Prevalence of Elevated Temperatures Among Horses Presented for Importation to the United States

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Long-distance transport of horses can result in stress and predispose horses to infections, particularly of the respiratory tract. Monitoring of body temperature is one means of detecting disease associated with long-distance travel. In this retrospective study, the prevalence of elevated temperature among horses arriving at United States air–ocean import centers was determined. The prevalence of elevated temperature in horses varied by import center as well as age and breed categories. The majority of elevated temperatures occurred at or within 12 h of arrival, typically as a single occurrence and usually as a low-grade elevation in body temperature (i.e., >101.5°F but <102.5°F). Determination of the specific causes of elevated temperatures, particularly the distinction between a stress response versus fever caused by infection, among this population of horses would require collection of additional data. Authors’ addresses: Department of Clinical Sciences, Colorado State University, College of Veterinary Medicine and Biomedical Sciences, 300 West Drake Road, Fort Collins, CO 80523 (Traub-Dargatz); and 2150 Centre Avenue, Building B, Fort Collins, CO 80526 (Bischoff); e-mail: Josie.Traub-Dargatz@colostate.edu. *Corresponding author. © 2011 AAEP.

1. Introduction

The importation of horses (the term horse will be used here to describe all equids, including horses, ponies, donkeys, and mules) into the United States is regulated by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services (USDA-APHIS-VS). Quarantine regulations are developed to reduce the risk of spread of infectious diseases and based on the status of the origin country for specified equine diseases. Other than those horses arriving for special events such as the World Equestrian Games, horses arriving by air or ocean are quarantined at one of three animal import centers: the New York Animal Import Center (NYAIC) in Newburgh, NY, the Miami Animal Import Center (MAIC) in Miami, FL, or the Los Angeles Animal Import Center (LA-AIC) in Los Angeles, CA.

On arrival to the United States, horses are examined by USDA-APHIS-VS personnel to check documentation and evaluate health status, which includes collecting rectal temperature and blood samples for official testing. Horses must remain in USDA quarantine for the period determined by USDA, which is based on the disease status of the origin country. Typically, these quarantine periods are referred to as 3-, 7-, and 60-day quarantine periods. Details regarding import requirements can be found at the National Center for Import and Export website. Historically, at least 3 days were
required to obtain regulatory test results; more recently, with expedited shipping of samples and reduced turnaround times at the laboratory, test results can be available in <3 days. Although the tests may be available in <3 days, all horses presented for import to the United States by air or ocean must remain in quarantine for a minimum of 42 h for observation. To be released from quarantine, horses must have negative results on the official tests, been held in quarantine for the specified period of time, and three non-elevated temperatures (<101.5°F) recorded for the 24-h period immediately before release. During quarantine, horses are observed for clinical signs of disease and given a physical examination, including recording of rectal temperature, that is generally performed every 12 h.

Above-normal body temperature can be the result of a true fever (most often caused by an infection), inflammation, hyperthermia because of heat stress, drug reactions, allergies, tumors, or other causes; other causes, such as age, breed, previous experience with air travel, disposition, and location in the cargo area, might explain an increased risk for occurrence of elevated body temperature. 2

To determine the prevalence of elevated body temperature among imported horses while in quarantine, the records for 4,720 horses were analyzed for this study. In addition, analysis of existing data was performed to determine factors associated with risk of an elevation in body temperature.

2. Materials and Methods

Individual records for horses imported over 1 calendar yr were retrieved from each center. The process for retrieval of data varied between centers depending on the type and availability of source documents (e.g., electronic or paper) in each center.

The study period for NYAIC and MAIC was calendar year 2008 and for LA-AIC, was calendar 2009. NYAIC and MAIC data for calendar year 2008 included at least four temperatures taken from each horse before release from quarantine. Data for calendar year 2009 were selected for LA-AIC, because before that time, the records included only entry and released body temperature recordings. Starting in January 2009, the LA-AIC records included at least four temperatures taken before release from quarantine.

NYAIC and MAIC are operated by USDA-APHIS-VS. LA-AIC import quarantine is a privately operated facility (Jet Pets, Inc.) with oversight by USDA-APHIS-VS; official records are maintained in the Los Angeles USDA-APHIS-VS office. Use of the term LA-AIC in this report refers to both Jet Pets, Inc. and the USDA-APHIS-VS Los Angeles office’s personnel that oversees import and quarantine of horses through Los Angeles.

