

RACING INJURY PREVENTION

CONDUCTED FOR THE CALIFORNIA HORSE RACING BOARD
AS PART OF THE RACING SAFETY PROGRAM

JULY 2011 - JUNE 2013



MISSION

The Racing Injury Prevention Program’s mission is to enhance equine, jockey, and industry welfare by partnering with horsemen and horsewomen to reduce the incidence of debilitating and fatal injuries to racehorses and jockeys at California racetracks and training facilities. We believe value is reflected in the quality of our research, educational outreach, and evidence based recommendations focused on practical applications to make a difference.

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“Knowing is not enough; we must apply. Willing is not enough; we must do.”

Johann Wolfgang von Goeth

If there ever was a time for action to improve equine welfare and restore the image of horse racing, it is now. We are faced with a great opportunity – and greater need – to reduce human and equine injuries on California racetracks.

Musculoskeletal injuries can be prevented because we know injuries develop over time, creating an opportunity to intervene and prevent injuries. If we act now utilizing evidence-based strategies, we can save the lives of both racehorses and jockeys and produce a tangible economic impact within the racing community.

The Racing Injury Prevention Program is one of the integrated components of the California Horse Racing Board’s Racing Safety Program. Veterinarians, research scientists, pathologists, epidemiologists, and engineers collaborate with members of the racing industry to ensure that all issues and perspectives are considered. We’ve come through the first year of the program, transforming as a team to make progress using innovative ideas and new strategies.

With the combined experience and expertise of our team, the Racing Injury Prevention Program is poised to deliver innovative evidence-based strategies for improving equine and jockey welfare. We are making progress in California working to discover, educate, and promote change that will also improve economic welfare within this \$30 billion a-year industry.





Santa Anita, California
Courtesy of Dr. Martin Vidal

RACING SAFETY PROGRAM

In early 2010, the Racing Safety Program (RSP) hit the ground running with a mission to reduce the incidence of debilitating and fatal injuries at California racetracks and training facilities.

The cornerstone of the RSP is the investigation conducted by the California Horse Racing Board (CHRB) for every racehorse fatality that occurs on a racetrack or training facility in California. The objective of this investigation is to establish the underlying reason for the fatal incident.

There are three related activities working together to support the racehorse fatality investigations. These are

▶ EQUINE POSTMORTEM PROGRAM (NECROPSY)

A necropsy is performed on all horses that die at California racetracks and is conducted by veterinary pathologists at the California Animal Health and Food Safety (CAHFS) Laboratory System at the University of California, Davis. Similar to human autopsy, the goal is to determine the cause of death

and identify other abnormalities that may have affected the horse's health. Information learned from the examination is useful for recognition of diseases and injuries in the racehorse population.

▶ TRACK SAFETY

The Track Safety Standards Project works with racetracks in optimizing their race surfaces for the safety of horses and riders. Standards are being developed by the CHRB to maintain race surface consistency within a racetrack.

Field and laboratory measurements of racetrack surfaces are compared to the components that affect surface behavior, like water content.

These comparisons guide surface management so that surface parameters are kept within safety standards. Individual standards are developed for each surface type.

▶ RACING INJURY PREVENTION

The Racing Injury Prevention Program commenced in October 2011.

The foundation of this program is the Enhanced Orthopedic Examination, conducted after necropsy using specialized equipment in the UC Davis, J.D. Wheat Veterinary Orthopedic Research Laboratory. Examinations focus on identifying pre-existing conditions that contribute to catastrophic injuries.

Research findings from these examinations are analyzed with intent of identifying pre-existing conditions that may contribute to catastrophic injury in race horses.

Knowledge gained from research findings are distributed to veterinarians and trainers through professional forums and continuing education programs.

Working together, evidence-based recommendations reach beyond the scope of injury identification into awareness, injury prevention and rehabilitation.



2009 Breeders Cup, Santa Anita, California
Courtesy of Dr. Mary Beth Whitcomb

RACING INJURY PREVENTION HIGHLIGHTS

The Racing Injury Prevention Program commenced in October 2011. The program's mission is to reduce the incidence of debilitating and fatal injuries, to both racehorses and jockeys alike, at California racetracks and training facilities.

This team has made discoveries and initiated new programs that have enhanced equine welfare and poise the industry for future growth through research and education.

The newly instituted Enhanced Orthopedic Postmortem Examination is the foundation of this program. These examinations are conducted by veterinarians at the UC Davis, J.D. Wheat Veterinary Orthopedic Research Laboratory using specialized equipment and tests, following necropsy by pathologists at the California Animal Health and

Food Safety (CAHFS) Laboratory System. The key emphasis of each examination is the identification of pre-existing conditions that promote career-ending injuries. The team discovered the pre-existing condition for the most common cause of deaths of racehorses, fetlock breakdown.

Knowledge of pre-existing conditions provides valuable insight into the events that precede catastrophic breakdown. Knowledge of these events provides opportunities to develop management strategies for injury prevention and clinical diagnostic methods for early injury

detection; ultimately extending the careers of racehorses. In 2013 a newly applied diagnostic technique resulted in the detection of a pre-existing condition in two California racehorses, which allowed for rehabilitation.



2009 Breeders Cup, Santa Anita, California
Courtesy of Dr. Mary Beth Whitcomb

Management factors as diverse as racetrack surfaces and training and racing regimens have been associated with career ending injuries in racehorses. Consequently, another focus of the program includes identification of factors that can be managed for injury prevention.

Findings of studies on race surface behavior were published and new studies on training and racing programs were initiated. Graphical depiction of the high-speed exercise history of horses is now reported with the enhanced orthopedic examination findings for consideration by racehorse caretakers.

Jockey health and safety is another industry concern. We compiled jockey accident reports, which detail the cause and outcome, of incidents for the last 6 years.

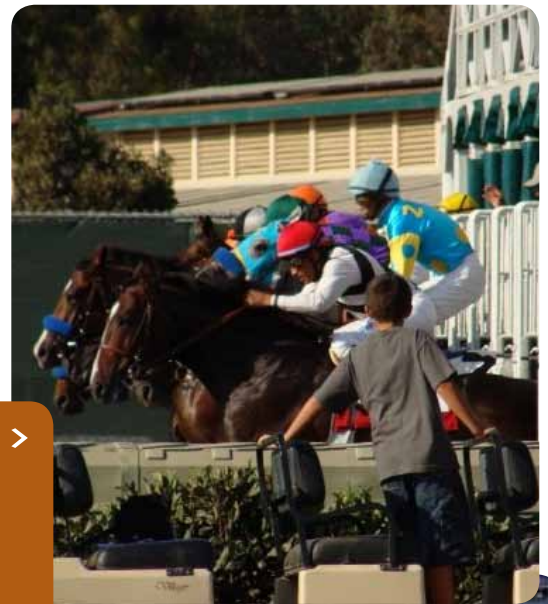
We learned that many jockey injuries occur when racehorses fall because of a catastrophic injury. Prevention of equine injuries will enhance jockey welfare.

Education of trainers, owners, veterinarians, grooms, and all caretakers of the horse is paramount to injury prevention.

1. High quality evidence based e-Learning education modules are being developed for online access to state-of-the-art information about injury development, detection, and prevention;
2. An information rich website was initiated; and

3. Technical Notes (fact sheets) about specific injuries were created and distributed.

The Racing Injury Prevention Program remains focused on research and education that contributes to improving the lives of equine athletes, jockeys and industry participants.



And they're off . . . Del Mar Racetrack, California
Courtesy of Dr. Elizabeth Collar >

Thoroughbreds enter the Racetrack at Del Mar
Courtesy of Dr. Elizabeth Collar
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Racing Injury Prevention team members. From left to right: Dr. Susan Stover, Shannon Mitchell, Dr. Erin McKerney, Tom Lazzari, Vanessa Dahl, Trixy (retired Thoroughbred), Jennifer Symons, Dr. Peta Hitchens, Tanya Garcia-Nolen, Dr. Elizabeth Collar, Christina Milne, Dr. Crystal Tjha.

OUR TEAM

The service, research and education components of the Racing Injury Prevention Program rely on exceptionally qualified, energetic people who have been recruited to fulfill the Program's aims.

Veterinarians are responsible for conducting the enhanced orthopedic postmortems, and producing the reports. In addition, they focused on discovering injury patterns during the course of the enhanced examinations. Research projects are designed to understand how injuries develop, how mild predisposing injuries can be detected, and factors for injury prevention.

For cases of interest, our veterinary pathologist and radiologist report on the histopathology of specimens and interpretation of radiographs, respectively.

