Australian horse owners and their biosecurity practices in the context of Hendra virus

Anke K. Wiethoelter[a,b,*,1], Nicole Schembri[b,1], Navneet K. Dhand[a], Kate Sawford[a], Melanie R. Taylor[b,c], Barbara Moloney[d], Therese Wright[d], Nina Kung[e], Hume E. Field[e,f], Jenny-Ann L.M.L Toribio[a]

[a] Farm Animal & Veterinary Public Health, The University of Sydney School of Veterinary Science, NSW, 2006, Australia
[b] Centre for Health Research, School of Medicine, Western Sydney University, Penrith, NSW, 2751, Australia
[c] Organisational Psychology, Department of Psychology, Macquarie University, NSW, 2109, Australia
[d] NSW Department of Primary Industries, Orange, NSW, 2800, Australia
[e] Queensland Department of Agriculture and Fisheries, Brisbane, Queensland, 4001, Australia
[f] EcoHealth Alliance, New York 10001, USA

ARTICLE INFO

Keywords:
Biosecurity
Horse
Horse owner
Hendra virus
Prevention
Questionnaire

ABSTRACT

In recent years, outbreaks of exotic as well as newly emerging infectious diseases have highlighted the importance of biosecurity for the Australian horse industry. As the first potentially fatal zoonosis transmissible from horses to humans in Australia, Hendra virus has emphasised the need to incorporate sound hygiene and general biosecurity practices into day-to-day horse management. Recommended measures are widely publicised, but implementation is at the discretion of the individual owner. This cross-sectional study aimed to determine current levels of biosecurity of horse owners and to identify factors influencing the uptake of practices utilising data from an online survey. Level of biosecurity (low, medium, high), as determined by horse owners' responses to a set of questions on the frequency of various biosecurity practices performed around healthy (9 items) and sick horses (10 items), was used as a composite outcome variable in ordinal logistic regression analyses. The majority of horse owners surveyed were female (90%), from the states of Queensland (45%) or New South Wales (37%), and were involved in either mainly competitive/equestrian sports (37%) or recreational horse activities (35%). Seventy-five percent of owners indicated that they follow at least one-third of the recommended practices regularly when handling their horses, resulting in medium to high levels of biosecurity. Main factors associated with a higher level of biosecurity were high self-rated standard of biosecurity, access to personal protective equipment, absence of flying foxes in the local area, a good sense of control over Hendra virus risk, likelihood of discussing a sick horse with a veterinarian and likelihood of suspecting Hendra virus in a sick horse. Comparison of the outcome variable with the self-rated standard of biosecurity showed that over- as well as underestimation occurred. This highlights the need for continuous communication and education to enhance awareness and understanding of what biosecurity is and how it aligns with good horsemanship. Overall, strengthened biosecurity practices will help to improve animal as well as human health and increase preparedness for future disease outbreaks.

1. Introduction

According to the World Organisation of Animal Health (OIE), biosecurity comprises a "set of management and physical measures designed to reduce the risk of introduction, establishment and spread of diseases, infections or infestations to, from and within an animal population" (OIE, 2016). Recent outbreaks of exotic as well as newly emerging infectious diseases in Australia such as equine influenza and Hendra virus (HeV) highlighted the importance of biosecurity for the Australian horse industry. This industry is estimated to contribute AUD $6.3 billion (around 1%) annually to the Australian gross domestic product (Gordon, 2001) and the successful containment and eradication of the equine influenza outbreak in 2007/08 was linked to substantial costs and losses (Smyth et al., 2011). The economic impact of HeV is

* Corresponding author. Current address: Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville VIC 3010, Australia.
E-mail address: anke.wiethoelter@unimelb.edu.au (A.K. Wiethoelter).
[1] Both authors contributed equally.

http://dx.doi.org/10.1016/j.prevetmed.2017.09.013
Received 21 March 2017; Received in revised form 24 September 2017; Accepted 26 September 2017

less well-characterised, although average support and response cost in a localised HeV outbreak and economic loss due to horse death are estimated to amount to AUD $30,660 per horse (Wilson and Ward, 2016).

First described in 1994, HeV sporadically spills over from bats of the genus *Pteropus* (also commonly called flying foxes or fruit bats) to horses (Murray et al., 1995; Halpin et al., 2000). Clinical signs in horses include a range of general, respiratory and/or neurological signs such as fever, abdominal pain, coughing, nasal discharge, loss of vision, and ataxia (Ball et al., 2014). Acute onset of illness and rapid deterioration leading to death within 48 h are also common. The broad range of unspecific signs make it difficult to diagnose HeV infections in horses and may lead to initial misdiagnosis as colic, intoxication, snake bite, or tick paralysis (Ball et al., 2014). Spillover incidents so far have been limited to Australia's east coast (Field, 2016). Although the exact mode of transmission from flying foxes to horses remains unknown, urine seems to be the most likely source of infection (Edson et al., 2015). Horses act as amplifying hosts, thereby enabling transmission of the virus to other horses, dogs and humans (Murray et al., 1995; Kirkland et al., 2015). However, transmission from horses is rare and requires close contact with bodily fluids or infected materials due to the low infectivity of HeV (Williamson et al., 1998; Marsh et al., 2011). To date only seven people have been infected with HeV, but no approved therapeutics are available as yet for human use (Broder, 2012) and the high human case fatality rate of 57% (Field and Kung, 2011) has raised public health concerns.