Data about horses quarantined at NYAIC were collected from hard-copy records. Data about horses quarantined at MAIC were collected primarily from the Animal Quarantine and Examination System (AQES) electronic database; hard-copy records were reviewed for horses that had elevated temperatures to determine the treatment performed on these horses. Data (gender, age, breed, country of origin, date of arrival, and date of release) about horses quarantined at LA-AIC were available from a USDA-APHIS-VS electronic database (Import Tracking System); temperature and treatment information were retrieved from hard-copy records.

Variables available for analysis were body temperature on arrival and at intervals while in quarantine, age, breed, gender, purpose/use, country of origin, port of embarkation (departure airport for flight), port of entry (arrival airport for the flight), and dates of arrival and release. Certain variables were collapsed into a limited number of categories for analysis.

Horses that had a temperature >101.5°F any time from arrival to release from quarantine were categorized as having had an elevated temperature. Univariable logistic models were constructed to evaluate the effect of each risk factor on prevalence of elevated temperatures within each center. A p value of <0.05 was considered significant.

Within each center, multivariable logistic models were constructed with risk factors as independent factors. Backward elimination was used to eliminate factors with a p value >0.05. Interactions between the factors were examined and if significant, were included in the final models.

A univariable logistic model was used to initially compare the prevalence of elevated temperatures between centers, with p values of <0.05 considered significant. A multivariable model was constructed with import center, breed, age, and gender categories; region of origin, interaction with center, and other factors were included. The initial results of the multivariable model were used to determine the significance of the interactions. Separate models were to be constructed for each center if there was an interaction by center.

An initial three-center, multivariable logistic model with center, breed, age, gender, region of origin, four interactions between center, and other factors showed that all interactions with center were significant, meaning that the effect of all of these factors varies by center. Separate models were, therefore, constructed for each center.

3. Results

NYAIC

The NYAIC received horses through one of three airports (port of entry): JFK in Jamaica, NY, Newark in Newark, NJ, and Stewart at Newburgh/New Windsor, NY. The most common countries of origin of horses being imported through NYAIC were Germany (32.4%), the Netherlands (22.2%), England (17.8%), Ireland (5.8%), Belgium (4.1%), France (3.7%), Sweden (2.6%), Spain (2.3%), and Denmark...
(1.8%). The following countries cumulatively accounted for 7.3% of all horses imported through NYAIC in 2008 (each accounting for 1.1% or less): Australia, Austria, Bermuda, the Czech Republic, Finland, Hong Kong, Iceland, Israel, Italy, Japan, Korea, Malaysia, Mexico, Poland, Portugal, Saudi Arabia, Slovakia, Switzerland, Thailand, and the United Arab Emirates. A majority of the horses received at the NYAIC embarked from the Netherlands.

Of the 2,062 horses that arrived in 2008, 236 (11.4%) had at least one elevated temperature from the time of arrival at NYAIC until release. Of the horses with an elevated temperature, 26.3% had recurrent elevated temperatures. Of the 236 horses with an elevated temperature, 81 had elevated temperatures >101.5°F but <102°F; 82 had their highest elevated temperature >102°F but <102.5°F, 22 had elevated temperatures from 102.5°F to <103°F, 24 had a highest temperature of 103°F to <103.5°F, 9 had their highest temperature from 103.5°F to <104°F, and 18 had elevated temperatures ≥104°F. Of the breed categories, the Friesian group had the highest prevalence of elevated temperature, and the Thoroughbred/other hot-blooded group had the lowest prevalence (Table 1).

Horses 1 yr of age or less had the highest prevalence (26.1%) of elevated temperatures. Prevalence of elevated temperatures in other age categories (2–4, 5–9, and ≥10 yr) was between 10% and 11%. There was a statistical difference between prevalence of an elevated temperature by age category (p < 0.0001).

An age and breed interaction was detected; therefore, the effect of breed within age category was examined. In the 2- to 4-yr age group, there was a significant difference between Warmbloods and Friesians, with Friesians being three times more likely to have an elevated temperature than Warmbloods. In contrast, Thoroughbreds and other hot-blooded breeds in the 2- to 4-yr age group were less likely to have a temperature elevation than Warmbloods. In the 5- to 9-yr age group, significantly more Warmbloods had an elevated temperature than did horses of other breeds and Thoroughbred/other hot-blooded breed horses.