The laboratory assistants prepare and radiograph necropsy specimens for the veterinarians. They maintain the database, up to date, which is critical to epidemiology studies to detect risk factors for injury.

Biomedical and agricultural engineers provide expertise for understanding the roles of exercise, damage accumulation in bone, and race surface behavior on development of injury – with the aspiration of injury prevention.

Epidemiologists are investigating factors that can be managed for injury prevention, both for horses and jockeys.

Our web design and communications expert is integral in the development of trainer education modules, and forging an online presence, as well as,

establishing public awareness, and positive associations with veterinarians and people who earn their livelihood at the racetrack.

At the University of California, Davis, the undergraduate and graduate students are an important component of research. Students have worked on such projects as investigating differences in racehorse limb dynamics on different racetrack surfaces, comparing wear patterns in racehorse shoes to see if there is a difference in the wear between different surfaces, and investigating associations between biomechanical properties of bones and exercise histories of horses that experienced a fatal humeral fracture.

RESEARCH AND EDUCATION

Performing enhanced orthopedic postmortem examinations on California racehorse specimens is a cornerstone of the Racing Safety Program. Sophisticated techniques, available in the J.D. Wheat Veterinary Orthopedic Laboratory at UC Davis are used to discover the reasons for injury.

Necropsies (postmortem examinations) are performed on all horses that die on California racetracks by veterinary pathologists to look for abnormalities in all of the body systems at California Animal Health and Food Safety (CAHFS) Laboratories.

➤ ENHANCED ORTHOPEDIC POSTMORTEM EXAMINATIONS

The enhanced examination is focused on identification of pre-existing lesions that promoted the catastrophic injury. These lesions provide valuable insight into the events that precede catastrophic breakdowns and provide opportunities to find clinical diagnostic methods for early detection of affected horses. Affected horses can often be rehabilitated and returned to racing.

Collaboration was streamlined with CAHFS by designing a standardized proforma for reporting findings from Enhanced Orthopedic Postmortem Examinations. The new report provides a case summary and cause of death, in a format designed to be easily interpreted by horsemen/horsewomen. Findings are integrated with the Racing Injury Prevention database for epidemiology studies of risk factors for injury development.

Standardized dissection, radiographic, and photographic protocols have been implemented to ensure consistent handling and through examination of specimens.

Templates for classification of findings of scapular, humeral and fetlock fractures were developed for further investigation. A standardized grading system for degenerative joint lesions in the fetlock, carpus and tarsus was initiated.

Efforts to enhance the orthopedic examination reports took a big step forward with the completion and validation of new software developed by key team members.

The software program converts exercise history data of case and control horses into variables and graphic illustration for statistical analysis used in epidemiological studies. An individual report for each case was developed and as of December 2012, appended to the enhanced necropsy reports.

With the implementation of these steps we are gaining valuable information about the events during and leading up to catastrophic injury in racehorses.



Renee Wren reviews, diagrams and catalogs fractured sesamoid bones for further research.

➤ MUSCULOSKELETAL INJURY (MSI)

FIGURE 1. Number of fatal musculoskeletal injury specimens submitted to the VORL for enhanced examination, by month of horse death.

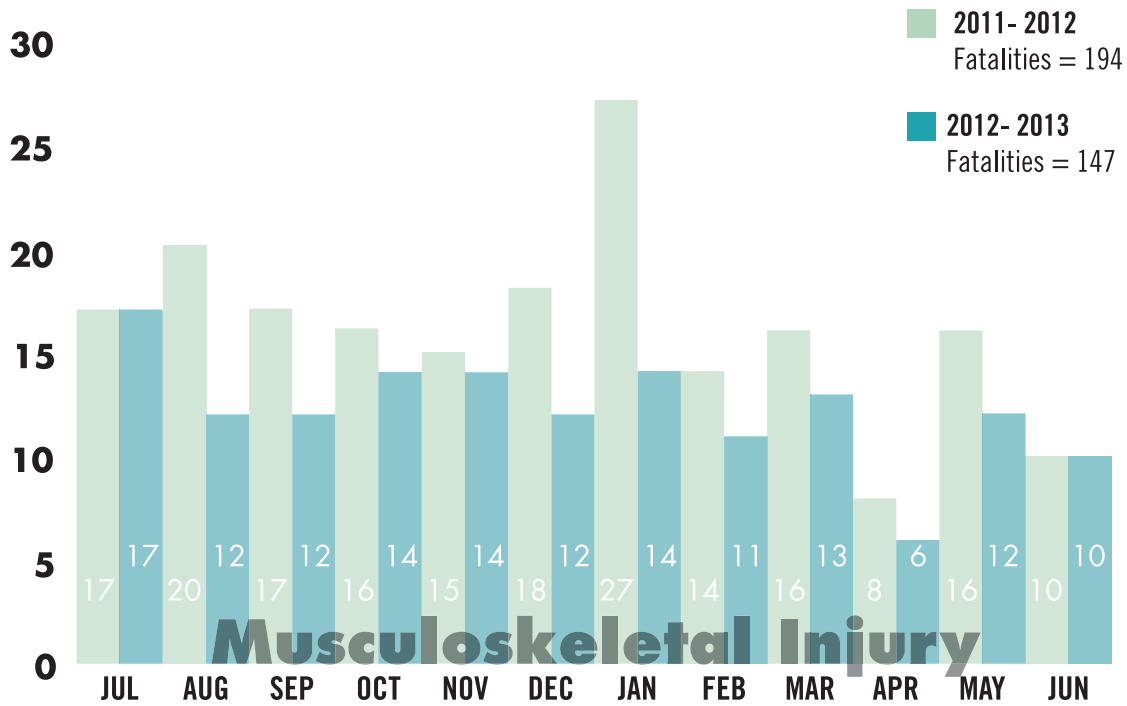


FIGURE 2. Percentages of musculoskeletal injury of horses that died and were examined as part of the Racing Injury Prevention Program between July 2011 to June 2013.

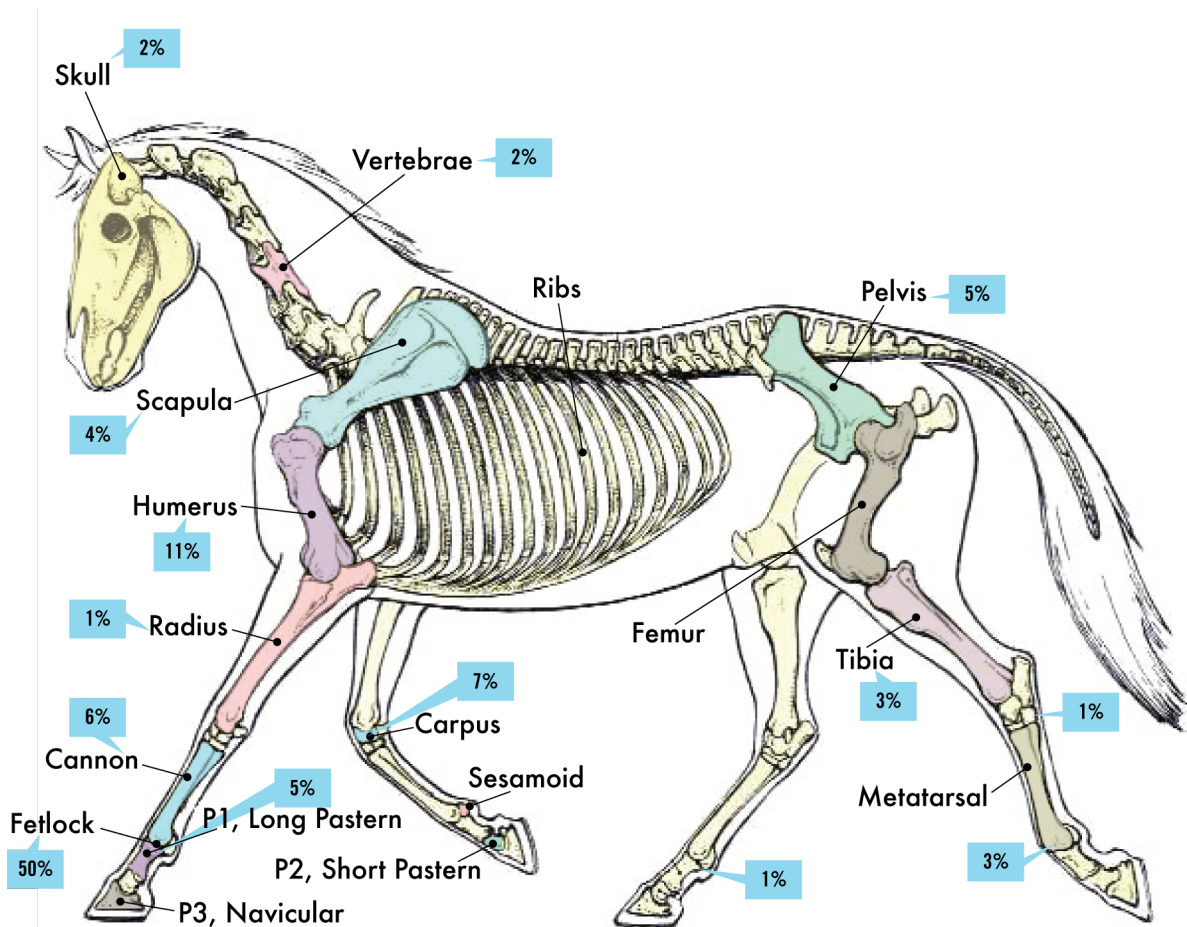


FIGURE 3. Number of horses that experienced a catastrophic injury during racing or training - Thoroughbreds and Quarter Horses.

