Objective—To determine characteristics, incidence rate, and possible associations with selected demographic characteristics of catastrophic musculoskeletal injuries (CMIs) in Thoroughbred racehorses.

Animals—76 Thoroughbreds with CMIs.

Procedures—Incidence rates of CMIs during racing or training were calculated with number of CMIs as the numerator and overall numbers of races or training events during 2004 and 2005 as the denominators. Exact 95% confidence intervals were calculated. Associations between incidence and dichotomous exposure factors, nominal factors, and ordinal factors were determined. Only univariable associations were examined.

Results—76 horses were euthanized because of CMI and represented 2.36 and 1.69 deaths/1,000 racing starts in 2004 and 2005, respectively. Of these, 57 were euthanized within 60 days before or after a race, which yielded a point incidence of 1.05/1,000 racing starts and 0.39/1,000 training starts.

Conclusions and Clinical Relevance—Incidence rate of CMIs at 2 Ontario racetracks was similar to that at other North American racetracks. A cumulative death rate of 1 to 2 deaths/wk should be considered typical when designing prevention strategies and offers a baseline value for measuring improvement. (Am J Vet Res 2007;68:1370–1375)

Epidemiologic characteristics of catastrophic musculoskeletal injuries in Thoroughbred racehorses

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During training or racing, horses may reach and sustain exercise intensities capable of overwhelming the musculoskeletal system’s response capacity, which can result in severe and sometimes fatal musculoskeletal injuries. These have been reported as the main reason for racing wastage.\(^1\)\(^3\) Catastrophic musculoskeletal injuries requiring euthanasia may fuel public antiracing sentiments, result in decreased public support for racing, and constitute an undesirable outcome for racehorses. Although racing injuries have been described in other racing jurisdictions,\(^6\)\(^9\) there are many variables pertaining to their occurrence that make it difficult to extrapolate information among geographic regions. Comparisons among studies are hampered by a lack of consensus as to what constitutes a specific risk factor for a specific lesion, differences in study methods, and lack of uniformity regarding description of injuries and putative risk factors. Because there are characteristics of CMIs that could be affected by local conditions, extrapolation of scientific data pertaining to other racing jurisdictions may result in inappropriate conclusions. Therefore, it would seem appropriate to study CMIs in each racing jurisdiction. Local studies have the advantage of being relevant to the specific jurisdiction, racing conditions, and training practices.

Investigation of racetrack fatalities increases the industry’s accountability for the use of animals and allows for the implementation of strategies to reduce their incidence.\(^9\) In other North American racing jurisdictions, the overall prevalence of fatal musculoskeletal injuries in Thoroughbred racing ranges from 1.2 to 1.7/1,000 starts,\(^5\)\(^8\) and in another study,\(^1\)\(^1\) 0.44% of horses required assistance to move off the racetrack. Few studies have investigated CMIs that occurred during training. However, prevalence for all training injuries resulting in lameness has been reported as 45%.\(^5\) Accurate acquisition and evaluation of these data are difficult because several factors cannot be controlled during training, which makes the obtained information potentially inaccurate and incomplete. Therefore, objectives of the study reported here were to determine characteristics, incidence, and possible associations with selected demographic characteristics of CMIs in Thoroughbred racehorses in Ontario, Canada.

Materials and Methods

Horses and data—Data were collected on horses that raced or trained at 2 racetracks (Fort Erie Race Track and Woodbine Racetrack) in Ontario, Canada,
and were submitted to the Animal Health Laboratory of the University of Guelph for a gross postmortem evaluation as part of the Ontario Racing Commission Death Registry Program for horses that died 60 days before or after a race. All postmortem examinations were performed by the senior veterinary pathologist on duty. During the 2004 and 2005 racing season, all horses euthanized because of a CMI and submitted for postmortem examination were evaluated, except for 3 horses suspected of having rabies. All horses were submitted to the program with a form indicating signalment, type of event preceding the injury, whether the injury was associated with or happened during racing or training or was not related to exercise (classified as other), date and location of time of injury, reason for euthanasia or suspected cause of death, attending veterinarian, and contact person (owner or trainer). Date of death was typically included, but when not included was assumed to be the submission date.

Other historical and exercise data were obtained from the Ontario Racing Commission, a commercial racing database,4 and the respective racetrack’s database. Inclusion criterion for final analyses was that the horse died or was euthanized because of a CMI within 60 days of racing or training.

Data regarding characteristics of all horses, races, and workouts were made electronically available from the commercial racing database or the racetracks’ administrations and compiled into a new electronic database.5 Data from horses were included when the horses had at least 1 recorded start or workout between January 1, 2004, and December 31, 2005, at either of the 2 Ontario racetracks. A software program6 was used to access data in the new database. Data were checked for repeated observations, and duplicates were deleted. A race duplicate was defined as a repeated combination of horse, track, date, and race number. A workout duplicate was defined as a repeated combination of horse, track, and date. A horse duplicate was defined as a record with a repeated name of a horse.

