Training failure among yearling horses

Jorge Hernandez, DVM, MPVM, PhD, and Dan L. Hawkins, DVM, MS

Objective—To compare financial returns between pinhooked yearling horses (ie, bought and trained for approximately 5 months with the goal of selling the horse at "2-year-olds in training" sales) that had mild or severe training failure and horses that had planned versus nonplanned training failure.

Animals—40 Thoroughbred pinhooked yearling horses.

Procedure—During the period from September 1998 through and April 1999, 20 horses had mild training failure (1 to 11 days lost), and 20 horses had severe training failure (13 to 108 days lost). Horses were assigned to these 2 groups on the basis of frequency distribution (median) of days lost during training. Horses were also categorized on the basis of type of training failure (planned vs nonplanned training failure). The outcome of primary interest was financial return. Median financial returns were compared among groups by use of the Mann-Whitney *U* test.

Results—Median financial returns for horses that had severe training failure ($1,000) were significantly different, compared with horses that had mild training failure ($24,000). Analysis of results also indicated that median returns were significantly different among horses that had planned training failure (–$2,000; eg, horses with radiographic abnormalities detected during routine prepurchase examinations that required surgical treatment, resulting in days lost during training), compared with horses that did not ($10,000).

Conclusions and Clinical Relevance—Training failure has an economic impact on revenues in pinhooked yearling horses. Lameness, planned training failure, respiratory disease, and ringworm were common and important causes of training failure. (*Am J Vet Res* 2001;62:1418–1422)

In the early 1980s, a novel concept of training and marketing young **Thoroughbreds (TB)**, known as "pinhooking," originated in Florida. This concept of training has rapidly grown in popularity and currently has a great impact on young TB marketing both nationally and internationally. Most pinhooked yearlings are purchased at yearling auction sales from July through September, although some are purchased privately. These yearlings are purchased solely for the purpose of resale at "2-year-olds in training" sales from late February through April. As the most important sales are the earliest, trainers have approximately 5 months to break, condition, and prepare their horses to work at high speeds during the presale training exhibition on the sales grounds. Two-year-old potential TB racehorses in these sales are the most advanced for their age and are close to being ready to race for their new owners. This intense accelerated schedule places unique demands on pinhooked yearling horses, compared with other yearlings that are developed into racehorses.

Infectious upper respiratory tract disease (IURTD) and lameness have been identified by trainers as an important health problem that can result in training failure in pinhooked yearling horses in Florida. According to Florida trainers, most yearlings that develop IURTD have clinical signs during the first 30 to 60 days after arrival at training facilities (September through October). In contrast, clinical signs of lameness are most often evident during the final 30 to 60 days of training (January through February), which is when the most intense high-speed work is performed in preparation for 2-year-olds in training sales. Some yearlings are pinhooked with known radiographic abnormalities that can be corrected surgically. Prior to purchase, the prospective buyer will plan for the surgery cost and convalescent time in the schedule for the horse, resulting in planned training failure. To the authors' knowledge, the relationship between training failure and financial returns in pinhooked yearling horses has not been reported. The purposes of the study reported here were to compare financial returns between pinhooked yearling horses that had severe or mild training failure (as measured by number of days lost during training) and to compare financial returns between horses that had planned versus nonplanned training failure at a training center in Florida.

Materials and Methods

Horses—Forty-two TB horses purchased at yearling sales (August and September 1998) solely for the purpose of resale (at 2-year-olds in training sales during February through April 1999) from 1 training center in Florida were considered for inclusion in the study. This center was selected because of the number of horses trained and willingness of the trainer to participate in the study. During training, 1 horse suffered a catastrophic musculoskeletal injury, and 1 horse died because of colitis; these 2 horses were not included in the analysis. The final study enrollment was 40 horses. As part of the normal vaccination program for prevention of viral respiratory infection, horses were vaccinated against equine herpesvirus and equine influenza virus (November 1998 and January 1999) by the attending veterinarian. Most horses were broken and subjected to a conditioning training program starting Sep 1, 1998.

Training failure and financial returns—During September 1998 and April 1999, 20 horses had mild training failure (1 to 11 days lost), and 20 horses had severe training failure (13 to 108 days lost). Horses were assigned to these

Received Jun 19, 2000.
Accepted Nov 14, 2000.
From the Department of Large Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610-0136. Dr. Hawkins' present address is Dubai Equine Hospital, PO Box 9373, Dubai, United Arab Emirates.
Supported by the Pari-Mutuel Wagering Research and Development Program in Florida (grant No. 280456412).
The authors thank Dr. Mary Lynne Vickers and Megan Downey for technical assistance.