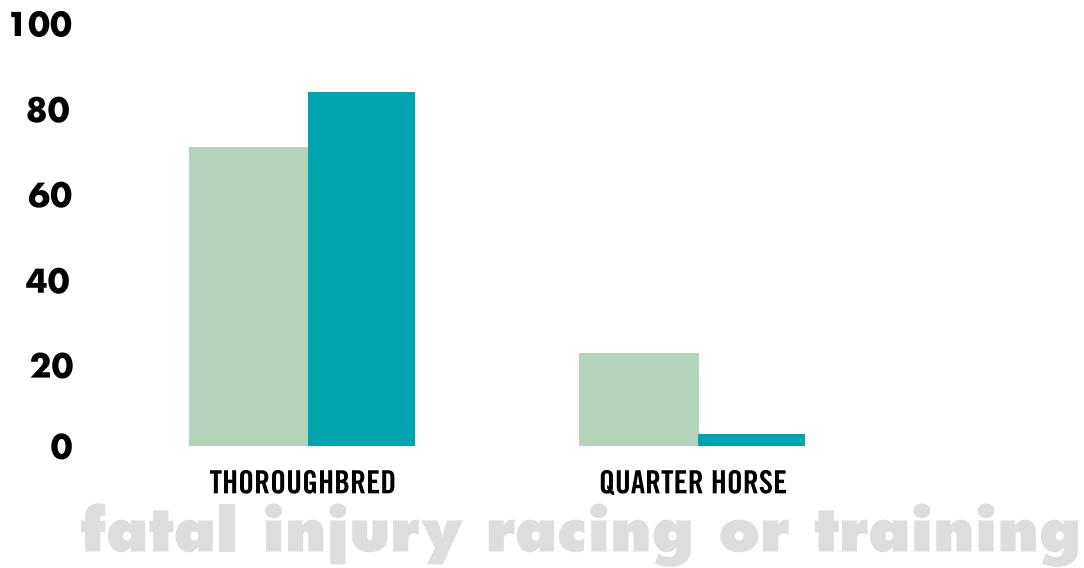
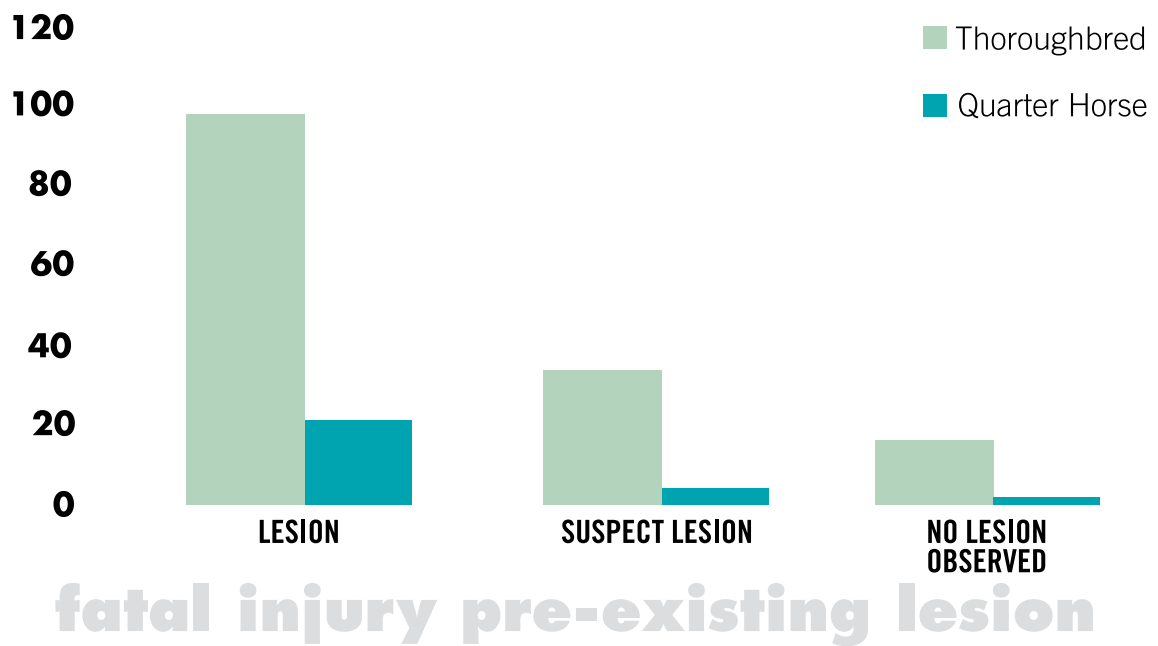
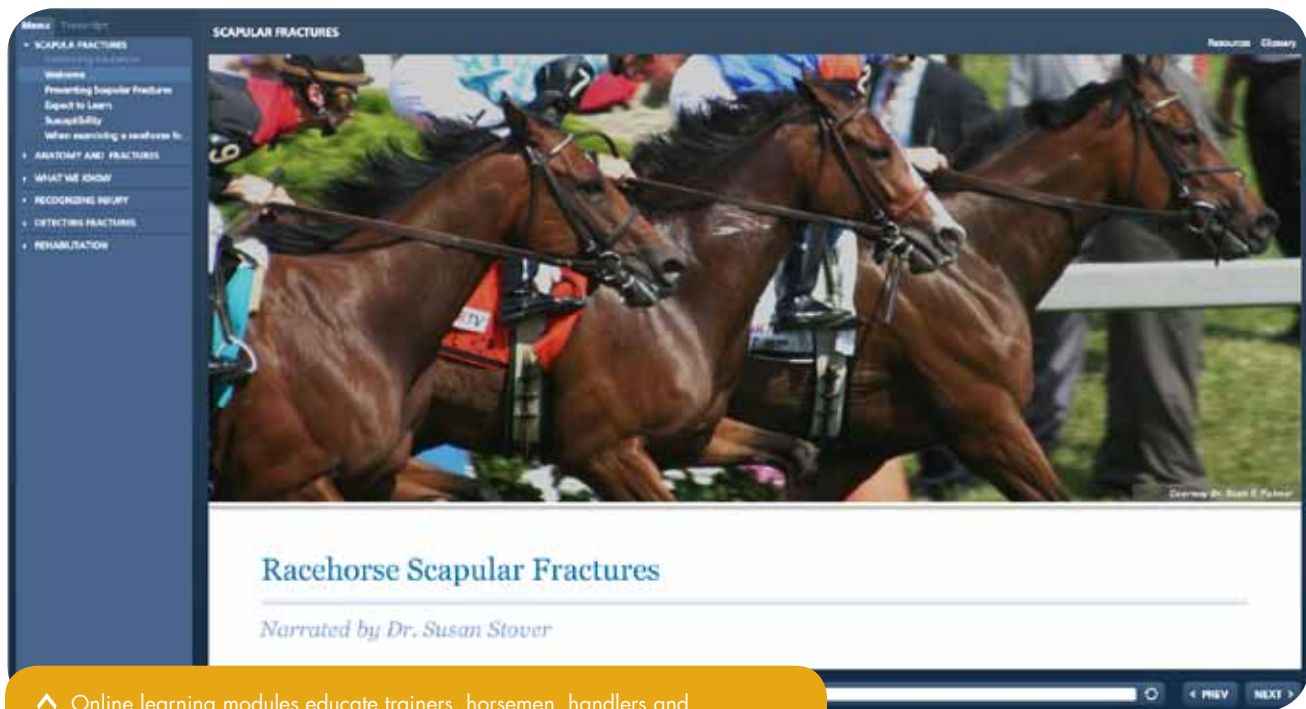


FIGURE 4. Number of fatal musculoskeletal injuries with pre-existing lesions from July 2011 to June 2013, by breed.





