POSTMORTEM EXAMINATION PROGRAM

Conducted for the California Horse Racing Board
July 1, 2016–June 30, 2017

California Animal Health and Food Safety Laboratory System

J.D. Wheat Veterinary Orthopedic Research Laboratory

School of Veterinary Medicine
University of California, Davis

October 2018

Postmortem

Examination

Program

California Animal Health and Food Safety Laboratory System

J.D. Wheat Veterinary Orthopedic Research Laboratory

School of Veterinary Medicine
University of California, Davis
Davis, CA 95616
(916) 752-8700

October 2018

Cover: Benoit Photos (www.benoitphoto.com)

TABLE OF CONTENTS

POSTMORTEM EXAMINATION PROGRAM

Introduction

The Postmortem Examination Program has been in operation since February 1990, and has performed examinations on 6,924 horses, as of June 30, 2017. Initiated by the California Horse Racing Board (CHRB), the program is a partnership with the California Animal Health and Food Safety Laboratory System (CAHFS) to meet three primary objectives: 1) to determine the nature of injuries occurring in racehorses, 2) to determine the reasons for these injuries, and 3) to develop injury prevention strategies. To accomplish this, a broad, cooperative approach was organized involving the development of a contract with the CAHFS to perform a necropsy on every horse that died spontaneously, or was euthanized on racetracks or at training facilities under the jurisdiction of the CHRB. This visionary partnership has become a national and international model for the racing industry in an effort to improve the safety and welfare of racehorses.

Pathologists at the CAHFS' Davis, Tulare and San Bernardino laboratories conduct postmortem examinations and compile detailed information on each horse, which is then reported to the CHRB. A broad range of specimens are collected and shared with veterinary scientists in other departments of the School of Veterinary Medicine at the University of California, Davis (UC Davis). Specimens from selected cases from CHRB horses necropsied at CAHFS laboratories are frequently shipped to the J.D. Wheat Veterinary Orthopedic Research Laboratory at UC Davis for in-depth analyses. This helps to more precisely determine the causes and risk factors that led up to catastrophic injuries in racehorses resulting in their death or euthanasia. Funding for postmortem examinations and ancillary testing was provided by the CHRB. Racing associations provide transportation of the horses to the nearest laboratory facility, and additional studies are frequently funded by the Center for Equine Health at UC Davis, and by private sources.

Information from the tests and data gathered from the postmortem examinations are analyzed in efforts to elucidate the specific cause of catastrophic injuries. In addition to musculoskeletal injuries, medical causes of disease and/or death of racehorses (colic, pneumonia, etc.), which comprise between 70 and 80 percent of the submissions, are also studied.

CALIFORNIA ANIMAL HEALTH & FOOD SAFETY LABORATORY SYSTEM
U C DAVIS

UCDAVIS
VETERINARY MEDICINE
California Animal Health and Food Safety Laboratory System

SUBMISSIONS

General Submission Information

During the 2016-17 fiscal year, 207 horses were submitted to CAHFS as part of the CHRB Postmortem Program. This number is only a slight increase from the 205 horses over the fiscal year 2015-16, and continues with a significant reduction in fatalities initiated several years ago. The 2014-15 total number of fatalities (187) represented the lowest number of fatalities over the past 20 years.

The graph below (Figure 1) shows the number of horses that have been submitted to the program since 1990 by fiscal year. The first year of the program (1990) began in February and does not represent a full fiscal year. The trend line shows that the number of horses submitted for the CHRB program have been increasing slightly almost every year until 2005-06, after which a decline, interrupted temporarily in 2008-09 and 2011-12, started until 2014-2015, which was followed by a slight increase in 2015-2016 and 2016-2017.

