Short communication:

Assessment of the proportion of under-reporting during the 2007 equine influenza outbreak in New South Wales, Australia

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Abstract

During the 2007 equine influenza (EI) outbreak in Australia, there was no objective information about the possible under-reporting of cases by horse owners either so that they would avoid movement restrictions or because of their inability to detect infection. This investigation aimed to estimate the proportion of underreporting during the outbreak based on the results of surveillance undertaken in conjunction with vaccination. The results provided improved estimates of morbidity during the outbreak and indicated the level of under-reporting likely to occur in future outbreaks of other infectious diseases in horses in Australia.

Keywords disease control program; epidemiology; equine influenza

Abbreviations EI, equine influenza; IPs, infected premises; NSW, New South Wales; PCR, polymerase chain reaction

Disease reporting is of paramount importance for accurate understanding of the epidemiology of a disease and for developing sound disease control programs. However, under-reporting of cases of human and animal diseases is common in most countries[1-4] which may bias morbidity and mortality rates and distort epidemiologic information for policy decisions. During the 2007 equine influenza (EI) outbreak in Australia, concerns were raised about the possible under-reporting of cases by horse owners [5] in order to avoid movement restrictions or due to their inability to detect infection. Given that no objective information about this issue was available, we undertook this investigation to estimate the proportion of under- reporting during the outbreak. The results provided improved estimates of morbidity during the outbreak and indicated the level of under-reporting likely to occur in future outbreaks of other infectious diseases in horses in Australia.

Our estimate of under-reporting proportion was based on the results of surveillance undertaken in conjunction with vaccination. Real-time Polymerase Chain Reaction (PCR) testing of nasal swabs from up to six horses per property was routinely undertaken on properties vaccinated as part of the EI response in NSW. We queried the database of response activities maintained by NSW Department of Primary Industries to identify properties where EI was first detected (i.e. at least one horse positive by PCR of nasal swab) on or after the date on which the horses on the property were vaccinated. These properties were considered not to have been reported voluntarily by horse owners and could include 1) those where the horses did not show clinical signs, and 2) those where horses showed signs but the disease was not reported to the authorities.

All analyses were conducted employing SAS statistical software (release 9.1, © 2002-03, SAS Institute Inc., Cary, NC, USA). Under-reporting was calculated as the proportion of all infected properties (IPs) that were not voluntarily reported to the authorities by horse owners:

$$\text{Under-reporting proportion} = \frac{\text{Number of properties not voluntarily reported as infected}}{\text{Total number of infected properties}}$$

Under-reporting proportion was calculated for different disease clusters/regions (used for reporting and management during the outbreak response) and compared using the Fisher's exact test to evaluate the null hypothesis of equality of under-reporting proportions between clusters. Exact 95% confidence intervals were calculated for the proportion of under-reporting, both overall and for each cluster. It should be noted that horses on some properties were vaccinated inadvertently, despite the property being confirmed infected before vaccination. For current analyses, such properties were excluded from the numerator.

We further estimated the true proportion of under-reporting using the Rogan and Gladen approach [6] after taking into account the property-level sensitivity of detection of EI infection at time of vaccination:

$$\text{True under-reporting proportion} = \frac{\text{Apparent proportion} + \text{Property-level specificity} - 1}{\text{Property-level sensitivity} + \text{Property-level specificity} - 1}$$

As no estimate of property level sensitivity was available, the true proportion was calculated at four different sensitivity estimates (0.25, 0.50, 0.75 and 1). However, we assumed the specificity of

detection of EI to be perfect (=1), given the clinical nature of the disease and the use of PCR to confirm cases, which simplified the above formula to:

$$\text{True under-reporting proportion} = \frac{\text{Apparent proportion}}{\text{Property-level sensitivity}}$$

At the time of data analysis (1st week of February, 2008), 5506 properties had been voluntarily reported by horse owners and confirmed to be IPs by the state authorities. In addition, 67 properties were detected infected as a result of testing done in conjunction with vaccination indicating that the overall under-reporting proportion was only 1.2% (95% confidence limits: 0.93%, 1.52%). Detailed results presented in Table 1 suggest that under-reporting proportion varied significantly and ranged from <1% in the Maitland-Central Coast, Hunter Valley and Sydney south clusters to about 10% in the Dubbo cluster (p<0.001).

Table 1. Proportion of under-reporting in different clusters based on the equine influenza database of NSW DPI investigated in the first week of February, 2008.

Cluster	Unreported IPs	Total number of IPs	Under-reporting percent	95% confidence intervals (%)
Dubbo	15	149	10.07	5.24, 14.90
Hunter Valley	2	331	0.60	0.00, 1.44
Maitland-Central Coast	5	1201	0.42	0.05, 0.78
Narrabri-Northern	6	82	7.32	1.68, 12.95
Other	7	87	8.05	2.33, 13.76
Parkes	4	158	2.53	0.69, 6.35
Sydney-South	19	2892	0.66	0.40, 1.02
Tamworth	9	673	1.34	0.61, 2.52
Overall	**67**	**5573**	**1.20**	**0.92, 1.49**

True under-reporting proportion was estimated to be 1.20%, 1.60%, 2.40% and 4.81%, respectively, if the property-level sensitivity was assumed to be 100%, 75%, 50% and 25%.

This appears to be the first objective assessment of the proportion of under-reporting in the 2007 EI outbreak. Overall, the results suggest that Australian horse owners responsibly reported the majority of cases of disease to the authorities. This could also be an indication of better coordination between the authorities, the industry and horse owners. However, even this less than 5% proportion of true

under-reporting can have substantial ramifications in an infectious disease outbreak especially if this occurs at the start of the epidemic. This would mean that a number of infectious cases of the disease would remain undetected that would continue to spread infection to other animals, thus making the control or eradication of the disease substantially more challenging. Therefore, severe measures such as a total movement standstill are required in the event of a disease outbreak in order to prevent movement of unreported cases of disease.

The wide variability in under-reporting between various clusters indicated that it would be worthwhile to evaluate the reasons for under-reporting in general and for such differences in particular. Approximately 10% of the under-reporting in the Dubbo region could be due to failure of horse owners to report observed clinical cases or their inability to detect mild clinical signs.

A thorough investigation should also be undertaken to understand the social or psychological reasons for under-reporting behaviour to enable disease control authorities to better mange future incursions of emerging infectious diseases in Australia. This is very important given that a study reported 'extremely high levels' of psychological distress during this outbreak [7]. Anecdotal evidence of under-reporting is available from several human and animal disease outbreaks worldwide [1-4], but the psychological or socioeconomic reasons for such behaviour have not been thoroughly investigated, including for under-reporting of animal diseases in Australia.

Acknowledgements

The authors are grateful to the Department of Primary Industry, New South Wales for providing access to the outbreak data and to the manuscript reviewers for providing constructive feedback.

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