Online learning modules educate trainers, horsemen, handlers and veterinarians on key research based findings, injury detection strategies and guidelines for treatment and rehabilitation of racehorses.

The Racing Injury Prevention Program remains focused on research and education that will contribute to improve the lives of equine athletes, jockeys and industry participants.

EDUCATION

With strong commitment design and development initiated the production of education modules. These modules serve as the supporting structure for distribution of research findings from the Program. Release of the first 5 modules is scheduled for mid 2013.

Relationships with the University of California, Davis Extension has propelled the learning modules into continuing education credits and learning tools for horse enthusiasts.

Courses will be offered online for access by horsemen and horsewomen at any time.

As a companion piece to the education modules, technical notes for scapular and humeral fractures have been developed and accessible on the web. The notes are e-mailed to the official and attending veterinarians following a related fracture.

TechNotes can be found on the J.D. Wheat Veterinary Orthopedic Research Laboratory website.



➤ CAUSE OF DEATH AND RESEARCH PRIORITIZATION PLAN

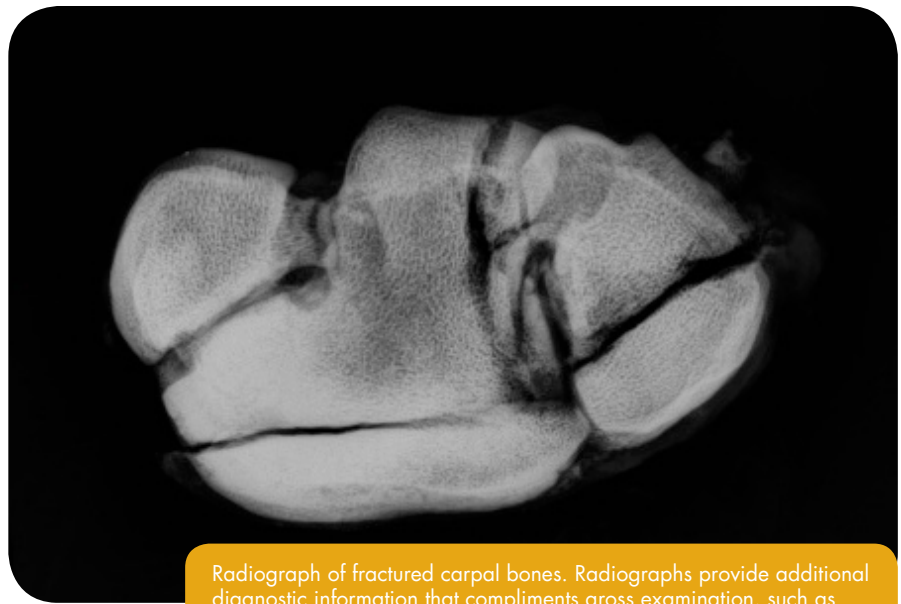
Much of the program's investment of time has focused on identifying those injuries for which the cause of death is unknown or poorly understood; and developing a research plan to better understand these specific types of injuries.

As a result of this research and planning there are **six key injuries** the program has identified and prioritized based on the potential to positively impact the racing industry.

Key areas of study and research include:

Fetlock proximal sesamoid bone fractures

- The largest cause of death in Thoroughbred and Quarter Horse racehorses
- This year's discovery of a pre-existing injury has focused efforts on characterization of the lesion and finding a method to detect the lesion



Radiograph of fractured carpal bones. Radiographs provide additional diagnostic information that compliments gross examination, such as fracture configuration and degenerative changes.

Carpal bone fractures

- The second largest cause of death in Quarter Horse racehorses (24% of deaths)
- Efforts are focused on identifying possible pre-disposing lesions

Canon bone fractures

- The cause of 19% of Thoroughbred and 5% of Quarter Horse deaths
- Efforts are focused on identifying common fracture patterns, pre-existing injuries and methods of detecting pre-existing injuries

Scapular fractures

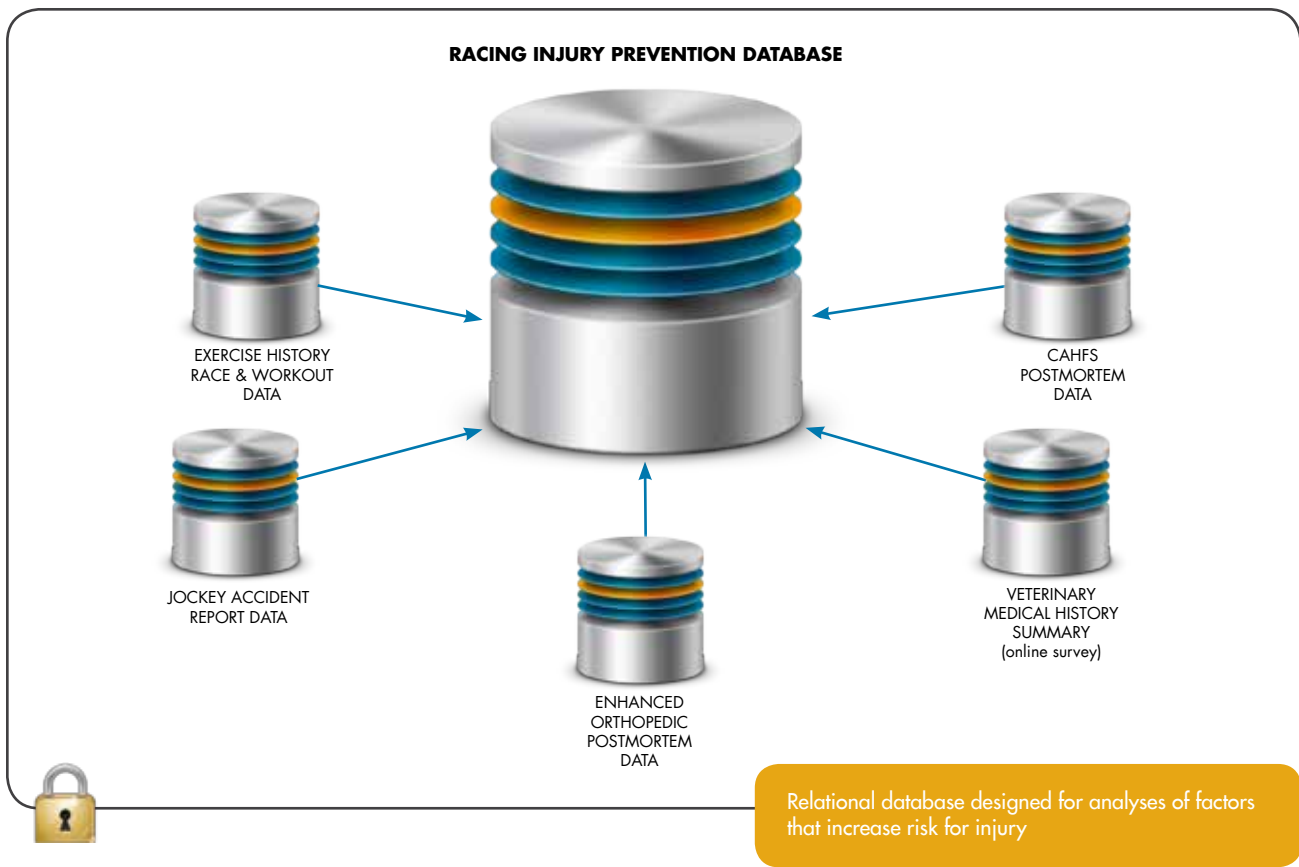
- Completed an epidemiologic study to determine exercise histories associated with scapular fracture in Thoroughbred and Quarter Horse racehorses.
- Developing methods for detecting pre-existing injury

Humeral fractures

- Survey initiated to uncover patterns /clinical signs that trainers and veterinarians could use to identify horses at high risk for incurring a humeral fracture

Vertebral fractures

- The third major cause of Quarter Horse deaths
- Efforts are focused on identifying a common fracture pattern and pre-existing injuries



RELATIONAL DATABASE

The relational database securely houses data for investigating the role of multiple factors for the prevention of horse and jockey injuries.