The highest prevalence (24%) of elevated temperature was in horses for commercial use. Approximately 12% of competition horses and 10% of breeding horses had elevated temperatures. No horses with a reported use of pleasure or other had an elevated temperature. There was a significant difference in occurrence of elevated temperature by use (p < 0.04). Gender and quarter of the year for arrival were not significantly associated with prevalence of elevated body temperature at NYAIC.

The majority of elevated temperatures occurred during the first 12 h in the center, with 39% of 236 horses (n = 92) having the first occurrence of elevated temperature on day 1 in the evening (most horses arrive in the evening) and 43% of horses (n = 101) having the first occurrence of elevated temperature on day 2 in the morning (this is the first 12 h after arrival for most horses in this center). Only 15.2% of 236 horses had an elevated temperature that first occurred in the afternoon of day 2 or later.

Of the 2,062 horses, 139 (6.7%) were treated at least one time with a non-steroidal anti-inflammatory drug (NSAID), most commonly phenylbutazone. Nearly 92% of horses treated with an NSAID had elevated temperatures.

Twenty-two horses (1.1%) received an antimicrobial drug (AMD) at least one time; 18 of 22 horses (81.8%) had elevated temperatures. The most commonly administered AMDs were trimethoprim sulfa followed by ceftiofur.

Because the NSAIDs and/or AMDs were being given to treat a horse that had an elevated temperature rather than being causally associated with induction of an elevated temperature, these variables were not included in any of the models used to describe risk factors for elevation in body temperature.
center is colocated at the airport. Countries of origin for horses in the MAIC were Argentina, Brazil, Colombia, Chile, Peru, Venezuela, Dominican Republic, Ecuador, Cayman Islands, Uruguay, Costa Rica, Mexico, Panama, El Salvador, Guatemala, Turks and Caicos Islands, Bahamas, the Netherlands, Belgium, United Kingdom, Denmark, France, Germany, Australia, and Malaysia. Nearly 75% of the horses were from Argentina or the Netherlands.

There were 106 (6.6%) horses that had one or more elevated temperatures from the time of arrival until release from quarantine; a vast majority of these elevated temperatures occurred on day 1 of quarantine (at arrival or during day 1). The majority of horses (88.7%) had only one occurrence of an elevated temperature. Of the horses with an elevated temperature, 13.2% had a temperature of 102.5°F or higher.

Warmbloods had a significantly lower prevalence of elevated temperature than did the Thoroughbred or other hot-bloody breed category and the other breed category (Table 2).

To determine risk factors for elevated temperature, four age categories were created. The majority of horses (62.6%) were 5–9 yr of age. There was a significant difference in prevalence of an elevated temperature by age group (p < 0.0001). The highest prevalence of elevated temperature was in the 1-yr or less age group (25.0%) followed by the 2- to 4-yr age group (11.9%).

The highest percentage of horses imported through MAIC by gender was female followed by castrated male. There was a significant difference by gender for occurrence of elevated temperature, with the highest prevalence in the intact male group (p < 0.0001).

There was no statistical interaction between age and gender.

For analysis, country of origin was collapsed into two regional categories: Mexico/Central America/South America and Europe. Eleven horses from Australia and Malaysia, none of which had elevated temperatures, were excluded from the analysis, because the number of animals was not high enough to justify creating a third region. Prevalence of an elevated temperature was more than two times as high for horses originating in the Mexico/Central America/South America region compared with those originating in Europe (p = 0.0003).

There was no significant difference in prevalence of an elevated temperature by horse purpose/use or quarter of the year for arrival.

Some information is not recorded in the electronic database of the MAIC, and therefore, hard-copy records of horses with elevated temperatures were requested to obtain information about treatments given and diagnostic tests performed for these horses. Stall cards were not available for 13 of 106 horses with elevated temperatures. Ten horses were treated at least one time with an NSAID—four with flunixin meglumine, five with phenylbutazone, and one with dipyrone. Six horses were treated at least one time with an AMD or a combination of AMDs—four received oxytetracycline, one received sulfadimethoxine, one received gentamicin/penicillin, one received gentamicin/penicillin and metronidazole, and one received gentamicin, ceftiofur, and metronidazole. Other treatments given, albeit infrequently, included application of ointment to wounds, bandaging of limbs, diuretic drugs, sedation, immunostimulants, gastrointestinal motility drugs, and electrolytes.