Being the first potentially fatal zoonosis transmissible from horses to humans in Australia, HeV has emphasised the need to incorporate biosecurity in horse management and handling practices and initiated a cultural shift (Weese, 2014). Due to its natural wildlife reservoir, eradication of HeV is impossible. Thus, the key is to prevent spillover from flying foxes to horses by vaccinating horses for HeV (Middleton et al., 2014) and minimising direct and indirect contact, e.g. covering feed and water, stabling horses overnight, or fencing off areas under fruit and flowering trees, which might attract flying foxes (QLD Department of Agriculture and Fisheries, 2013; Freeman, 2017). In addition, sound hygiene and general biosecurity practices (e.g. avoid sharing gear, isolate sick horses, handle healthy horses first, clean and disinfect contaminated equipment, use appropriate personal protective equipment (PPE) when handling sick horses) are recommended and have been widely publicised. These routine biosecurity measures not only prevent the spread of HeV from horses, but also minimise the chance of transmission of other endemic infectious diseases such as *Streptococcus equi* ssp. *equi* (strangles) and equine herpes virus infections. Implementation and integration of these measures into day-to-day practice, however, is at the discretion of horse owners and managers. Only limited information is available on general biosecurity practices routinely applied by horse owners in Australia (Schemann et al., 2011) and elsewhere (Kirby et al., 2010; Rogers and Cogger, 2010; Rosanowski et al., 2012; Traub-Dargatz et al., 2012). Research has shown that horse owner uptake of recommended biosecurity measures varied due to demographic factors and presence of disease, as well as different perceptions of risks and the effectiveness of measures and management strategies (Rogers and Cogger, 2010; Schemann et al., 2011).

Therefore, the aim of this study was twofold: first, to determine current levels of biosecurity implemented by horse owners and managers in Australia in the context of HeV and second, to identify factors influencing the uptake of recommended biosecurity practices to inform communication and policies around preventative health care for horses.

2. Materials and methods

This study utilised data from an online survey conducted as part of a larger research project on 'Horse owners and Hendra virus − A longitudinal study to evaluate risk' (HHALTER). This project comprised five online surveys conducted at six-monthly intervals from November 2012 to November 2014 and is described elsewhere (Taylor et al., 2016). In short, each survey covered the same core questions that remained unchanged over time to explore trends and changes in horse owners' perception of HeV risk as well as various supplementary questions to investigate specific topics of interest over the course of the project. Supplementary questions in the second survey described and analysed here focussed on biosecurity practices of horse owners. The Human Research Ethics Committee of Western Sydney University reviewed and approved this research project (H9824).

2.1. Participant recruitment and questionnaire design

The target population for the surveys comprised people who owned, leased, managed or regularly cared for any number of horses (hereafter referred to as horse owners), were 18 years of age or older, and lived in Australia. Participants were recruited in a number of ways; horse industry related stakeholders such as associations, organisations, and interest groups, who had previously indicated their willingness to support the project (Sawford et al., 2014), promoted links to the surveys prominently on their websites, newsletters or other forms of member communication. In addition, horse owners, who had participated in previous equine research (Taylor et al., 2008; Schemann et al., 2011; Kung et al., 2013) and who agreed to be contacted for further studies, were sent an invitation and link via email. Additional participants were recruited via the HHALTER project website and Facebook page or by word of mouth from other participants. The majority of participants enrolled in the study by clicking on the link provided, completing the questionnaire online and giving their consent by submitting their answers. A postal version was available to participants without internet access. The second survey was open for participation over an eight-week period (22nd May–17th July 2013) to all Australian horse owners and two reminders were send out after four and seven weeks, respectively, to enable maximum data capture among the target population (Dillman, 2007).

The questionnaire (available on request) was designed with SurveyMonkey© (Palo Alto, CA, USA), piloted by a small number of horse owners to assess the content, appropriateness and skip logic of questions, and altered according to feedback received before it was made electronically available. It comprised 60 closed, semi-closed and open-ended questions and took approximately 20–30 min to complete depending on the length of responses supplied for the optional, open-ended questions.

2.2. Data handling and statistical analysis

At completion of the survey period, all participant responses were exported into Excel 2010 (© Microsoft, Redmond, WA, USA), cleaned, checked for duplicates, and merged to form a comprehensive dataset. Statistical analyses were conducted in SAS, release 9.4 (© SAS Institute Inc., Cary, NC, USA).

2.2.1. Outcome variable

The outcome variable investigated in this study was based on two questions asking participants whether they performed general biosecurity practices around healthy (9 items) and sick horses (10 items) 'never', 'rarely, "sometimes", 'often' or 'always'. Biosecurity practices were derived from government recommendations (Animal Health Australia, 2010; QLD Department of Agriculture and Fisheries, 2013; Freeman, 2017) as well as those reported following the 2007/08 Australian equine influenza outbreak in Australia (Schemann et al., 2011). They focussed on horse-to-horse (9 items), horse-to-people (7 items) as well as horse-to-other animal interactions (3 items) (Table 1). Responses to these 19 items were examined and, if necessary, categories of responses were reversed to reflect recommended practices, before re-categorising them into binary variables with the categories 'yes, performed regularly' ('often' and 'always') and 'no, not performed regularly' ('sometimes', 'rarely' and 'never'). All 19 binary variables were