- **Postmortem information** provides insight into events that lead to catastrophic injury and subsequently be used for detection of affected horses for catastrophic injury prevention
- **Exercise history data** provide a tool to help trainers recognize high risk training patterns and modify training of racehorses for injury prevention.
- **Jockey accident information** is useful for identifying factors that can be modified to reduce jockey injuries and the economic cost associated with medical care.
- **Racehorse history information** is useful for recognizing signs that can be used for identifying racehorses at higher risk for injury that might then be examined more thoroughly.

RESEARCH FINDINGS AND IMPLICATIONS

1. Racetrack Surfaces

Racetrack surface has been implicated as a contributing factor to racehorse musculoskeletal injuries. During high speed gallop, hind limb fetlock hyper-extension was greater on a dirt surface compared to a synthetic surface. Synthetic race surfaces may mitigate the risk of injury to the hind limb fetlock structures by reducing fetlock hyper-extension and associated strains in fetlock support structures. Horizontal displacement of the heel during slide was greater on the dirt surface. The hoof had an extended “toe up” orientation, prior to grab of the synthetic surface. Horses running on a synthetic surface exhibited reduced horizontal slide of the hoof.

– Symons, Garcia-Nolen and Stover, 2012

2. Training Patterns

Racehorses that are in early high-speed training but behind that of their training cohort should be examined for signs of scapular stress remodelling. Quarter Horses that had a prolonged lay-up and Thoroughbreds that have endured high-speed training for a longer duration than that of their training cohort also were at greater risk.

– Vallance, Entwistle, Hitchens, Gardner and Stover, 2012

3. Exercise

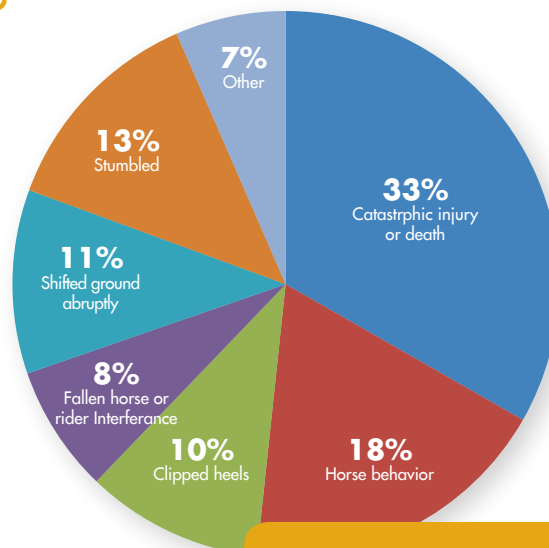
An increase in distance exercised affects the material properties of bone. Additionally, horses with longer careers tended to have a greater post-yield strain, and those with a greater number of works have increasing measures of ultimate strain. The results of this study have identified the need for further research to confirm the effects of different exercise regimes on mechanical properties of bone. Confirmation of these findings will assist in making evidence-based recommendations aimed at prolonging the careers of race horses, improving performance, and increasing the mechanical properties of bone, that will ultimately protect them against catastrophic limb fracture.

– Symons, Garcia-Nolen and Stover, 2012

4. Jockey Injuries

The incidence of falls by jockeys in California is lower than that reported by other countries, but the incidence of injuries is comparable. Jockeys riding in Quarter Horse races are more likely to fall than those riding in Thoroughbred races. A high proportion of falls were observed to be as a result of catastrophic injury or sudden death of the horse. An in-depth analysis of the association between horse breakdown and jockey injury is required.

– Hitchens, Hill and Stover, 2013



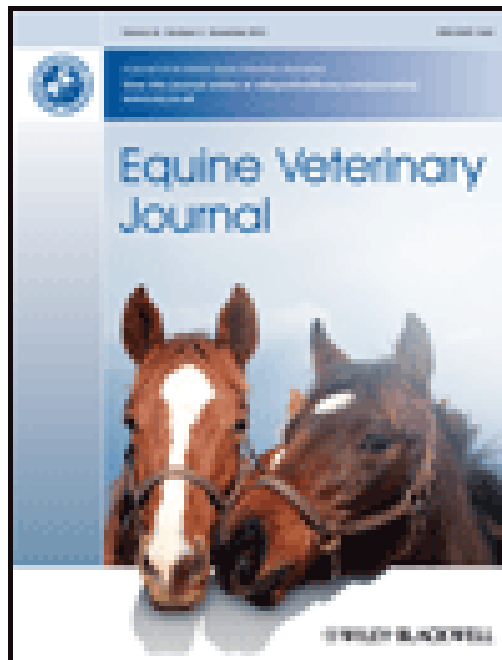
Causes of Jockey Falls

➤ PUBLICATIONS

Distribution of information learned from the program is critical to enable horsemen to make changes that positively impact equine welfare and jockey safety.

Applied Science and Published:

1. Catastrophic scapular fractures in Californian racehorses: Pathology, morphometry and bone density. *Vallance SA, Spriet M, Stover SM. Equine Vet J. 2012 43(6): 676-685.*
2. Effects of equine racetrack surface type, depth, boundary area, and harrowing on dynamic surface properties measured using a track-testing device in a laboratory setting. *Setterbo JJ, Yamaguchi A, Hubbard M, Upadhyaya SK, Stover SM. Sports Engineering. 14(2-4): 119-137.*
3. Dynamic properties of a dirt and a synthetic equine racetrack surface measured by a track-testing device. *Setterbo JJ, Fyhrie PB, Hubbard M, Upadhyaya SK, Stover SM. Equine Vet J. 2012.*
- Online
4. Humeral stress remodeling locations differ in Thoroughbred racehorses training and racing on dirt compared to synthetic racetrack surfaces. *Dimock AN, Hoffman KD, Puchalski SM, Stover SM. Equine Vet J. 2012.*
- Online
5. Case-control study of high-speed exercise history of Thoroughbred and Quarter Horse racehorses that died related to a complete scapular fracture. *Vallance, Entwistle, Hitchens, Gardner and Stover. Equine Vet J. 2012.*



6. Fatal musculoskeletal injuries of Quarter Horse racehorses: 314 cases (1990-2007). *Sarraffian TL, Case JT, Kinde H, Daft BM, Read DH, Moore JD, Uzal FA, Stover SM. J Am Vet Med Assoc. 2012 Oct 1;241(7):935-942.*
7. Characteristics of Thoroughbred and Quarter Horse racehorses that sustained a complete scapular fracture. *Vallance SA, Case JT, Entwistle RC, Kinde H, Barr BC, Moore J, Anderson ML, Arthur RM, Stover SM. Equine Vet J. 2012 Jul;44(4):425-431.*
8. Possible role of carpal hyperextension in superficial digital flexor tendinopathy. *Whitlock D, Garcia TC, Vallance SA, Stover SM. Equine Vet J. 2012 Sep;44(5):559-563.*
9. Jockey falls, injuries and fatalities associated with Thoroughbred and Quarter Horse racing in California, 2007-2011. *Hitchens PL, Hill AE, Stover SM. Orthopedic Journal of Sports Medicine. January - June 2013; 1 (1).*
9. Distal hind limb kinematics of breezing Thoroughbred racehorses on dirt and synthetic racetrack surfaces. *Symons JE, Garcia TC, Stover SM. Equine Vet J. 2013 Jun 7.*
10. Prevalence of abnormal radiographic findings in 2-year-old Thoroughbreds at in-training sales and associations with racing performance. *Meagher DM, Bromberek JL, Meagher DT, Gardner IA, Puchalski SM, Stover SM. J Am Vet Med Assoc. 2013 Apr 1;242(7):969-76.*

Basic Science – Published:

1. Effects of mineral content on the fracture properties of equine cortical bone in double-notched beams. *McCormack J, Stover SM, Gibeling JC, Fyhrie DP. Bone. 2012 Jun;50(6):1275-1280.*

2. Analysis of miniature single and double-notch bending specimens for estimating the fracture toughness of cortical bone. *McCormack J, Wang XS, Stover SM, Gibeling JC, Fyhrie DP. J Biomed Mater Res A.* 2012 Apr;100(4):1080-1088.
3. Forelimb muscle activity during equine locomotion. *Harrison SM, Whitton RC, King M, Haussler KK, Kawcak CE, Stover SM, Pandy MG. J Exp Biol.* 2012 Sep 1;215(Pt 17):2980-2991.
4. How do metacarpophalangeal joint extension, collateromotion and axial rotation influence dorsal surface strains of the equine proximal phalanx at different loads in vitro? *Singer ER, Garcia T, Stover S. Journal of Biomechanics,* 46: 738-744.
3. Prevalence of abnormal radiographic findings in 2 year old Thoroughbreds at in-training sales and associations with racing performance. *Meagher DM, Bromberek JL, Meagher DT, Gardner IA, Puchalski SM, Stover SM. Journal of the American Veterinary Medical Association.*
3. Havemeyer Meeting on New Advances in the Understanding of Tendinopathies II – Sept 21-26, 2012, Estes Park, CO
 - Limb Biomechanics and Tendon Injury
4. Hallmarq Experts Meeting, Sept 30, 2012, Chicago, IL
 - Predisposing Pathology for Catastrophic Failure of the Racehorse Fetlock
5. California Animal Health and Food Safety Laboratory – October 4, Tulare, CA
 - Workshop on Nomenclature and Diagnostic Descriptors for Musculoskeletal Lesions
6. Equine Welfare Summit IV – October 16, 2012, Lexington, KY
 - Scapular Fracture Continuing Education Module for Racehorse Trainers

PRESENTATIONS

The following studies were presented at industry or scientific conferences.