LA-AIC

There were 1,058 horses imported through LA-AIC in 2009 that originated from 21 countries, with a majority from Europe and the next largest group from Australia/New Zealand. There were 127 horses (12%) that had at least one elevated temperature; of those, 15% had a temperature of 102.5°F or higher. For analysis, the country of origin was collapsed into four regions of origin (Australia/New Zealand, United Arab Emirates [UAE], Europe, and other); 77% of horses originated from Europe, and 19% originated from Australia/New Zealand.

The highest prevalence of elevated temperatures (13.9%) occurred among horses originating from Europe, and the lowest prevalence of elevated temperatures (4%) occurred in horses originating from Australia/New Zealand. There was a significant difference (p = 0.006) in the prevalence of horses with elevated temperatures associated with quarter of the year; however, the highest prevalence of elevated temperatures did not occur during the hottest

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**Table 2. Number and Percentage of Horses at MAIC by Breed and Number and Percentage of Horses With an Elevated Temperature by Breed**

<table>
<thead>
<tr>
<th>Breed*</th>
<th>Number of horses (%)</th>
<th>Number of horses with elevated temperature (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoroughbred or other hot bloods</td>
<td>593 (37.1)</td>
<td>47 (7.9)</td>
</tr>
<tr>
<td>Warmblood†</td>
<td>586 (36.6)</td>
<td>21 (3.6)</td>
</tr>
<tr>
<td>Other‡</td>
<td>421 (26.3)</td>
<td>38 (9.0)</td>
</tr>
<tr>
<td>Total</td>
<td>1600 (100.0)</td>
<td>106 (6.6)</td>
</tr>
</tbody>
</table>

*Thoroughbred or other hot bloods included Thoroughbred, American Saddlebred, Arabian, and polo pony.
†Warmblood included Warmblood, Hanoverian, Holsteiner, and Westphalian.
‡Other included Andalusian, Appaloosa, French Saddle Horse, mule, not specified, other, Paint, Paso Fino, pony, and Quarter Horse.
environmental temperature period. The highest prevalence of elevated temperatures was from October to December (17.1%); the lowest prevalence occurred in July to September (8%).

The majority of horses at LA-AIC (47.1%) were 5–9 yr old. The highest prevalence of elevated temperatures occurred in horses that were 1 yr of age or less, with a statistical difference between prevalence of an elevated temperature by age (p < 0.0001). Prevalence of elevated temperatures declined with increasing age. Of the 1,058 horses at LA-AIC, 29.9% were females, 25.2% were intact males, and 44.9% were castrated males. The prevalence of elevated temperatures among females and intact males (17.7% and 16.1%, respectively) was higher than for geldings (6.0%); this difference was statistically significant (p < 0.0001).

For designated purpose, the highest prevalence of elevated temperature was in the competition (13.8%) and other use (13.4%) categories. Prevalence of an elevated temperature in the pleasure horse category was 9.8%. None of the horses in the breeding category had an elevated temperature. There was a significant difference in occurrence of elevated temperature by use (p < 0.002).

The effect of breed on prevalence of elevated temperature for horses in this center varied by region of origin of the horse; a Friesian from Europe was 3.8 times more likely to have an elevated temperature than a Thoroughbred/other hot-blooded breed from Europe (Table 3).

Table 3. Odds Ratios and 95% Confidence Intervals for Elevation in Temperature for Comparison of Breed Within Region of Origin for Horses at LA-AIC

<table>
<thead>
<tr>
<th>Breed</th>
<th>Australia/New Zealand</th>
<th>UAE and other</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friesian</td>
<td>0.08 (0.01–0.65)</td>
<td>4.6 (0.7–31.6)</td>
<td>3.8 (1.5–9.1)</td>
</tr>
<tr>
<td>Other*</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Thoroughbred and other hot</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>bloods†</td>
<td>Not estimatable§</td>
<td>Not estimatable§</td>
<td>0.6 (0.3–1.1)</td>
</tr>
<tr>
<td>Warmblood‡</td>
<td>3.8 (1.5–9.1)</td>
<td>1.9 (0.9–4.0)</td>
<td>0.6 (0.3–1.1)</td>
</tr>
</tbody>
</table>

*Other breeds included pony, Belgian, Quarter Horse, Hackney, Appaloosa, Palomino, Mule, Welsh, other known, and nondesignated breeds.
†Thoroughbred and other hot breeds included Thoroughbred, Thoroughbred cross, Arabian, polo pony, and American Saddlebred.
‡Warmbloods included Warmblood, Trakehner, Westphalian, Oldenburg, Holsteiner, Hanovarian, Haflinger, and Royal Warmblood Studbook of the Netherlands (KWPN).
§This value was not estimatable, because none of the Warmbloods from these regions had an elevated temperature.