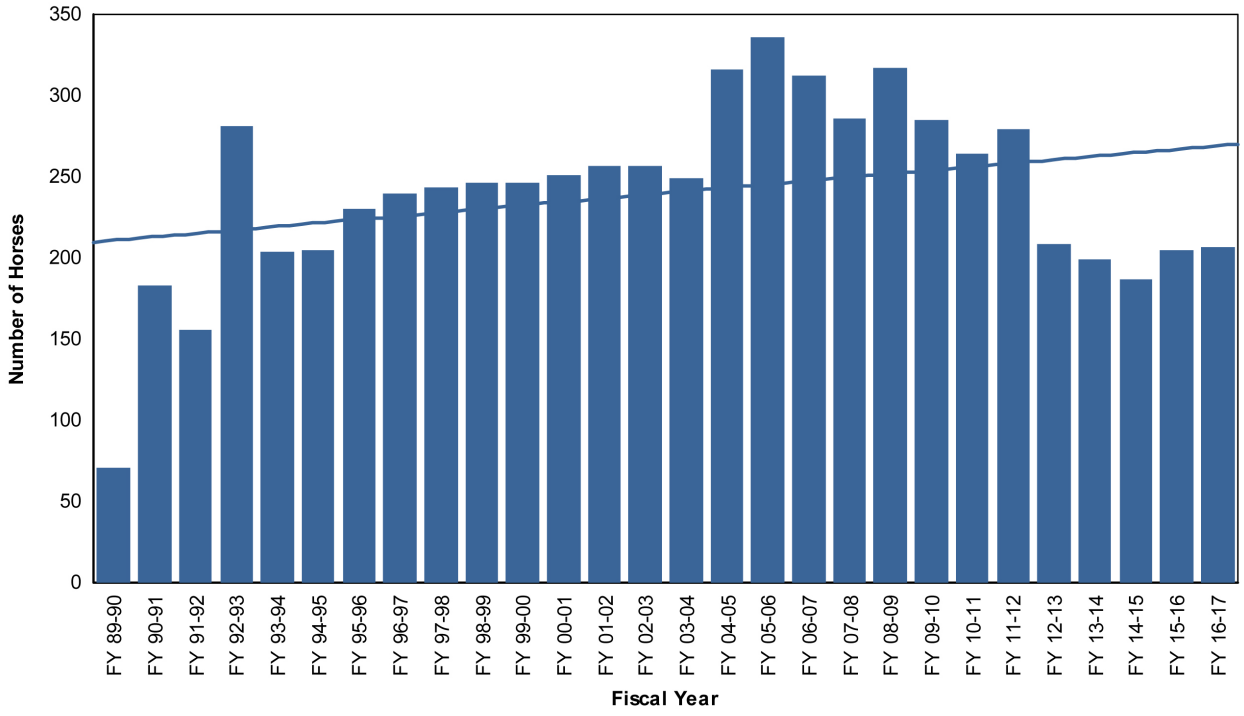
The CAHFS' Davis and San Bernardino laboratories performed the majority of necropsies during this fiscal year, with horses being brought directly to the closest CAHFS facility. Only one CHRB horse necropsy was performed at the Tulare laboratory during the 2016-2017 fiscal year. At the time of submission, the CHRB track official categorizes the activity of the horse at the time of injury into one of three types: non-exercise, racing or training (Table 1).

Continued

Table 1. Activity at Time of Injury/Fatality

Non-Exercise	42 (20%)
Racing	82 (40%)
Training	83 (40%)
Total	**207 (100%)**

Figure 1. Number of Horses Submitted to the CHRB Postmortem Program by Fiscal Year



The vast majority of catastrophic injuries (80 percent), occurred during or immediately following training or racing. This is in agreement with previous years, in which most fatalities were exercise-related. The third category of fatalities, accounting for ~20 percent of submissions, included horses in the non-exercise group. These were horses suffering primarily from medical conditions, such as colic, infectious diseases or other conditions, although a few musculoskeletal injuries occurred in the non-exercise group of horses.