1. International Conference of Racing Analysts & Veterinarians – Sept 17-21, 2012, Philadelphia, PA
 - California Racing Safety and Postmortem Program
 - Overview of the Pathogenesis of Skeletal Injuries
 - Pre-existing Pathology that Predisposes to Catastrophic Fetlock Injury
 - Comparison of Dynamic Properties of Dirt and Synthetic Surfaces
2. Northeast Association of Equine Practitioners – Sept 21-22, 2012, Pittsburgh, PA
 - Bone Biology and Overuse Injury
 - Stress Fractures in Racehorses
 - Factors Contributing to Overuse Injuries
 - Combined Lameness/ Podiatry Presentation – Shoeing and Footing
7. International Conference of the Health, Safety and Welfare of Jockey – September 22-23, 2012, Oceanport, NJ
 - Incidence of jockey falls, injuries and fatalities in California, 2007 - 2011
8. CHRB Medication and Track Safety Committee meeting, Kenneth L. Maddy Equine Analytical Chemistry Laboratory Lab, May 22, 2013
 - Incidence and costs of jockey falls, injuries and fatalities in California, 2007 – 2012
 - Pre-existing lesion demonstration

Accepted for Publication:

1. Validation of a Laboratory Method for Evaluating Dynamic Properties of Reconstructed Equine Racetrack Surfaces. *Setterbo JJ, Chau A, Fyhrie PB, Hubbard M, Upadhyaya SK, Symons JE, Stover SM. PLOS ONE,* Nov 2012
2. The Importance of Intrinsic Damage Properties to Bone Fragility: A Finite Element Study. *Hardisty MR, Zauel R, Stover SM, Fyhrie DP. Journal of Biomechanical Engineering,* Sept 2012

RECOMMENDED RESEARCH & DEVELOPMENT

EDUCATION AND MARKETING

Produce additional education modules with accompanying technical notes.

A mix of public relation press releases, presentations, web and social based media are the heart of continuing to build brand awareness and third party relationships. Collaborating with UC Davis Extension a joint marketing plan will be established that maximizes awareness of the program in local markets with plans to expand to national markets.

REPORTING AND EVALUATING FATALITIES

Evaluate and report 100% of the racehorse fatalities due to musculoskeletal injury for the second program year.

Include exercise history reports as an attachment to the enhanced necropsy reports.

CAUSE OF DEATH AND RESEARCH PRIORITIZATION PLAN

Identify those injuries for which the 'reason' for the cause of death is currently unknown or poorly understood.

Update the prioritized research plan for each of these injury types.

- Carpal bone injury
- Vertebral injury

Develop physical examination and imaging techniques to detect early, mild injuries.

- Fetlock injury
- Scapular injury
- Humeral injury
- Metecarpal injury

RESEARCH

RACE SURFACE STUDIES

Race surface studies, including effects on limb biomechanics and racehorse limb kinematic differences between race surfaces will be studied. The main objective of this work is to link surface mechanical properties and equine limb behavior in a computational model to determine the optimal surface properties to reduce the incidence of suspensory apparatus injuries. The following year will be dedicated to implementing this model to understand the effects of different surface properties on the risk for fetlock injuries.

RISK FACTORS FOR INJURY

Epidemiologic data and computer modeling techniques will be combined with postmortem findings to detect factors with high risk for injury including:

- Race surfaces
- Training and racing history
- Periods of unsoundness
- Horseshoes
- Hoof conformation
- Surgery
- Medication

MEDICAL HISTORY

Unsoundness and treatment history of fatally injured and other horses is compared to seek clues that can be used to detect horses at risk for injury (Survey implemented in May 2012).

Online survey ongoing through the program's second year. The current objective is to increase participation.

METHODS FOR INJURY DETECTION

- Clinical radiographs for cannon bone injuries
- Physical examination (palpation) and ultrasound for detection of scapular stress fractures
- Feasibility of ultrasound for detection of lower back spinal injuries
- Special radiographic views for detection of proximal sesamoid bone injuries
- Clinical radiographs and ultrasound for the detection of distal sesamoidean ligament injuries

JOCKEY INJURY

Investigate the incidence of, and risk factors for, jockey falls and injuries.

Identify risk factors for falls and injuries to jockeys, and specifically provide analysis of jockey injuries that resulted from catastrophic injury or sudden death of the horse.

RESEARCH BRIEFS

JOCKEY SAFETY

Key Findings

Jockeys riding in Quarter Horse races had a greater fall and injury rate than those riding in Thoroughbred races. A high proportion of falls by jockeys occurred during a race and were caused by catastrophic injury or sudden death of the horse.



Courtesy Dr. Mary Beth Whitcomb

Implications and Relevance

The high proportion of falls as a result of horse injury or fatality is cause for concern. Prevention strategies aimed at improving horse injury and fatality rates will in-turn lead to a reduction in falls by, and injuries to, jockeys.

Summary

Incidence rates and characteristics of falls and injuries to horse racing jockeys in California were described.

Data on race-day falls and injuries were extracted from jockey accident reports submitted to the California Horse Racing Board from January 2007 to December 2011.

Licensed jockeys riding in Quarter Horse races had greater fall and injury rates than those riding in Thoroughbred races.

More than half of all falls resulted in a substantive injury, where the jockey was declared unfit to continue riding in subsequent races, or was transported to a hospital.

The majority of falls, including falls with a more severe outcome, occurred during a race. A substantial proportion of jockey injuries that resulted in an inability to ride in the next scheduled event occurred in concert with a catastrophic injury or sudden death of the horse.

This study enabled a comparison of fall, injury and fatality rates from the state of California in the United States, with rates reported internationally. We found that fall rates were lower, but injury and fatality rates were comparable to other countries.

Potential future directions for this research include investigation of risk factors for falls and injuries to jockeys, quantification of direct and indirect costs incurred as a result of jockey injuries, and development of a decision-tree model that measures the effects of implementing different safety strategies on fall and injury rates and their associated costs.

Reference

For more information please contact: Dr. Peta Hitchens by email at plhitchens@ucdavis.edu

PROXIMAL SESAMOID BONE FRACTURES



Courtesy Dr. Mary Beth Whitcomb

Hypothesis

Regions of increased porosity and discoloration identified grossly within the fracture faces of fractured proximal sesamoid bones represent pre-existing lesions, which weaken and predispose the bone to catastrophic fracture.

Implications and Relevance

Catastrophic fetlock breakdown injuries involving proximal sesamoid bone fractures comprise approximately 50% of racehorse deaths in California annually. Identification of predisposing factors is an important step in reducing catastrophic fetlock breakdowns in the racehorse.

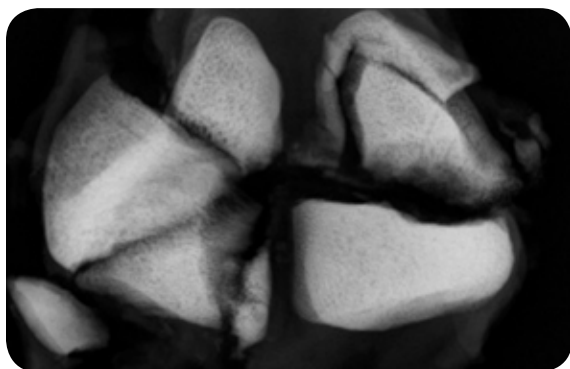
Summary

In Thoroughbred and Quarter Horse racing in California, catastrophic breakdown injuries to the fetlock comprise **50%** of all cases examined which makes it the most common site for catastrophic breakdown in California racehorses. Most of the fetlock cases examined involve fractures of the PSB. The frequency and severity of injuries sustained in this region make continued education and clinical

prevention strategies a key focus for current and future research.