Of the 1,058 horses quarantined at LA-AIC, 107 (10.1%) received an AMD. Of the horses treated with an AMD, 43 had an elevated temperature; 56 (5.3%) of 1,058 horses received an NSAID while in quarantine, and 35 of these 56 horses had an elevated temperature.

Center Comparisons
The origin of imported horses varied by center (Table 4). The majority of horses imported through MAIC originated from the Americas; no horses were imported through MAIC from Australia/New Zealand or the Middle East. The vast majority of horses imported through NYAIC and LA-AIC were from Europe, whereas only about one-third of the imports into MAIC came from this region.

The prevalence of elevated temperature varied significantly (p < 0.0001) by import center: 12.0% for LA-AIC, 11.4% for NYAIC, and 6.6% for MAIC. The lowest prevalence of elevated temperatures occurred in horses at MAIC; there was no significant difference in prevalence of elevated temperatures between NYAIC and LA-AIC.

There were clear differences in the types of horses imported into the three centers (Table 1). For example, no Friesian horses and a lower percentage of horses 4 yr of age or less (22.8%) were imported into MAIC compared with the other two centers (LA-AIC = 31.4% and NYAIC = 36.1%). Young age was a risk factor for elevated temperature across all three centers. Yearlings and foals tend to have their normal temperature at the high end of the normal range for adult horses. This is, in part, thought to be because of the incompletely developed thermoregulatory center in these younger horses, and it is thought that their normal temperature range can extend to 102.2°F. Of the 1,058 horses quarantined at LA-AIC, 107 (10.1%) received an AMD. Of the horses treated with an AMD, 43 had an elevated temperature; 56 (5.3%) of 1,058 horses received an NSAID while in quarantine, and 35 of these 56 horses had an elevated temperature.

These differences in types of horses imported into the centers potentially could explain some of the difference in overall prevalence of elevated temperatures between LA-AIC and NYAIC versus MAIC. Several models were created to evaluate the potential risk...
factors for elevated temperatures across centers. An interaction by center was detected when the initial model was created.

Several additional models were used to explore the effect of center on the outcome of interest (e.g., prevalence of an elevated temperature at least one time at arrival or during quarantine). In one model, the data from NYAIC and LA-AIC were combined and compared with data from MAIC. In a second model, Friesians and horses 1 yr of age or less were excluded from the data across all three centers. In a third model, data for Friesians were omitted, and four age categories were collapsed into two age categories (4 yr of age or less and 5 yr of age or more).

The higher prevalence of horses with an elevated temperature at LA-AIC than at MAIC was explained in part by the fact that there was a higher percentage of young horses (4 yr of age or less) at LA-AIC, and the prevalence of elevated temperature among young horses entering LA-AIC was very high (60.9%). The higher prevalence of elevated temperatures in horses at NYAIC than at MAIC was explained, in large part, by the fact that the prevalence of elevated temperatures among Warmbloods entering NYAIC was much higher than among Warmbloods entering MAIC (12.4% vs. 3.6%). The result of combining LA-AIC and NYAIC data was that the higher prevalence of elevated temperatures in Warmbloods in NYAIC was offset by the LA-AIC data, and the higher prevalence of elevated temperatures in young horses (4 yr of age or less) in LA-AIC was offset by the lower prevalence of elevated temperatures in Warmbloods entering LA-AIC (6.2%). Because the reasons for different prevalence of elevated temperatures varied between NYAIC and MAIC versus LA-AIC and MAIC, combining data from LA-AIC and NYAIC to make conclusions was not considered scientifically defensible.