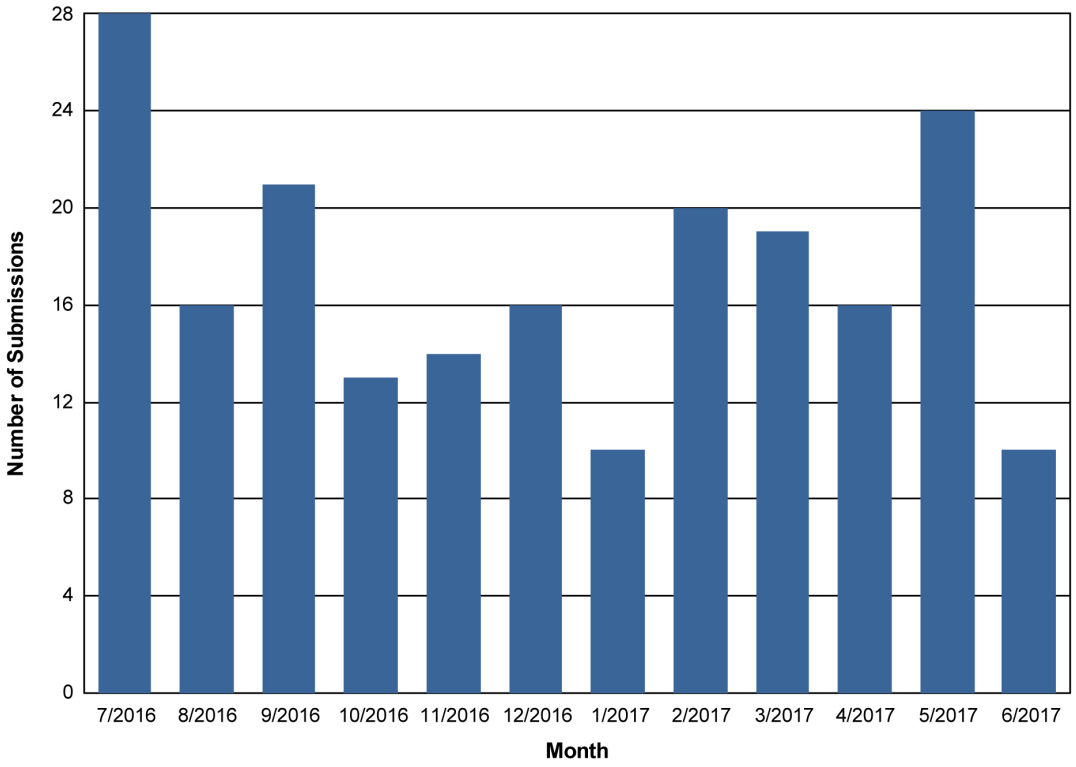
As in the past, the vast majority of submissions (176; ~85 percent) during FY 2016-17 were Thoroughbreds (Table 2). Twenty-nine of the horses submitted in 2016-17 (~14 percent) were Quarter Horses. This is a slight increase over the prior fiscal year (13 peercent). With very small numbers of the other breeds, not enough data exists to allow comparison of injury rates among breeds for any predisposition to any particular type of injury.

Continued

Table 2. Submissions by Breed and Month

Breed	Jul 16	Aug 16	Sep 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Total
Quarter Horse	2	3	4	3	2	3	1	1	4	0	4	2	**29**
Standardbred	0	0	0	0	0	0	1	1	0	0	0	0	**2**
Thoroughbred	26	13	17	10	12	13	8	18	15	16	20	8	**176**
Grand Total	**28**	**16**	**21**	**13**	**14**	**16**	**10**	**20**	**19**	**16**	**24**	**10**	**207**

Figure 2. Number of Horses Examined by Month



The number of horses submitted per month was variable, although there were not obvious clusters of submissions at any given month of the year (Table 2 and Figure 2). This is very similar to submission patterns over the last few years.

The largest proportion of submissions (~72 percent) were horses between 2 and 4 years old (Table 3). Approximately 19 percent of all racehorses submitted were 2 years old or less. The number of horses submitted with catastrophic injuries or death dropped dramatically after the fourth year of age (Table 3 and Figure 3). This distribution is consistent with the age distribution that has been seen in prior years of the program. We cannot conclude if horses 5 years of age and greater are less susceptible to the injuries of racing because the total number of horses in each age group that are racing and training on facilities controlled by CHRB are not known to us.