This study identified and described proximal sesamoid bone lesions using gross observations, micro-computed tomography, scanning electron microscopy and histopathology. Through detailed descriptions and analysis of identified lesions we can better understand the properties or pre-disposing factors, which may lead to structural or mechanical weakness in the fetlock.

Future direction for this research includes, looking at relationships between PSB fractures and degenerative changes within the fetlock joint and correlations with exercise history. Detailed analysis and pattern identification aid in devising clinical methods of detection for trainers and veterinarians to use to identify and address changes before catastrophic injuries occur.



Proximal sesamoid bones (PSBs) from 30 horses that suffered a catastrophic fetlock breakdown with PSB fracture were studied.

Reference

For more information please contact: Dr. Erin McKerney, DVM by email at erinmckerney@gmail.com

LUMBAR VERTEBRAL FRACTURES



Key Findings

Lumbar vertebral fractures in racehorses occur most commonly at the junction between the 5th and 6th lumbar vertebrae, have a typical configuration, and are accompanied by evidence of ventral pre-existing stress remodeling (callus and spondylosis). From July 2011 to December 2012 there were six catastrophic L5-L6 fractures. Four of these six cases were two year old Quarter Horses where the catastrophic breakdown resulted in a jockey injury.

Implications and Relevance

The dramatic and catastrophic nature of these fractures and high incidence of human injuries make these cases a priority. Knowledge of common signalment and fracture locations may enhance practitioners' ability to detect injuries early, pursue diagnostics, rest horses, and prevent catastrophic horse and human injuries.

Potential future directions for this research include research into other possible imaging modalities or diagnostics to assess injury to this area, therapies for horses with suspect injury, and a prospective study to further assess additional predisposing or lesions.

Summary

The objectives of this study are to determine if lumbar vertebral fractures occur in Thoroughbred and Quarter Horse racehorses in consistent configurations, if they have predisposing lesions, and if they occur in horses with distinctive characteristics and warnings.

Currently a retrospective review of case details and necropsy findings of Thoroughbred and Quarter Horse racehorses that died and were necropsied through the California Horse Racing Board Postmortem Program from 1990 to 2012 will determine the incidence rate of lumbar vertebral fractures in Thoroughbreds and Quarter Horses. Post mortem examination, computed tomography, digital

radiography, histology and post ly tank processing examination on five cases of catastrophic spinal fractures and three non-fractured lumbar spine case controls should reveal the predisposing abnormality.

Reference

For more information please contact: Dr. Elizabeth Collar, DVM by email at emcollar@ucdavis.edu

EVALUATING DYNAMIC PROPERTIES OF RACE SURFACES



Key Findings

The dynamic properties of race surfaces can be evaluated in the laboratory. Thus race surface materials and management procedures can be studied on a small, more economically feasible scale than conversion of entire racetrack surfaces.

Implications and Relevance

Dynamic impact properties of race surfaces can be evaluated in a laboratory setting, allowing for further study of factors affecting surface behavior under controlled conditions.

Summary

Race surface mechanical testing in a controlled laboratory setting will allow for objective evaluation of dynamic properties of surfaces and factors that affect surface behavior. The objective of this study was to develop a method for reconstruction of race surfaces in the laboratory and validate the method by comparison with racetrack measurements.

Track-testing device (TTD) impact tests simulated equine hoof impact on dirt and synthetic race surfaces;

tests were performed both in situ (racetrack) and using laboratory reconstructions of harvested surface materials. Clegg Hammer in situ measurements were used to guide surface reconstruction in the laboratory. Dynamic surface properties were compared between in situ and laboratory settings.

Laboratory reconstruction of racetrack surface materials successfully reproduced the properties of real racetrack surfaces.

Laboratory reconstruction of racetrack surfaces guided by Clegg Hammer measurements yielded TTD impact measurements similar to in situ values.

Reference

For more information please contact: Jennifer Symons by email at jesymons@ucdavis.edu

RACE SURFACE EFFECTS ON LIMB DYNAMICS



Key Findings

Horses have less hind fetlock hyper-extension and hoof slide on a synthetic surface compared to a dirt surface.

Implications and Relevance

Fetlock injuries account for more than 50% of musculoskeletal injuries in racehorses. Understanding differences in limb behavior on different surfaces may facilitate design of race surfaces that promote limb behaviors consistent with musculoskeletal health.

Summary

Race surface behavior can be modified through surface composition and maintenance. However, the relationship between race surface behavior and equine distal limb behavior remains unknown. The objective of this study was to characterize, quantify and compare Thoroughbred hind limb motion on a dirt surface and a synthetic surface.

Kinematic markers were applied to anatomical landmarks on the left hind limb and hoof of 5 Thoroughbred racehorses. Two high speed video cameras were used to

record 2-D translation of kinematic markers and associated limb motion while horses breezed on a dirt racetrack surface and on a synthetic racetrack surface. Distal limb joint angles and hoof orientation/translation were plotted during stance. Peak joint angles and hoof translation were compared between the dirt surface and the synthetic surface.

Horses breezing on a dirt surface had 7% greater hind limb maximum fetlock hyper-extension and 66% greater horizontal hoof slide compared to a synthetic surface.

Reduced hind fetlock hyper-extension of horses breezing on a synthetic surface is likely to be associated with reduced forces and deformations of the suspensory apparatus. These differences are expected to reduce fetlock injuries.

Future studies plan to use computational modeling to predict limb behavior as a function of surface

Reference

For more information please contact: Jennifer Symons by email at jesymons@ucdavis.edu.



▲ From left to right; Dirt, Synthetic and Turf

SURFACE EFFECTS ON HORSESHOES



Hypothesis

Wear grooves on the solar surface of the horseshoe (surface between the hoof and horseshoe) may be more extensive on horseshoes from horses that exercised on synthetic surfaces compared to horseshoes from horses that exercised on dirt surfaces. This is because the hoof slides less on the stickier synthetic surface, resulting in greater deceleration and thus greater force between the hoof and horseshoe that creates larger wear grooves between the hoof and horseshoe.

Implications and Relevance

Race surfaces have the potential to affect risk for musculoskeletal injuries in racehorses through the transfer of forces from the surface to the bones and joints of the limbs. Surface forces are transferred through the horseshoe at the interface of the surface and the hoof. Wear of the horseshoe may also reflect forces transferred between the surface and the limb during the interaction of the hoof with the race surface.

Summary

In this study we compared wear patterns on the solar surface of aluminum race horse shoes to provide insight on differences for hoof impact between dirt and synthetic racing surfaces. Nail placement, presence or absence of shoe clips, shoe size, horse limb and race track as a function of surface were

associated with wear horse shoe groove length or width. Horse shoes used on synthetic surfaces had longer grooves than those used on dirt surfaces. The longer the distance from the last nail used to the heel, the greater the groove length observed. Shoes without clips had longer grooves compared to shoes with clips. These factors may allow greater movement in

heel expansion, which could affect absorption forces by the structures of the leg and hoof during the stance phase.

Reference

At the time of publication this research was in progress. For more information please contact: Vanessa Dahl by email at vdahl@ucdavis.edu.

HUMERAL AND SCAPULAR FRACTURE SURVEY



Courtesy Dr. Mary Beth Whitcomb

Objectives

1. To better understand the events that lead to catastrophic scapular and humeral fractures in racehorses
2. To aid trainers and veterinarians in injury prevention and education

Summary

Scapular and humeral fractures happen very suddenly, unexpectedly and often without warning. Complete fractures of the scapula and humerus are almost always fatal; but, when recognized early, predisposing incomplete stress fractures can heal and horses are able to successfully return to racing. The purpose of this study is to determine if there are any signs, subtle or otherwise, that could be indicative of humeral or scapular stress fractures and impending catastrophic fracture.

The study is being conducted by phone survey of trainers by Erin McKerney DVM. The information is kept strictly confidential, and will be summarized in anonymous form for use by trainers and veterinarians for injury prevention.

In Thoroughbred and Quarter Horse racing in California, humeral and scapular fractures comprise approximately 14% of breakdown injuries. Though overall these injuries represent a smaller subset than other injuries, these injuries are especially devastating as they often happen suddenly without warning and are almost always fatal.

The information will be useful for trainers and veterinarians to better detect and address injuries clinically before catastrophic breakdown occurs.

Information on these injuries can be found in technical notes on the [Racing Injury Prevention Program](#) page of the UC Davis J.D. Wheat Veterinary Orthopedic Research Laboratory website.