### Table 4. Percentage Distribution of Horses and Prevalence of Horses That Had Elevated Temperatures by Breed, Age, Region of Origin, and Center

<table>
<thead>
<tr>
<th>Variable</th>
<th>LA-AIC</th>
<th>MAIC</th>
<th>NYAIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friesian</td>
<td>4.2</td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>Other breeds</td>
<td>24.2</td>
<td>26.3</td>
<td>10.3</td>
</tr>
<tr>
<td>Thoroughbred/other hot bloods</td>
<td>24.1</td>
<td>37.1</td>
<td>22.5</td>
</tr>
<tr>
<td>Warmblood</td>
<td>47.5</td>
<td>36.6</td>
<td>64.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 or less</td>
<td>6.0</td>
<td>2.3</td>
<td>6.3</td>
</tr>
<tr>
<td>2–4</td>
<td>25.3</td>
<td>20.5</td>
<td>29.8</td>
</tr>
<tr>
<td>5–9</td>
<td>47.1</td>
<td>62.6</td>
<td>46.1</td>
</tr>
<tr>
<td>10 or more</td>
<td>21.6</td>
<td>14.6</td>
<td>17.8</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Region of origin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia/New Zealand</td>
<td>18.7</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>Middle East</td>
<td>1.7</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>Europe</td>
<td>76.6</td>
<td>37.5</td>
<td>95.1</td>
</tr>
<tr>
<td>Americas*</td>
<td>2.2</td>
<td>62.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Asia</td>
<td>0.8</td>
<td>0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Americas category includes Mexico and Central and South America (Argentina, Brazil, Cayman Islands, Chile, Costa Rica, Dominican Republic, Equador, El Salvador, Guatemala, Panama, Peru, The Bahamas, Turks and Caicos Islands, Uruguay, and Venezuela).

### 4. Discussion

Horses are transported worldwide for various purposes, such as competition, change of ownership, and breeding. Multiple factors can influence the outcome of transport. Transport has been recognized for a long time as being stressful to horses. Potential stressors include isolation from herd mates, forced proximity to unfamiliar or aggressive horses, novel or threatening surroundings, exposure to new pathogens, restraint of normal activity patterns, forced adoption of an abnormal posture, extremes in temperature and humidity, noise, and water and feed deprivation. Duration of transport also can affect the outcome of transport. The duration of transit for horses being transported by air varies based on multiple factors. Horses often arrive at the departure airport 1–2 h before they are loaded into the jet stalls. Ideally, the horses are in the jet stalls waiting to be loaded onto the aircraft 1–2 h before the flight’s scheduled departure.
departure time.6 After arrival at the airport of destination, the horses are loaded onto various means of ground transport for the trip to the U. S. import center.8 The trip from the airport to the import center can take 3–4 h if going from JFK or Newark to NYAIC depending on traffic and weather conditions. Even when the ground transport distance is short, such as for Miami, Los Angeles, and Stewart arrivals, it may take 1 h from aircraft arrival to arrival of the horses at the import center.6 Actual flight times for arriving horses were not included in the import center databases or records, and there was no record of the transport time before loading onto the aircraft.

During a year-long study conducted in Dubai, 26 of the quarantined horses (3.5%) had at least one rectal temperature of 101.6°F or more4,5; 22 of 26 horses had the first elevated temperature at arrival. Of these horses, five (19.2%) had more than one episode of elevated temperature. None of the horses developed pleuropneumonia.4,5 Nearly 92% (674) of the horses transported to Dubai traveled by air; the balance (62; 8.4%) traveled by road.4,5 The prevalence of elevated temperature for horses traveling by road (9.7%) was more than three times greater than for those horses traveling by air (3.0%).4,5

Results of a 1990 survey of 112 horses transported from England to Australia showed that seven horses (6.3%) had developed respiratory disease (shipping fever) on arrival in Australia.7 The air travel duration was longer for the horses involved in this study, because they were transported at a time when wide body jets with longer flight range were unavailable. Also, the horses were housed in open versus jet stalls, and therefore, comparability to the horses transported in the current study is limited.6 In a second study carried out for the Hong Kong Jockey Club, 1 of 18 horses shipped into Hong Kong for the International Bowl and Cup in December 1993 developed respiratory disease, and all horses had a transient low-grade fever at arrival.8 The duration of transport and origin of horses varied in this study, and the horses that had the most arduous trips were more likely to have temperature elevations.6

This U. S. study showed some clear associations within each import center between the occurrence of elevated temperature in body temperature and risk factors such as age and breed. The data in this report clearly illustrate that age has an effect on the prevalence of elevated temperature among imported horses in all three centers. Horses 4 yr of age or less in all three centers were at greater risk for an elevated temperature than were older horses. It is possible that younger age is a surrogate for lack of experience with air transport and/or susceptibility to transport stress. It is also possible that the normal body temperature for some of these younger animals is above the 101.5°F temperature defined as elevated for this report.