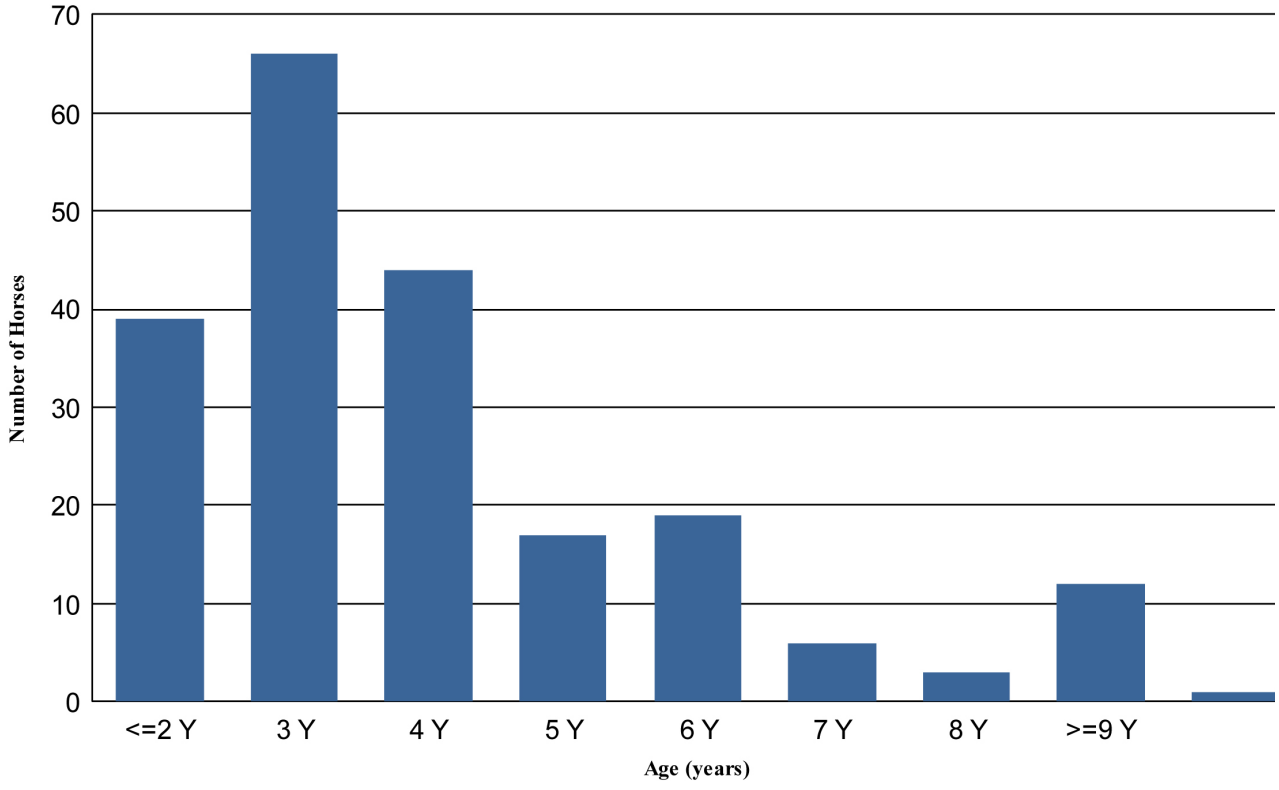
Submissions By Breed and Age

Table 3. Submissions by Breed and Age

Breed/Age	<=2	3	4	5	6	7	8	>=9	NR*	Total
Quarter Horse	12	8	3	3	1	0	0	2	0	**29**
Standardbred	0	0	0	0	1	0	0	0	1	**2**
Thoroughbred	27	58	41	14	17	6	3	10	0	**176**
Total	**39**	**66**	**44**	**17**	**19**	**6**	**3**	**12**	**1**	**207**

*NR: Age not reported (pony horses)

Figure 3. Number of Horses Examined by Age



Submissions By Gender

The gender distribution of the horses submitted during 2016-17 is shown in Table 4 below. Males represented ~62 percent of the total group, with 43 percent of males being intact (stallions) and 57 percent geldings. Females comprised ~ 38 percent of the group, with the majority of them being intact, but one animal being neutered.

Table 4. Distribution of Horses by Gender and Category

Gender	Non-Exercise	Racing	Training	Total
Female	17	28	32	**77 (37%)**
Neutered Female	0	1	0	**1 (1%)**
Male	9	23	23	**55 (26%)**
Neutered Males	16	30	28	**74 (36%)**
Total	**42**	**82**	**83**	**207 (100%)**

Injuries

As previously mentioned, the categories of injury represent the activity of the horse or circumstances at the time of the fatal or catastrophic injury. The largest cluster of fatal injuries, ~72 percent, occurred in 2-, 3- and 4-year-old racehorses (Table 5). The age of the horses submitted for non-exercise-related fatalities was also concentrated between 2 and 4 years of age.

Table 5. Category of Injury/Fatality by Age

Category/Age	<=2	3	4	5	6	7	8	>=9	NR*	Total
Non-Exercise	10	7	8	2	5	2	1	6	1	**42**
Racing	11	27	16	10	10	4	0	4	0	**82**
Training	18	32	20	5	4	0	2	2	0	**83**
Total	**39**	**66**	**44**	**17**	**19**	**6**	**3**	**12**	**1**	**207**

*NR: Age not reported (pony horses)

During this fiscal year, Thoroughbred horses suffered almost the same number of racing and training catastrophic injuries (~ 40 for both; Table 6). This is different from last year, when racing injuries were higher than training injuries, but similar to previous years when the percentage of racing fatalities was very similar to that of training catastrophic injuries.

Quarter Horses suffered only five (17 percent) catastrophic injuries during training in this period. This is very similar to the previous two years (17 and 18 percent, respectively), but higher than the years before in which catastrophic injuries of Quarter Horses during a training session were infrequent. Quarter Horse submissions during 2016-17 were only slightly higher than the previous year (29 in

Continued

2016-17, versus 27 in 2015-16), keeping on with the slight decline that had started seven years ago. Figure 4 shows the historical number of Quarter Horses submitted to the program since its inception.