Horses considered for inclusion in the study were classified by the body system primarily involved with regard to the decision for euthanasia. Catastrophic musculoskeletal injuries were classified by the gross pathologic diagnosis, event that preceded injury (racing or training), limb side (right or left), and anatomic structure involved (joint or a single bone). For the latter, injury was classified as involving a bone when a single bone was involved and as involving a joint when at least 2 bones that wholly or partially formed a particular joint were involved.

Statistical analysis—Three types of incidence rates were calculated. First, the overall incidence rate was calculated by use of the number of available cases or number of all CMIs as numerators and all starts as a denominator (racing study population). Second, the incidence of racing-related CMIs was calculated by use of the number of training-related CMIs as a numerator and number of workouts during the study period as a denominator (training study population). For this calculation, horses were included in the numerator only when they had a recorded workout ≤ 60 days prior to death or a submission date. Exact 95% CIs of the incidence data were calculated on the basis of the Poisson distribution. For determination of incidence for a specific month, the date of the last race was assumed to be the date of injury.

Contingency tables and exact tests with 2-tailed P values were used to evaluate associations between incidence and dichotomous exposure factors. These factors included year of event (2004 vs 2005), track (Woodbine vs Fort Erie), surface (dirt vs turf), and type of event (racing vs training). Poisson regression models and likelihood ratio tests were used to evaluate associations between incidence and nominal or ordinal factors with > 2 levels. Nominal factors included sex (female, sexually intact male, and geldings) and month, whereas ordinal factors included age, with horses > 8 years old included in 1 group. Only univariable associations were examined. Software7 was used for analyses, and values of P < 0.05 were considered significant.

Results

The 2004 and 2005 racing meets in Ontario extended from April to November and comprised 32 weeks for Woodbine Racetrack and Fort Erie Racetrack. Races were held 5 times/wk at Woodbine Racetrack and 4 times/wk at Fort Erie Racetrack. Both racetracks were flat and had a surface of dirt or turf. The control population for racing-related CMIs consisted of 38,097 starts, with 4,033 and 7,767 starts on Fort Erie Racetrack in 2004 and 2005, respectively, and 13,303 and 12,994 starts on Woodbine Racetrack in 2004 and 2005, respectively. There were 5,091 horses racing during the study period, with 1,022 and 1,708 horses racing at Fort Erie Racetrack in 2004 and 2005, respectively, and 2,910 and 2,938 horses racing at Woodbine Racetrack in 2004 and 2005, respectively. There were 43,072 recorded workouts in 2004 and 2005. In 2004, 5,659 workouts were recorded at Fort Erie Racetrack and 5,332 at Woodbine Racetrack. In 2005, 2,448 workouts were recorded at Fort Erie Racetrack and 29,633 workouts were recorded at Woodbine Racetrack. More than 95% of the horses that raced at these 2 racetracks were housed and trained at the track where they raced.

One hundred thirteen Thoroughbred horses died within 60 days of racing or training (61 in 2004 and 52 in 2005), including 47 geldings, 45 females, and 21 sexually intact males. Seventy-six horses died or were euthanized because of a CMI (41 during 2004 and 35 during 2005). Thirty-seven horses died or were euthanized for non-CMI-related problems, including gastrointestinal tract problems, skull fractures, cardiovascular problems, septic arthritis, neurologic disease, and sudden death. Death rate for all causes for 2004 and 2005 was 3.5 and 2.5 deaths/1,000 starts, respectively. Among causes of death, CMI was the most common (67.2%) with an overall incidence rate of 1.99/1,000 starts, which accounted for 2.36 deaths/1,000 starts and 1.69 deaths/1,000 starts in 2004 and 2005, respectively. Other
er causes of death or reasons for euthanasia included nonappendicular musculoskeletal problems (eg, septic arthritis-tendonitis, septic cellulitis, and severe arthrosis [7.9%]), cardiovascular problems (eg, exercise-induced pulmonary hemorrhage and ruptured aorta [8.8%]), gastrointestinal tract problems (eg, intestinal torsion and ruptured aorta [7%]), respiratory tract problems (eg, equine protozoal myeloencephalopathy and equine herpesvirus-1 [7%]), neurologic problems (eg, equine protozoal myeloencephalopathy and equine herpesvirus-1 [7%]), respiratory tract problems (eg, ruptured trachea [0.8%]), other (eg, anesthetic death [0.8%]), and unknown (0.8%). For 4 horses, neither date of death nor date of submission was available in the records.