Implications and Relevance:

Together, humeral and scapular fractures comprise approximately 14% of catastrophic breakdown injuries in California racehorses annually. These injuries are devastating as they often happen suddenly without warning and are almost always fatal. Identification of predisposing factors with continued education and research are the keys to reducing catastrophic breakdowns in the racehorse.

EQUINE MEDICAL HISTORY SURVEY



Courtesy Dr. Mary Beth Whitcomb

Study Goal

To determine if recent medical history can provide clues to detecting horses at risk for catastrophic injury.

Summary

The Equine Medical History Survey is available online.

The survey asks questions related to lameness, medication, and surgery history because these factors may provide clues to identifying racehorses at risk for fatal injury.

The survey is designed to detect factors that can be managed to decrease loss of horses and associated tolls on jockey welfare, industry economics, and public perception of the racing industry. This goal will be achieved by comparing medical histories between horses that had a fatal injury with horses that did not have a fatal injury.

Veterinarians have been selected to complete the confidential survey because they either cared for a horse that experienced a fatal injury or they cared for a horse that did not have a fatal injury and was randomly selected as a control horse.

Implications and Relevance:

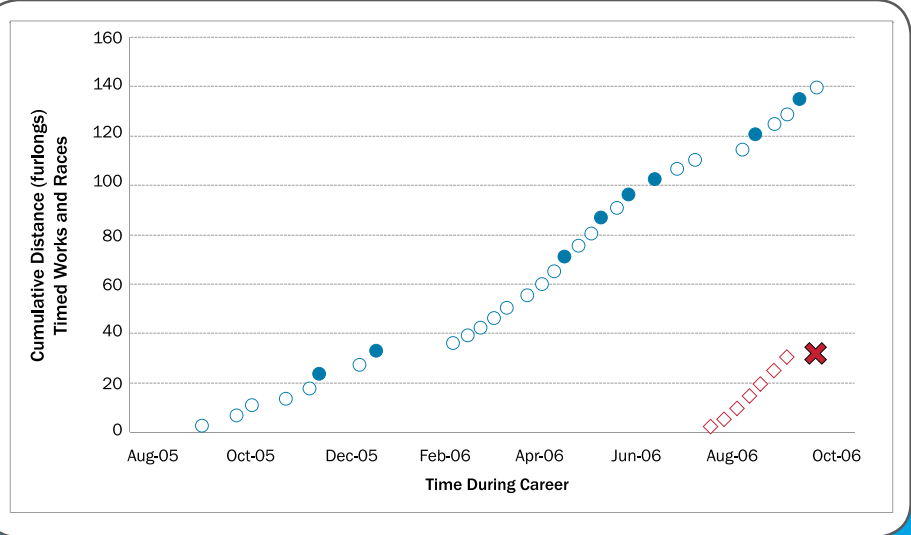
The study will provide information that can be used to identify:

1. Horses at high risk for catastrophic injury, and
2. Management factors that can be modified to reduce the risk for all horses.

Reference

For more information please contact: Dr. Peta Hitchens by email at plhitchens@ucdavis.edu

EXERCISE HISTORY STUDIES



Key Findings

1. Exercise intensity plays a role in development of injury.
2. Fatally injured horses (red symbols) have different exercise patterns than other horses (blue symbols).

Summary

Using specialized math-based software a custom calculation program was developed to generate and summarize exercise histories of horses with musculoskeletal injuries.

Key variables describing the exercise activity during a horse's career, such as number of races, number of lay-ups, and exercise intensity at the start of career, are calculated for data analysis.

The event history for the injured horse is displayed over time. Variables that capture features of exercise events are compared between the injured horse and other horses of the same breed, age, and sex.

Using the data collected, an exercise history report is generated and appended to the

necropsy report. This information can be a useful tool for trainers to detect unusual exercise schedules that may be associated with risk for injury.

Exercise history data are also useful for epidemiological analyses of the associations between exercise activity and musculoskeletal injuries.

Implications and Relevance:

Exercise and training are managed by trainers. Knowledge about exercise and exercise routines are helpful in identifying patterns that may cause injury. By identifying these patterns, potential risk for fatal injury can be prevented.

RACING SAFETY PROGRAM BIOGRAPHYS



SUSAN M. STOVER, DVM, PHD, DIPL ACVS

Sue is the principal investigator of the Racing Injury Prevention Program and a veterinarian with specialty training in equine surgery and lameness. She completed her veterinary degree at Washington State University and subsequent residency in equine surgery and PhD training in Comparative Pathology at the University of California at Davis. Her research focuses on the biomechanics, pathogenesis, diagnosis, treatment, and prevention of musculoskeletal injuries in equine athletes.



PETA L. HITCHENS, MvPhMgt, PhD

Peta is a Postdoctoral Scholar with advanced training in epidemiology and expertise in jockey falls and injuries. She completed her doctorate at the Menzies Research Institute Tasmania, Australia and her Masters in Veterinary Public Health Management at the University of Sydney, Australia. In addition to Project Manager, Peta investigates the incidence of, and risk factors for, jockey falls, injuries and fatalities in California.



ERIN MCKERNEY, DVM

Erin is a veterinarian with advanced training in sport horse medicine. She completed her veterinary degree at University of California Davis, then completed a clinical sport horse medicine internship at Peninsula Equine Medical center in Menlo Park, California. Erin conducts enhanced orthopedic examinations, with research focused on humeral, scapular and proximal sesamoid bone fractures.



ELIZABETH COLLAR, DVM

Liz is a veterinarian with advanced training in equine lameness and surgery. She completed her veterinary degree at University of Minnesota, then completed an equine surgery internship at Hagyard Equine Medical Institute in Kentucky. Liz conducts enhanced orthopedic examinations, with research focused on vertebral spine fractures.



CRYSTAL TJHIA, PHD

Crystal is a biomedical engineer with advanced training in bone fragility. She received her PhD from University of California at Davis. Crystal's roles include computer software development to investigate the role of exercise in injury development and evaluation of bone specimens for micro-damage.



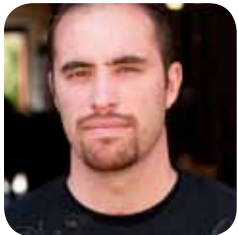
SHANNON MITCHELL

Shannon is a graphic designer, content manager and web designer. She received her graphic design training at the University of California at Davis. Shannon manages, designs, develops and distributes information and research findings through multimedia channels and e-Learning educational materials.



REGINA ZAVODOVSKAYA, DVM DIPL ACVP

Regina is a veterinarian with specialty training and board certification in veterinary pathology. She completed her veterinary degree and pathology residency training at the University of California at Davis. Regina has a special interest in orthopedic pathology, conducts enhanced orthopedic examinations, and provides histopathological expertise.



TOM LAZZARI, BS

Tom photographs, and processes necropsy specimens for the enhanced orthopedic examinations. Tom received his animal science degree from University of California at Davis. Tom's experiences range from small animal veterinary technician to laboratory technician for the Animal Science Meat Laboratory.



CHRISTINA MILNE, BS, BA

Christina photographs, and processes necropsy specimens for the enhanced orthopedic examinations. Tina's diverse background ranges from wildlife rehabilitation in the jungle of Guatemala to veterinary assistant in North Carolina. She holds a BS in Biology and a BA in Environmental Studies with a focus in Conservation Biology.



TANYA GARCIA-NOLEN, MS

Tanya is a biomedical engineer with advanced training in musculoskeletal imaging. She received her Masters degree in Biomedical Engineering from University of California at Davis. Tanya manages the laboratory, oversees the musculoskeletal biomechanics, imaging, and gait research studies, and performs computer programming for research projects.



ASHLEY E HILL, DVM, MPVM, PHD

Ashley is a veterinarian with advanced training in preventive medicine and epidemiology. She received her veterinary, MPVM, and PhD degrees from the University of California at Davis and works in the California Animal Health and Food Safety Laboratory System. Ashley assists with understanding the role of medication in injury development.



JEN SYMONS, MS

Jen is a biomedical engineer with advanced training in bone mechanics. She received her Masters degree in Biomedical Engineering from University of California at Davis. She is a life long equestrian focusing on equine athletic performance and injury prevention. Jen investigates the effect of race surface properties on limb biomechanics in order to develop strategies for designing race surfaces to prevent fetlock injuries.



VANESSA DAHL, BS

Vanessa is an animal scientist who received her Animal Biology degree from the University of California at Davis. She has a variety of experiences with sport horses and horse models. Vanessa is studying racehorse horseshoes for factors associated with race surfaces.

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