In 2016-17, ~78 percent of the total primary injuries or conditions in all breeds were due to musculoskeletal problems (Table 7), which is consistent with what has been observed in previous years. Of this group, ~ 92 percent of injuries affected the front or rear legs (Table 8). The injuries listed in these tables represent the primary injury to the horse.

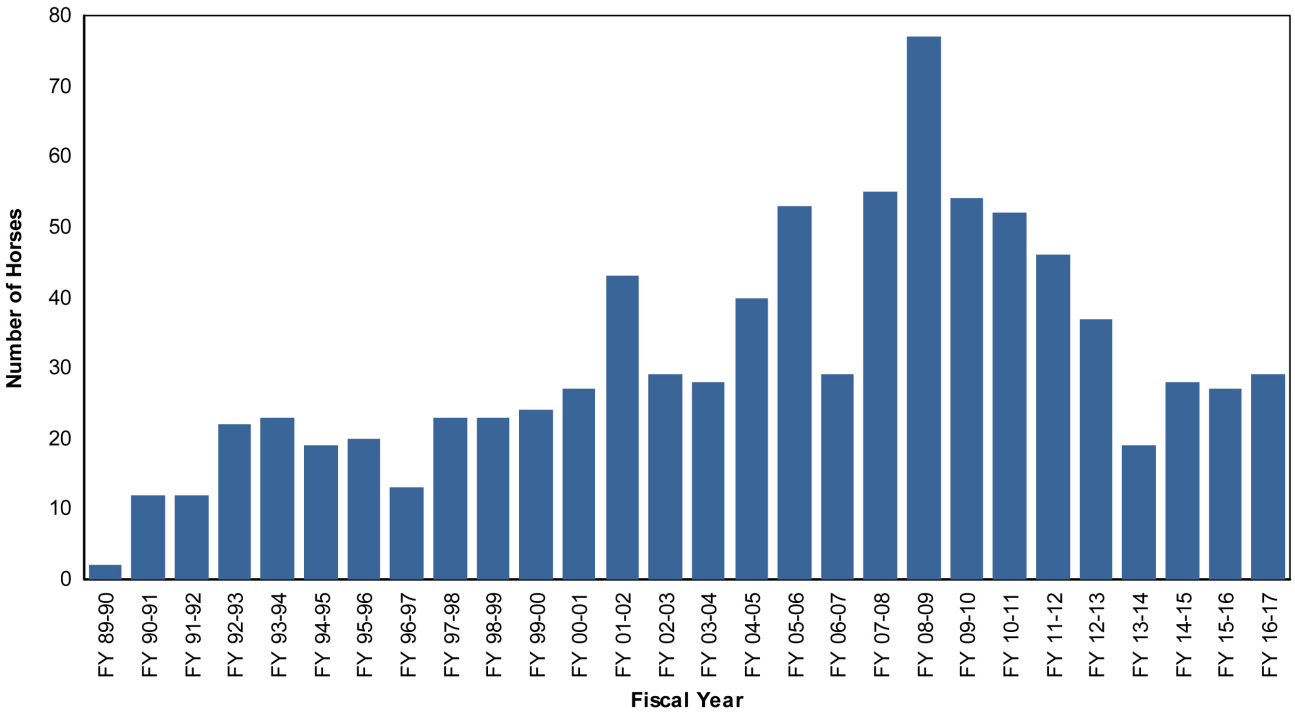
In many cases, several primary findings for each horse submitted were recorded. Thus, the total

Continued

Table 6. Category of Injury/Fatality by Breed

Injury Class by Breed	Non-Exercise	Racing	Training	Total
Quarter Horse	9	15	5	**29**
Standardbred	1	1	0	**2**
Thoroughbred	32	66	78	**176**
Total	**42**	**82**	**83**	**207**

Figure 4. Number of Quarter Horses Submitted to the CHRB Postmortem Program by Fiscal Year



number of reported injury types exceeds the number of horses submitted. This is especially true in severe injuries involving multiple bones in the limbs. In these cases, multiple related injuries, such as tendon and ligament ruptures are identified concomitantly.

Musculoskeletal injuries are most likely to occur during racing or training. Because these injuries are by far the most common, most of the investigative efforts at the University of California, Davis, have focused on causes and prevention of limb injuries.

Table 7. Organ Systems Affected

Breed	GI	MS	Nerv	Resp	Inte	Uro	WB	Total
Quarter Horse	3	20	1	2	0	0	3	**29**
Standardbred	0	0	0	0	0	1	1	**2**
Thoroughbred	9	141	1	6	2	0	17	**176**
Total	**12**	**161**	**2**	**8**	**2**	**1**	**21**	**207**

(GI= Gastrointestinal; MS= Musculoskeletal; Nerv= Nervous; Resp= Respiratory; Inte= Integumentary; Uro= Urogenital; WB= Whole body).