2 groups based on their frequency distribution (median) of days lost during training. Horses were also categorized into 2 groups on the basis of type of training failure (planned vs nonplanned). Radiographic abnormalities were detected in 8 yearlings during routine prepurchase examinations and were treated surgically; these yearlings had a planned training failure. Thirty-two yearlings were considered normal. The primary outcome of interest was financial returns (2-year-olds sale price minus yearling purchase price). In horses that were not shown at 2-year-olds sales, the return value was recorded as $0.

Data collection—A data recording form was developed for data collection of epidemiologic interest. Data included horse number identification, foaling date, sex (colt, filly), arrival date, age at arrival (months), breaking date, days from arrival to breaking date, days lost because of various causes (eg, planned training failure, lameness, respiratory disease, ringworm, rain), total days lost from all causes, purchase price, and sale price. The authors visited the training center 7 days before the horses arrived in Florida to review the data collection process with the trainer. Follow-up visits were then performed every week during September, every other week during October, and monthly from November until the end of the follow-up period (April 1999). Information gathered on the data recording form was entered and stored by use of commercially available computer software.[a] All information was kept confidential.

Isolation and identification of respiratory viruses—Attempts were made to obtain nasopharyngeal swab samples from horses with clinical signs of IURTD (eg, sudden onset of cough, fever, serous or mucoid nasal discharge) to isolate and identify respiratory viruses. Swab samples were collected by the attending veterinarian, placed in viral transport medium, and refrigerated or cooled on ice packs. Samples were properly identified (horse number and date), packed, and shipped to the University of Florida College of Veterinary Medicine within 24 hours. In the laboratory, samples were assigned a code number and kept frozen (–70 C) until tested for virus isolation and identification. Cultured rabbit kidney cells and cultured equine dermis cells were used for virus isolation of **equine herpesvirus (EHV)** from swab samples.[1,2] A polymerase chain reaction assay was used to identify EHV-1 and EHV-4.[3] Ten- to 11-day-old embryonated chicken eggs were used for virus isolation of **equine influenza virus (EIV)** from swab samples. Laboratory procedures for isolation and identification of EIV and EHV were performed at the University of Kentucky Disease Diagnostic Center in Lexington.

Statistical analyses—The general hypothesis was that training failure has no effect on financial returns in pinhooked yearling horses. First, horses were grouped on the basis of training failure (mild or severe). The Mann-Whitney *U* test was used to test for differences between groups with regard to age, purchase price, and days from arrival to breaking date because these variables failed to meet assumptions for parametric testing[4]; median financial returns were compared among groups also by use of the Mann-Whitney *U* test. Differences of distribution of sex were compared between groups by use of a χ^2 test.[5] The adjusted effect of training failure on financial returns (rank-transformed data) was analyzed by use of an ANOVA; number of days from arrival to breaking date (rank-transformed data) was included in the model as a covariate.[6] Proportions of horses that were shown at 2-year-olds in training sales and proportions of horses with returns ≥ $10,000 in each group were compared among groups by use of a χ^2 test. The cutoff of $10,000 was selected on the basis of estimated costs of breaking and training. The adjusted effect of number of days from arrival to breaking date on horses that were shown at 2-year-olds sales and horses with returns ≥ $10,000 in each group was determined by

Table 1—Financial returns in pinhooked yearling horses that had mild or severe training failure

Variable	Mild training failure (1 to 11 days lost) n = 20	Severe training failure (13 to 108 days lost) n = 20	*P* value
Gender			
Colts (%)	10 (50)	9 (45)	0.75
Age (mo) *	17 (16–20)	18 (16–20)	0.28
Purchase price ($)*	30 (9–575)	27 (14–900)	0.37
Days from arrival to breaking date *	12 (3–61)	5 (3–31)	0.05
Outcome			
Financial returns ($) *	24 (–13–230)	1 (–18–61)	0.03
Horses showed at 2-year-olds sales (%)	18 (90)	14 (70)	0.11
Horses with returns ≥ $10,000 (%)	12 (60)	7 (35)	0.11

*Values are reported as median (range). Dollar amounts are reported in thousands.

