The Veterinary Journal 214 (2016) 34–39

Contents lists available at ScienceDirect

The Veterinary Journal

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

The incidence and risk factors for shipping fever in horses transported by air to Hong Kong: Results from a 2-year prospective study

M.J. Hurley [a,*,†], C.M. Riggs [a], N. Cogger [b], S.M. Rosanowski [b]

[a] Department of Veterinary Clinical Services, Hong Kong Jockey Club, Sha Tin Racecourse, Sha Tin, New Territories, Hong Kong
[b] EpiCentre, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11-222, Palmerston North, New Zealand

ARTICLE INFO

Article history:
Accepted 6 January 2016

Keywords:
Equine
Logistic and Poisson regressions
Pleuropneumonia
Travel sickness

ABSTRACT

A 2 year prospective study was performed between February 2011 and January 2013 to determine the incidence and risk factors for shipping fever (SF) in horses transported by air to Hong Kong (HK). Using a questionnaire, data were collected from professional flying grooms regarding the journey to HK and horses in the shipment. Horses were monitored in quarantine for 2 weeks after arrival in HK, and clinical signs of SF recorded. Poisson and logistic regression models were used to identify risk factors for SF at the horse and shipment levels.

The study analysed data from 869 horses on 81 flights arriving from Australia ($n = 24$), New Zealand (NZ; $n = 18$), the United Kingdom (UK; $n = 33$) and the United States of America (USA; $n = 6$). The incidence risk of SF was 10.8 per 100 horses and the proportion of shipments with at least one horse that developed SF was 49/81 (60%). The study identified that the rate per shipment of SF in shipments of horses originating from NZ, the USA and the UK was 2.40 (95% confidence interval [CI] 1.22–4.71), 2.43 (95% CI 0.66–8.89) and 3.08 (95% CI 1.60–5.93) times the rate of SF compared to Australia. Shipments arriving in HK during March and May were 5.61 (95% CI 1.55–20.31) and 4.51 (95% CI 1.43–14.26) times more likely to contain horses that developed SF compared to shipments arriving in January. The identification of these risk factors and the recognition of at-risk shipments will help focus attention on preventative strategies.

Introduction

Shipping fever (SF) is a common respiratory disease of horses associated with transport over long distances by road, rail, sea, or air (Racklyeft et al., 2000). Horses affected by this condition typically first develop a fever, followed by other clinical signs as the condition progresses. These clinical signs may include inappetence, lethargy, coughing, nasal discharge, dyspnoea, tachycardia, abducted elbows, reluctance to move and a stiff gait (Mair and Lane, 1989; Wilkins, 2003; Davis et al., 2014). When SF is identified and treated in the early stages of the infection, affected horses usually recover quickly (Raidal, 1995; Seltzer and Byars, 1996; Racklyeft et al., 2000). However, if the infection spreads and pleuropneumonia develops, intensive medical treatment is necessary and the prognosis for a horse returning to its former level of activity becomes poor (Racklyeft et al., 2000; Davis et al., 2014). Horses with severe SF may develop secondary complications, such as pulmonary abscessation, colitis and laminitis, which can be fatal (Raidal, 1995; Hudson et al., 1999; Sprayberry and Byars, 1999). The stress associated with long distance travel, confinement in adverse environmental conditions, an elevated head position, and pre-existing lower respiratory disease are well-known risk factors that contribute to the development of SF in horses (Racklyeft and Love, 1990; Leadon, 1995;[1]; Racklyeft et al., 2000; Davis et al., 2014).

The Hong Kong Jockey Club (HKJC) is responsible for the administration of Thoroughbred flat racing in Hong Kong (HK). There is no breeding industry in HK and consequently, all horses are imported by air. Shipments of horses arrive continuously throughout the year, with flights originating from Australia, New Zealand (NZ), the United Kingdom (UK), or the United States of America (USA). Due to the long flight times associated with travel from these destinations, horses imported into HK are at a risk of developing SF.

To date, research relating to the air transport of horses has investigated areas such as the recovery and acclimatisation following air transport (Marlin et al., 2001) and the effects of air transport on

* Corresponding author. Tel.: +64 27 6200 888.
E-mail address: michael@equinevetconsultants.com (M.J. Hurley).
† Current address: Michael Hurley & Associates, Brackenfield House, Cambridge, New Zealand.

[1] See Leadon, D., 1999. Horse Transport: History, Current Practices, the Future and Veterinary Recommendations. Rural Industries Research and Development Corporation, Kingston, ACT, Australia. https://rirdc.infoservices.com.au/downloads/99-073.pdf (accessed 12 August 2014).

http://dx.doi.org/10.1016/j.tvjl.2016.01.006
1090-0233/

behaviour and heart rate (Stewart et al., 2003). Few studies have been performed to identify risk factors for SF that could be specific to air transport (Leadon et al., 1990; Thornton, 2000; Ohmura et al., 2012; Maaskant et al., 2013). The objectives of the current study were to determine the incidence risk of SF in horses imported into HK and to identify factors that may contribute to the development of this condition. Both objectives were addressed at the horse- and shipment-levels, with these data having potential relevance in determining future best practice for the management of horses travelling long distances by air.

Materials and methods

Study design and data collection

A 2 year prospective study was performed between February 2011 and January 2013 on all routine shipments of horses imported into HK. Horses travelling temporarily to HK to compete in international race meetings were not included in the study. Flying grooms accompanying these shipments completed a detailed questionnaire that provided information about the journey from the quarantine unit of origin to arrival at the airport in HK. This questionnaire is available from the authors on request.

All horses were quarantined for at least 3 weeks before departure to HK and received no pre-travel treatments, such as antimicrobials or other medications. Horses were transported in dedicated jet stalls, each typically containing three horses, by one of four airlines (British Airways, Cathay Pacific, Singapore Airlines or Qantas) in either a Boeing 747-400 F or 747-8 F freighter.