Table 8 lists catastrophic injuries by limb and other axial locations. The number of front limb injuries sustained during racing (75) was higher than those injuries sustained during training (71). There were variable numbers of right and left rear limb injuries, but equal numbers of right and left front limb injuries.

Table 8. Musculoskeletal Structures Affected

Structure Affected	Non-Exercise	Racing	Training	Total
Left Front	0	32	35	**67**
Left Rear	1	0	2	**3**
Right Front	0	41	26	**67**
Right Rear	3	2	6	**11**
Pelvis	1	2	4	**7**
Skull	4	0	0	**4**
Vertebra	1	1	3	**5**
Various Structures*	6	0	0	**6**
Total	**16**	**78**	**76**	**170**

* Includes laminitis and/or tendinitis of one or more legs

Table 9. Musculoskeletal Injury Type by Breed

Diagnosis	Quarter Horse	Thoroughbred	Total
Carpal Fracture – Left	1	4	**5**
Carpal Fracture – Right	7	8	**15**
Fedlock Failure – Left Front	2	48	**50**
Cervical Stenosis	0	2	**2**
Fedlock Failure – Left Rear	0	1	**1**
Fedlock Failure – Right Front	3	31	**34**
Fetlock Failure – Right Rear	0	2	**2**
Femur Fracture – Right	0	1	**1**
Humerus Fracture – Left	0	6	**6**
Humerus Fracture – Right	0	4	**4**
Laminitis	0	2	**2**
Metacarpus III Fracture – Left	0	3	**3**
Metacarpus III Fracture – Right	1	4	**5**
Metatarsus III Fracture – Right	0	2	**2**
P1 Fracture – Left Front	0	1	**1**
P1 Fracture –Left Rear	0	1	**1**
P1 Fracture – Right Front	0	4	**4**
P1 Fracture – Right Rear	0	2	**2**
Patella Fracture – Left	1	0	**1**
Patella Fracture – Right	1	0	**1**
Pelvis Fracture	0	7	**7**
Radius Fracture – Right	0	1	**1**
Scapula Fracture – Left	0	2	**2**
Scapula Fracture – Right	3	2	**5**
Skull Fracture	1	3	**4**
Tendinopathy	0	1	**1**
Tibia Fracture – Right	0	3	**3**
Ulna Fracture – Left	1	0	**1**
Vertebra Fracture	1	3	**4**
Total	**22**	**148**	**170**

Track Surface and Musculoskeletal Injuries in Thoroughbreds

The distribution of musculoskeletal injuries in Thoroughbreds was evaluated when comparing the three types of track surfaces in which these horses performed. Table 10 shows the limb distribution of injuries in horses running on different surfaces. As before, these data show that for the current fiscal year the absolute number of injuries on dirt surfaces was higher than on other surfaces. Because the total number of horses racing on each surface is not known to CAHFS, it cannot be determined from this data whether the injury rates differ by track surface.

Table 10. Musculoskeletal Injury: Affected Limb by Track Type

Structure Affected	Dirt	Synthetic	Turf	N/A*	Total
Left Front	53	7	7	0	**67**
Left Rear	1	1	0	1	**3**
Pelvis	4	1	1	1	**7**
Right Front	53	8	6	0	**67**
Right Rear	5	1	2	3	**11**
Skull	0	0	0	4	**4**
Vertebra	2	2	0	1	**5**
Various Structures**	0	0	0	6	**6**
Total	**118**	**20**	**16**	**16**	**170**

*Inuries that did not occur on a racing/training surface. **Includes laminitis and/or tendinopathies of one or more legs.

Other Organ Systems Affected by Injuries

Gastrointestinal:

Of the gastrointestinal system diagnoses, colitis and enteritis/enteropathies were the most frequently observed. Causes of most cases of colitis during this period were bacterial, with *Clostridium difficile* being the most prevalent species identified.

Diagnosis	Total
Cecal Rupture	1
Colitis	5
Enteritis/Enteropathy	3
Gastric Rupture	2
Gastrointestinal Neoplasm	1
Total	**12**

Integumentary:

As usual, diseases of the integumentary system were rare during this reporting period.

Diagnosis	Total
Cellulitis	1
Hoof Avulsion	1
Total	**2**

Other Organ Systems Affected by Injuries continued

Nervous System:

Equine protozoal myelitis keeps occurring in racehorses, although at low prevalence.