Table 2—Causes of training failure in 40 pinhooked yearling horses

Variable	Horses	Total days lost	Median (range) days lost
Lameness	17	518	26 (3–106)[a]
Planned training failure	8	172	21 (13–34)[a]
Respiratory disease	18	126	5 (3–23)[b]
Equine protozoal myeloencephalitis	1	80	—
Ringworm	9	66	6 (3–17)[a,b]
Rain	31	38	1 (1–2)
Cribbing surgery	1	24	—
Girth injury	3	16	6 (3–7)
Other causes	3	16	5 (5–6)
Colic	2	7	3 (1–6)
No rider	4	6	1 (1–3)
Withers injury	1	6	—

[a,b]Median days lost due to different causes with different superscripts are significantly different ($P \leq 0.05$).

use of logistic regression.[7] The variable days from arrival to breaking date was categorized into 2 groups (3 to 6 and 7 to 61 days) based on their frequency distribution (median). Using logistic regression, adjusted **odds ratios (OR)** and 95% **confidence intervals (CI)** were determined. The OR was used as an epidemiologic measure of association between a factor (eg, training failure: mild, severe) and the outcome of interest (eg, horses that were shown at 2-year-olds sales or horses with returns ≥ $10,000). For instance, if no association existed between the factor and the outcome of interest, the OR was 1.[8] The greater the departure of the OR from 1 (either larger or smaller), the stronger the association between the factor and the outcome. The upper and lower limits of a 95% CI indicate that one can be 95% confident in the assertion that the true OR falls within this interval. If the interval is broad, the precision is low.

Kruskal-Wallis tests were used to compare median days lost because of common and important causes of training failure among yearling horses.[4] Scheffe's method was used on rank-transformed data to test pairwise comparisons among causes of training failure. In addition, horses were grouped on the basis of type of training failure(non-planned vs planned training failure). Median total days lost and median financial returns were compared among groups by use of the Mann-Whitney *U* test.

For all tests, a 2-sided *P* value ≤ 0.05 was considered significant. Power analysis was performed on the study's potential for rejecting the null hypothesis of no effect on outcomes of interest. Power is the likelihood that the study will identify a true effect correctly.[8] All analyses were performed by use of statistical software.[a,b]

Results

Effect of mild versus severe training failure on financial returns—Forty (19 colts and 21 fillies) yearling horses were included in this study. Median age was 18 months (range, 16 to 20), and median purchase price was $28,000 (range, $9,000 to $900,000). Proportions of colts, median age, and median purchase price did not differ significantly ($P \geq 0.28$) between horses that had mild or severe training failure. Median financial returns were $24,000 and $1,000 in horses that had mild and severe training failure, respectively. Median returns between groups were significantly different (**Table 1**). The proportion of horses that were shown at 2-year-olds sales was 90% among horses that had mild training failure, compared with 70% in horses with severe training failure; all horses shown at the sales were sold. The proportion of horses that registered returns ≥ $10,000 was 60% in the former group of horses, compared with 35% in the latter group. These proportions did not differ significantly (P = 0.11). Horses with mild training failure were 5 times as likely to show at 2-year-olds sales, compared with horses with severe training failure (95% CI, 0.8, 32.1). Further, horses with mild training failure were 2.9 times as likely to register returns ≥ $10,000, compared with horses with severe training failure (95% CI, 0.8, 11.3).

Causes of training failure—Lameness, planned training failure, respiratory disease, and ringworm were common and important causes of training failure (**Table 2**). Among these causes of training failure, median days lost because of lameness (26 days) or planned training failure (21 days) were significantly different, compared with respiratory disease (5 days). Most horses affected with lameness had training failure during October or January (**Fig 1**). Horses affected with IURTD lost a median of 5 training days during an epidemic in November. Identification of influenza virus in nasal secretions from 4 horses indicated that A/equine/2 influenza virus was the etiologic agent associated with IURTD. Ringworm was a cause of training failure in 9 pinhooked yearling horses. Horses affected with ringworm were off training for a median of 6 days.

Effect of nonplanned versus planned training failure on financial returns—Eight of 40 horses had a planned training failure. Seven of these 8 horses had chip fracture lesions of the fetlock and 1 of the carpus (**Table 3**). All 8 horses had arthroscopic surgery and were off training for a median of 21 days. Seven of the 8 horses had training failure from other causes (ie, lameness, respiratory disease, ringworm, withers injury, rain), resulting in additional days lost. Median total days lost was significantly higher among horses

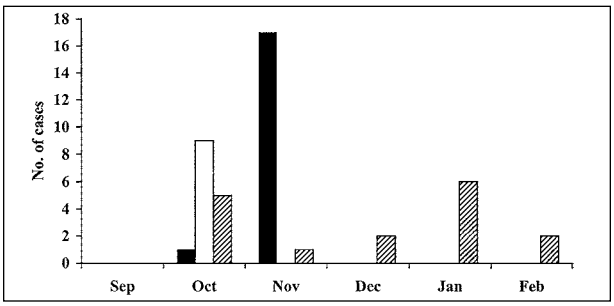

Figure 1—Incidence of respiratory disease (black bars), ringworm (white bars), and lameness (striped bars) in pinhooked yearling horses (September 1998–February 1999).