During the compulsory 2 week post-arrival quarantine period, the rectal temperature of each horse was recorded twice daily, and abnormal clinical signs and treatments were documented on quarantine charts by veterinarians from the Department of Veterinary Clinical Services (DVCS) at the HKJC.

The questionnaire completed by flying grooms for this study was authorised by the HKJC and endorsed by the airfreight divisions of New Zealand Bloodstock, International Racehorse Transport and BBA Shipping & Transport Limited.

Shipping fever case definition

Horses were diagnosed with SF if they developed one or more clinical signs of lower respiratory tract infection associated with air transport to HK. Clinical signs included fever (>38.6 °C), inappetence, depression, coughing, nasal discharge, increased respiratory rate or effort and adventitious lung sounds.

Statistical analysis

All data on individual horses and shipments were entered into a customised database (Microsoft Access 2010). Shipment-level explanatory variables included the country of origin, the number of horses in the shipment, the date of departure and arrival, the month of the shipment, the thermostat setting in the cargo hold, position of the horses in the aircraft, total time in the aircraft, total travel time between quarantine units, as well as details of any delays and stopovers that occurred during the shipment. Horse-level explanatory variables included the age, sex and whether the horse was imported for racing or for use at one of the riding schools located in HK.

The outcome variables were determined at the horse and shipment levels. The horse-level outcome variable was the presence of SF in an individual horse. The shipment-level outcome variable was the number of horses with SF per consignment. Continuous explanatory variables were described using medians and interquartile ranges (IQR) for non-normally distributed variables and mean and standard deviations (SD) for normally distributed variables. Nominal explanatory variables were described using counts and percentages. A mixed effect logistic regression was used to determine those factors that were associated with whether or not a horse developed SF, including the horse-level variables of age and horse use. Country of origin was retained in the final model. Biologically plausible two-way interaction terms between variables were considered for inclusion in the multivariable model. Model diagnostics were conducted using summary measures of the goodness-of-fit of the final model (Hosmer and Lemeshow, 2000). To account for the clustering of horses, a random effect term for shipment was used.

Shipment-level explanatory variables were screened using univariable Poisson regression to determine those factors that were associated with the rate of SF in a consignment of horses and those with $P < 0.20$ were included in a multivariable model, offset by the number of horses on the shipment. Continuous exposure variables were modelled as categorical variables based on terciles in the univariable analyses. A preliminary multivariable model was built using a manual backwards method of elimination in which variables were retained in the model if the likelihood ratio test statistic was significant at $P < 0.05$. Continuous variables were examined for best fit, as described by Parkin et al. (2005) and as categories based on terciles. Biologically plausible two-way interaction terms between the main effect variables were considered for inclusion in the multivariable model. Significance was assessed using the likelihood ratio test statistic. Over dispersion was checked using deviance and Pearson goodness-of-fit measures. All statistical analyses were performed using Stata version 11.1 (Statacorp LP).

Results

Descriptive statistics

During the study period, data were collected from 869 horses on 81 flights arriving into HK, with a median of 10 (IQR 5–14) horses per shipment. Flight data were not provided for six flights that also arrived during this period. Shipments departed from one airport in NZ, two airports in Australia, and three airports in both the UK and the USA. The median number of shipments per month was 3 (IQR 2–4; Fig. 1) and the median number of horses to arrive in HK per month was 35 (IQR 26–47.8; Fig. 2). The descriptive summary of shipments and the number of horses imported are shown in Table 1. Of the horses that were imported, 840/869 (96.7%) were Thoroughbreds destined for racing in HK and the remaining 29 were a variety of horse breeds destined for riding schools. All 29 riding school horses came from the UK. The age of the horses imported ranged from 2 to 18 years of age with all horses imported for racing aged less than 6 years old. Male horses comprised 97.9% of the horses imported into HK.

The descriptive statistics for the shipment-level variables are shown in Table 2. In total, 39/81 (48%) shipments had a stopover on the way to HK lasting between 1 h 30 min and 3 h. All shipments from the USA had a stopover: 23/33 (70%) from the UK, 9/18 (50%) from NZ and 1/24 (4%) from Australia. Overall, 22/81 (27%) of shipments were delayed during the journey, with delays lasting between 1 and 7 h. Horses were positioned in the front third of the aircraft for 38/81 (47%) flights, 23/81 (28%) were positioned in the rear third of the aircraft and 20/81 (25%) in the middle third.

During the 2 week quarantine period, 94/869 (10.8%) horses, from 49/81 (60%) flights, developed clinical signs of SF (Table 3), resulting in an incidence risk of 10.8 cases per 100 horses. Of the SF cases, 36/94 (38%) were diagnosed immediately upon arrival in quarantine, and within 24 h 84/94 (89%) of all cases had been identified. Nearly all horses diagnosed with SF (90/94, 96%) had a fever of ≥38.6 °C, and in 62/94 (66%) cases this was the only clinical sign; 18/94 (19%) had two clinical signs and 14/94 (15%) had three or more clinical signs. Apart from fever, horses diagnosed with SF were

Table 1
Description of the shipments ($n = 81$) and horses ($n = 869$) imported into Hong Kong between February 2011 and January 2013, stratified by originating country.

Country of origin	Shipments *n* (%)	Horses per shipment					
		n (%)	Minimum	25th percentile	Median	75th percentile	Maximum
Australia	24 (29.6)	260 (29.9)	3	8	11	13	20
United Kingdom	33 (40.7)	272 (31.3)	1	4	6	12	23
New Zealand	18 (22.2)	319 (36.7)	3	9	14.5	25	48
United States of America	6 (7.4)	18 (2.1)	2	2	3	4	4