Diagnosis	Total
Equine Protozoal Myelitis	1
Myelopathy	1
Total	**2**

Reproductive:

Abortion is a rare occurrence in racehorses submitted for postmortem. In this case, the cause of the abortion was not determined.

Diagnosis	Total
Abortion	1
Total	**1**

Respiratory:

The number of respiratory disease cases increased slightly from the previous fiscal year (2015-2016) during which only five cases were identified. The main cause of pneumonia (including pleuropneumonia) was *Streptococcus equi,* subsp. *zooepidemicus.*

Diagnosis	Total
Pneumonia	6
Pulmonary Hemorrhage	1
Rhinitis	1
Total	**8**

Whole Body:

The number of unexplained sudden deaths in horses remains relatively high with 12 cases reported during this period.

Diagnosis	Total
Hemoabdomen	1
Hemothorax	2
Septicemia	2
Unexplained sudden death	12
Unexplained cause of disease (euthanasia)*	3
Total	**20**

* Refers to horses that were euthanized but the cause of disease was not found on postmortem examination.

RESEARCH SUPPORT

Research Sponsors

- Center for Equine Health, with funds provided by:
  - State of California Satellite Wagering Fund
  - Southern California Equine Foundation
  - Private donors
- Dolly Green Foundation
- Grayson-Jockey Club Research Foundation, Inc.
- Pacific Coast Quarter Horse Racing Association

Researchers and Collaborators

Mark Anderson
Rick Arthur
Francisco Carvallo
Peter Chu
Vanessa Dahl
Karina Fresneda
David Fyhrie
Tanya Garcia
Lucy Gomez
Dave Hawkins
Ashley Hill
Janet Moore
Akinyi Nyaoke
Sarah Puchalski
Meredith Rhea
Kanako Sakaguchi
Tiffany Sarrafian
Susan Stover
Jennifer Symons
Shrini Upadhyaya
Francisco Uzal
Leslie Woods

OUTREACH AND PRESENTATIONS TO SCIENTIFIC MEETINGS

1) Racehorse pathology/Diagnostic special session. 59th Annual meeting of the American Association of Veterinary Diagnostic Laboratories. Greensboro, NC, October 16, 2016. Chair: F. Uzal, L. Kennedy
2) Racehorse pathology special session. Annual meeting of the American College Pathologists. New Orleans, LA, December 7, 2016. Chair: F. Uzal, L. Kennedy
3) Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
4) The CHRB Postmortem program. F. Uzal. Workshop: Examination of the musculoskeletal system and heart of racehorses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
5) Importance of the postmortem program for CHRB and the racing industry in California. R. Arthur. Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
6) Anatomy, anatomic nomenclature, fracture nomenclature and general fracture mechanics. S. Stover. Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
7) Postmortem protocol for musculoskeletal lesions of racehorses. S. Diab. Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
8) Specific examples of lesions and nomenclature. S. Stover. Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.