Table 3—Total days lost and financial returns in pinhooked yearling horses that had nonplanned or planned training failure

Variable	Nonplanned training failure n = 32	Planned training failure n = 8	*P* values
Gender			
Colts (%)	32 (47)	4 (50)	0.87
Age (mo)*	18 (16–20)	18 (17 –19)	0.34
Purchase price ($)*	28 (9– 900)	27 (15 – 45)	0.65
Days from arrival to breaking date*	6 (3– 61)	5 (3– 20)	0.38
Outcome			
Total days lost*	10 (1– 108)	38 (19 – 80)	0.003
Financial returns ($)*	10 (–13–230)	–2 (–18 – 30)	0.05

See Table 1 for key.

that had planned training failure (38 days), compared with horses that did not (10 days). Median financial returns were significantly lower among horses that had planned training failure (–$2,000), compared with horses that did not ($10,000). Among horses with planned training failure, the horse with the least returns (–$18,000) was a $43,000 filly that lost 40 days of training (34 days lost because of planned training failure and 6 to withers injury); the horse with the most returns ($30,000) was a $15,000 colt that lost 19 days of training (13 days lost because of planned training failure, 1 because of rain, 4 because of lameness, and 1 because the horse was off feed). Among horses with nonplanned training failure, the horse with the least returns (–$13,000) was a $50,000 filly that lost 9 days of training (8 days lost because of ringworm and 1 because of rain); the horse with the most returns ($230,000) was a $170,000 colt that lost 2 days of training because of rain. Proportions of colts, median age, and median purchase price did not differ significantly between horses with nonplanned versus planned training failure.

Discussion

Results of the study reported here indicated that training failure has an economic impact on lost revenues in pinhooked yearling horses. Median financial returns in horses that had severe training failure were significantly lower, compared with horses that had mild training failure. We examined separate analyses, using a return value of –$10,000 (cost of breaking and training) or the purchase price as a negative return (instead of $0) in horses that were not shown at the sales, and median returns changed from $1,000 to –$1,000 in horses that had severe training failure. Median returns ($24,000) did not change in horses with mild training failure. Failure to detect a significant effect of training failure on the proportion of horses that showed at 2-year-olds sales or proportions of horses that registered returns ≥ $10,000 may be attributable to the fact that tests of low statistical power may have been used, or too few horses were studied. If the true difference in proportions of horses that were shown at 2-year-olds sales was 20% (eg, 90% mild training failure vs 70% severe training failure) and horses with returns ≥ $10,000 was 25% (60% vs 35%, respectively), then the power of detecting this difference given the sample sizes used was 35% at the 5% level of significance.

To our knowledge, this was the first study performed in the United States to assess the impact of training failure on returns in pinhooked yearling horses. Causes of training failure among TB racehorses have been reported.[9,10] However, results from these studies are difficult to compare with results of the present study because of differences in study animals and outcomes measured. In 1 study,[9] lameness was the most important cause of training failure among 2- and 3-year-old TB in Germany. Incidence of training failure because of lameness was associated with intensity of training; number of days lost was not reported. In another study performed in Australia,[10] lameness was the most common reason for days lost in training among TB that were followed through their 2- and 3-year-old racing seasons. In the study reported here, lameness was the most important cause of training failure among pinhooked yearling horses. In October, most horses affected with lameness had mild training failure 2 to 3 weeks after their breaking date in preparation for training at the racetrack. In January, most affected horses had severe training failure during high-speed exercise in preparation for 2-year-olds in training sales.

Infectious upper respiratory tract disease was a common cause of training failure among pinhooked yearling horses. During September and October, all study horses remained nonvaccinated against influenza virus and herpesvirus. History of vaccination against respiratory viruses in horses before arrival to the training center was unknown. It is possible that vaccination of horses within days of arrival could have provided protection or reduced the incidence of IURTD. However, results from previous studies suggest that the efficacy of vaccination for prevention of IURTD in horses is questionable. In 1 vaccine field trial,[11] rates of IURTD were not significantly different among vaccinated (36/226 [16%]) and nonvaccinated (26/120 [22%]) horses stabled at a TB racetrack. In another study,[12] history of vaccination was not associated with decreased risk of IURTD during 3 influenza epidemics in horses stabled at a TB racetrack. Finally, results of another study[1] revealed there was no significant difference in history of recent vaccination against influenza virus or herpesvirus between affected horses with detected viral respiratory infections and affected horses without detected viral infections.