Friesians were at greater risk than other breeds for elevated temperature at both LA-AIC and NYAIC; no Friesians were imported through MAIC. The effect of breed on prevalence of elevated temperatures varied across centers for breed categories other than Friesians. Why certain breeds, such as Friesians, might be predisposed to a higher prevalence of elevated temperature was not determined by the existing data.

The majority of elevated temperatures occurred within 12 h of arrival to an import center, typically as a single event, and usually as a low-grade elevation (i.e., >101.5°F but <102.5°F), and this finding was similar to the findings of Kettle5 and Leadon.4,5 These findings suggest that occurrences of an elevated temperature later in the quarantine period, high temperatures, or repeated elevations in temperature should be considered unusual events and thus, be of potential concern. Such events should be taken more seriously than elevations observed at arrival and one-time, low-grade elevations, both for the sake of the animal’s welfare and because of the potential risk that these horses may pose for transmission of contagious diseases. Although the majority of horses in this report had self-limiting elevated temperatures or required minimal intervention to resolve the low-grade elevation in body temperature, the individual horse should be monitored for additional increase in body temperature, recurrence of elevated temperature after the use of NSAIDs, and other signs of disease based on physical examination to most appropriately determine the need for treatment and diagnostic testing beyond a physical examination.

The prevalence of elevated temperatures among horses in quarantine varied by center, and there seemed to be an influence of center not described by the available data. Factors beyond those available in the existing data likely influenced the occurrence of elevated temperature of shipped horses. Data were not available to determine the ground transport that the horses experienced before embarkation or to determine the location of the horses within the cargo area of the aircraft. Also, data was not available regarding the horses’ previous experiences with air transport or the type of cargo that was on the shipment with the horses. Additional studies would be necessary to determine if some of the elevated temperatures were because of infection caused by potential factors such as aspiration of pharyngeal secretions, head position during transport, air-quality conditions during transport, or a contagious agent.

Opportunities for diagnostic interventions on horses during quarantine are limited by the fact that all samples from quarantined horses must be under the supervision of regulatory officials until the horse is released from quarantine. The NYAIC has an in-house laboratory that allows them to perform some laboratory investigations such as a complete blood count (CBC), and the other two centers
do not have in-house CBC capability. Because horses are still in quarantine, the handling of samples obtained from these horses and all testing to be performed outside of the quarantine center has to be conducted under regulatory control. Thus, if additional diagnostics on horses with elevated temperatures were to be pursued, a protocol for how such samples would be handled and where they would be tested must be developed to assure that no exotic disease agent is released through the processing of such samples.

The literature contains many references to psychological stress-induced rise in core temperature (PSRCT) in humans and animals. In a review article on the mechanisms and mediators of PSRCT, Oka concluded that PSRCT is a true fever with an associated rise in the thermoregulatory set point. The PSRCT is responsive to NSAID treatment in some situations. Results of animal studies suggest that the mechanism for PSRCT is mediated and modulated by classic neurotransmitters such as noradrenaline and 5-hydroxytryptamine, prostaglandin, and neuropeptides (corticotrophin-releasing factor). Additional conclusions were that PSRCT is not caused by increased locomotor activity during stress, and the magnitude of PSRCT is the same in warm and cold environment. Examples of stress-inducing experiments conducted on rats included open-field stress tests (rats are put in an open space in which they feel exposed and vulnerable), handling, and cage change. Cyclooxygenase inhibitors, which are considered to be NSAIDS, attenuate the rise in core body temperature experienced by rats exposed to these stressors. Cyclooxygenase inhibitors also attenuate the increase in body temperature of pigs caused by physical restraint. It seems possible that some of the elevated temperatures experienced by imported horses on arrival at the import center, particularly those that resolved without treatment or with a single dose of NSAID, represent a form of PSRCT. Additional investigation to rule out other causes of elevated temperatures would be necessary to support this hypothesis.

In conclusion, the data included in this report summarize records for 4,720 horses. This study seems to represent the largest number of records for horses shipped by air to be evaluated for prevalence of an elevated body temperature. Analysis of the existing data identified several factors associated with risk of an elevation in temperature. Additional work is necessary to determine more definitively the cause of and potential interventions for elevated temperatures among imported horses.

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References and Footnote


*aPersonal communication, D. Leadon, 2011.*