Continued

OUTREACH AND PRESENTATIONS TO SCIENTIFIC MEETINGS

9) Lower limb dissection. J. Moore. Workshop: Examination of the musculoskeletal system and heart of racehorses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
10) Specific examples of lesions and nomenclature. S. Stover. Workshop: Examination of the musculoskeletal system and heart of race horses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
11) Cardiac necropsy. S. Diab. Workshop: Examination of the musculoskeletal system and heart of racehorses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
12) Coding fetlock lesions. M. Rhea and A. Hill. Workshop: Examination of the musculoskeletal system and heart of racehorses and the CHRB necropsy program. Tulare, CA, 16 November 2016.
13) Basic anatomic and pathological nomenclature of the musculoskeletal system in racehorses. Approach to finding pre-existing lesions. S. Stover. Racehorse pathology/Diagnostic special session. 59th Annual meeting of the American Association of Veterinary Diagnostic Laboratories. Greensboro, NC, October 16, 2016.
14) Postmortem protocol for musculoskeletal lesions of racehorses. S. Diab. Racehorse pathology/ Diagnostic special session. 59th Annual meeting of the American Association of Veterinary Diagnostic Laboratories. Greensboro, NC, October 16, 2016.
15) The racehorse postmortem program in California. F. Uzal. Racehorse pathology/Diagnostic special session. 59th Annual meeting of the American Association of Veterinary Diagnostic Laboratories. Greensboro, NC, October 16, 2016.
16) Humeral and Axial Fractures. F. Uzal. Annual meeting of the American College Pathologists. New Orleans, LA, December 7, 2016.
17) Prevalence, location and symmetry of non-catastrophic ligamentous suspensory apparatus lesions. A. Hill. Annual meeting of the American College Pathologists. New Orleans, LA, December 7, 2016.
18) Idiopathic hemorrhage associated with anticoagulant rodenticide exposure in exercising horses. R. Arthur. Annual meeting of the American Association of Equine Practitioners, Las Vegas, NV, December, Proceedings of the AAEP: 61:155-160, 2015.
19) Sudden death associated with anticoagulant rodenticide exposure and idiopathic hemorrhage in exercising horses. R. Arthur, 21st International Conference of Racing Analysts and Veterinarians, Montevideo, Uruguay, 25-28 October, 2016.
20) The California racehorse postmortem program. F.A. Uzal, 21st International Conference of Racing Analysts and Veterinarians, Montevideo, Uruguay, 25-28 October, 2016.
21) Special issue on racehorse pathology and diagnostics for *Journal of Veterinary Diagnostic Investigation.* Invited editors: F. Uzal, L. Kennedy. July 2017. Forthcoming.
22) Early Pathological events in proximal sesamoid bone fracture: Factors that play a role in injury prevention. S. Stover. Havemeyer Conference on Subchondral Bone Injury. Newmarket, England, 2015.
23) Racing injury prevention. S. Stover. Equine Welfare Advisory Committee, California Animal Health and Food Safety Laboratory, University of California, Davis. 2015
24) Training for injury prevention, insights from the CHRB/CAHFS Racehorse Postmortem Program. S. Stover. Western University of Health Sciences Pomona, CA. 2016.
25) Why are soft tissue injuries becoming so prevalent in sport horses? What pathology has taught us about how we should train and rehabilitate racehorses. S. Stover. Veterinary Orthopedic Society Conference. Big Sky, Montana. 2016.

Continued

OUTREACH AND PRESENTATIONS TO SCIENTIFIC MEETINGS

26) Diagnostic workup of upper limb stress fractures and proximal sesamoid bone remodeling; Training for Injury Prevention. S. Stover. Bouthieb Endurance Village, Abu Dhabi, UAE. 2016.

27) Epidemiology of racehorse fractures. S. Stover. Dubai Equine Hospital, Dubai, UAE. 2016.

28) Research findings relevant to implementation of the fatality review program for official veterinarians. S. Stover. California Horse Racing Board – Official Veterinarian Meeting University of California, Davis, CA. 2016.

29) Surface management: Fetlock and hoof motion. S. Stover. American College of Veterinary Surgeons Symposium, Seattle, WA. 2016.

30) Basic anatomic and pathological nomenclature of the musculoskeletal system in race horses. Approach to finding pre-existing lesions. S. Stover. Greensboro, North Carolina; American Association of Veterinary Laboratory Diagnosticians meeting. 2016.

SCIENTIFIC PUBLICATIONS

1) Introduction to special issue on racehorse pathology: in the service of human and equine welfare. Uzal FA, Kennedy LA, Maxie G. Journal of Veterinary Diagnostic Investigation. 2017 29: 381-382.

2) Sudden death in racehorses: postmortem examination protocol. Diab SS, Poppenga R, Uzal FA. *Journal of Veterinary Diagnostic Investigation.* 2017 29:442-449.

3) Diab SS, Stover SM, Carvallo F, Nyaoke AC, Moore J, Hill A, Arthur R, Uzal FA. Preexisting lesions associated with complete diaphyseal fractures of the third metacarpal bone in 12 Thoroughbred racehorses. Gray SN, Spriet M, Garcia TC, Uzal FA, Stover SM. *Journal of Veterinary Diagnostic Investigation*. 2017 29:437-441.

4) Nomenclature, classification, and documentation of catastrophic fractures and associated preexisting injuries in racehorses. Stover SM. *Journal of Veterinary Diagnostic Investigation*. 2017 29:396-404.

5) Retrospective study of fatal pneumonia in racehorses. Carvallo FR, Uzal FA, Diab SS, Hill AE, Arthur RM. *Journal of Veterinary Diagnostic Investigation*. 2017 29:450-456.

6) Diagnostic approach to catastrophic musculoskeletal injuries in racehorses. Diab SS, Stover SM, Carvallo F, Nyaoke AC, Moore J, Hill A, Arthur R, Uzal FA. *Journal of Veterinary Diagnostic Investigation*. 2017 29:405-413.

California Animal Health and Food Safety Laboratory System

J.D. Wheat Veterinary Orthopedic Research Laboratory

School of Veterinary Medicine
University of California, Davis
West Health Sciences Drive
Davis, California 95616