Horses affected with ringworm were off training to prevent spread of infection to other horses and humans and to decrease environmental contamination. Young horses are most likely prone to ringworm because of a lack of previous exposure.[13] Horses on prolonged antibiotic or immunosuppressive therapy are also more susceptible to ringworm.[14] In our study, history of exposure to antibiotic or immunosuppressive therapy in horses before arrival at the training center (eg, at yearling preparation and sales) was unknown.

In the present study, median financial returns were significantly lower and median total days lost were significantly higher among pinhooked yearling horses that had planned training failure, compared with horses that did not. These results suggest that trainers should be cautious when buying yearlings that have radiographic abnormalities evident during routine prepurchase examinations that will require surgical treatment. Yearlings with planned training failure are also susceptible to other common and important causes of training failure such as lameness, respiratory disease, and ringworm. The cumulative effect of 1 or more causes of training failure (in addition to that from surgical treatment) can yield a high number of total days lost. Six of 8 horses with planned training failure lost > 34 days of training (because of cumulative days lost from other causes of training failure in addition to that from planned training failure); 4 of these 6 horses registered financial returns < $7,000. Therefore, trainers buying yearlings that

will require surgical treatment should consider the frequency and severity of all common and important causes of training failure. An understanding of the impact of training failure in pinhooked yearlings will aid horse owners and trainers in making management decisions to improve methods for developing athletic ability and performance.

[a]Statistix Analytic Software, version 7, Tallahassee, Fla.
[b]Epi Info, USD Inc, Stone Mountain, Ga.

References

1. Mumford EL, Traub-Dargatz JL, Salman MD, et al. Monitoring and detection of acute viral respiratory tract disease in horses. *J Am Vet Med Assoc* 1998;213:385–390.

2. Collins JK, Kari S, Ralston SL, et al. Equine viral arteritis at a veterinary teaching hospital. *Prev Vet Med* 1987;4:389–397.

3. Wagner WN, Bogdan J, Haines D, et al. Detection of equine herpesvirus and differentiation of equine herpesvirus type 1 from type 4 by the polymerase chain reaction. *Can J Microbiol* 1992;38: 1193–1196.

4. Daniel WW. Non-parametric and distribution-free statistics. In: Daniel WW. *Biostatistics: a foundation for analysis in the health sciences*. 3rd ed. New York: John Wiley & Sons, 1983;388–435.

5. Fleiss JL. Assessing significance in a fourfold table. In: Fleiss JL. *Statistical methods for rates and proportions*. 2nd ed. New York: John Wiley & Sons, 1981;19–32.

6. Kleinbaum DG, Kupper LL, Muller KE, et al. One-way analysis of variance. In: Kleinbaum DG, Kupper LL, Muller KE, et al, eds. *Applied regression analysis and other multivariable methods*. 3rd ed. Boston: PWS-KENT Publishing Co, 1998;423–483.

7. Hosmer DW, Lemeshow S. Introduction to the logistic regression model. In: Hosmer DW, Lemeshow S, eds. *Applied logistic regression*. 1st ed. New York: John Wiley & Sons, 1989;1–23.

8. Martin SW, Meek AH, Willeberg P. Disease causation and design of field trials. In: Martin SW, Meek AH, Willeberg P, eds. *Veterinary epidemiology: principles and methods*. 1st ed. Ames, Iowa: Iowa State University Press, 1987:121–148, 176–192.

9. Lindner A, Dingerkus A. Incidence of training failure among Thoroughbred horses at Cologne, Germany. *Prev Vet Med* 1993;16:85–94.

10. Bailey CJ, Reid SW, Hodgson DR, et al. Impact of injuries and disease on a cohort of two- and three-year-old thoroughbreds in training. *Vet Rec* 1999;145:487–493.

11. Morley PS, Townsend HGG, Bogdan JR, et al. Efficacy of a commercial vaccine for preventing disease caused by influenza virus infection in horses. *J Am Vet Med Assoc* 1999;215:61–66.

12. Morley PS, Townsend HGG, Bogdan JR, et al. Risk factors for disease associated with influenza virus infections during three epidemics in horses. *J Am Vet Med Assoc* 2000;216:545–550.

13. Pascoe RR. The epidemiology of ringworm in racehorses caused by Trichophyton equinum var autotrophicum. *Aust Vet J* 1979;55:403–407.

14. Logas DB, Barbet J. Diseases characterized by multifocal to diffuse alopecia, crusts, and papules. In: Colahan PT, Mayhew IG, Merritt AM, et al, eds. *Equine medicine and surgery*. 5th ed. St Louis: CV Mosby Co, 1999;1913–1915.