Among the 76 horses with CMIs, regions affected included the metacarpal-metatarsal region (22 [29%]), carpus (15 [19.7%]), proximal sesamoid bones (14 [18.4%]), metacarpal-metatarsal joint (7 [9.2%]), proximal phalanx (6 [7.9%]), humerus (3 [3.9%]), suspensory ligament (3 [3.9%]), pelvis (2 [2.6%]), tibia (2 [2.6%]), distal interphalangeal joint (1 [1.3%]), and scapula (1 [1.3%]). Sixty-two (81.6%) horses had CMIs that affected the hind limbs (5 left and 7 right), and 12 horses had CMIs that affected the forelimbs (29 left and 32 right; 2 [2.6%]), distal interphalangeal joint (1 [1.3%]), and scapula (1 [1.3%]).

### Table 1—Age distribution of Thoroughbred racehorses with CMIs that occurred during racing or training in 2004 and 2005 at 2 racetracks in Ontario, Canada.

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>No. of horses (%)</th>
<th>Incidence and 95% CI</th>
<th>Control population (No. of horses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>15 (19.7)</td>
<td>0.75 0.16–2.20 0.55 0.18–1.28</td>
<td>3,980 9,123</td>
</tr>
<tr>
<td>3</td>
<td>22 (28.9)</td>
<td>1.10 0.60–1.84 0.21 0.04–0.61</td>
<td>12,756 14,388</td>
</tr>
<tr>
<td>4</td>
<td>21 (27.6)</td>
<td>1.31 0.71–2.19 0.41 0.11–0.90</td>
<td>10,713 9,708</td>
</tr>
<tr>
<td>5</td>
<td>4 (5.2)</td>
<td>0.34 0.04–1.23 0.21 0.01–1.18</td>
<td>5,670 5,402</td>
</tr>
<tr>
<td>6</td>
<td>6 (7.8)</td>
<td>1.07 0.22–3.12 0.47 0.01–2.63</td>
<td>2,814 2,120</td>
</tr>
<tr>
<td>7</td>
<td>4 (5.2)</td>
<td>2.50 0.52–7.30 0.00 0.00–4.33</td>
<td>1,201 852</td>
</tr>
<tr>
<td>≥ 8</td>
<td>4 (5.2)</td>
<td>1.31 0.03–7.30 1.40 0.29–4.10</td>
<td>763 2,139</td>
</tr>
</tbody>
</table>

*No. of CMIs/1,000 racing starts. 1 No. of CMIs/1,000 training workouts.

### Table 2—Sex distribution of Thoroughbred racehorses with CMIs that occurred during racing or training in 2004 and 2005 at 2 racetracks in Ontario, Canada.

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of horses (%)</th>
<th>Incidence and 95% CI</th>
<th>Control population (No. of horses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact male</td>
<td>15 (19.7)</td>
<td>1.52 0.48–3.35 1.30 0.52–2.67</td>
<td>3,286 5,402</td>
</tr>
<tr>
<td>Gelding</td>
<td>38 (50)</td>
<td>1.26 0.80–1.88 0.18 0.04–0.51</td>
<td>18,220 17,055</td>
</tr>
<tr>
<td>Female</td>
<td>23 (30.2)</td>
<td>0.73 0.38–1.27 0.21 0.08–0.54</td>
<td>19,488 15,062</td>
</tr>
</tbody>
</table>

See Table 1 for key.
Incidence of training-related CMIs did not differ significantly (P = 0.29) between racetracks, between dirt versus turf (P = 0.59), among age groups (P = 0.37), between years (P = 0.7), or among months of racing (P = 0.5). Incidence did differ significantly (P = 0.01) between horses on the basis of sex. Sexually intact males (colts and stallions) had a higher incidence of training-related CMIs than did females (incidence ratio, 6.17; 95% CI, 1.80 to 21.1), whereas the incidence in geldings did not differ from that in females (incidence ratio, 0.83; 95% CI, 0.19 to 3.74). Horses had a higher (P = 0.01) risk of CMI injury during racing than during training (incidence ratio, 2.7; 95% CI, 1.47 to 5.0).

**Discussion**

Results of the study reported here were similar to those of comparable studies\(^6,8\) in other racing jurisdictions. When considering all causes of death in the study reported here, there were 2.9 deaths/1,000 starts, which represented an overall death rate of 1 horse every 5 days. The most common cause of death was musculoskeletal disease, which was in accordance with other studies.\(^6,8\) The overall (training or racing) incidence of CMI (1.99 CMIs/1,000 starts) for the 2 years studied was higher than that of other studies and represented approximately 1 CMI/wk. This type of injury has high public visibility, and a percentage of CMIs should be considered preventable in comparison to other causes of death that are perceived as unpreventable (eg, colic). Other racing jurisdictions have reported rates of CMI as low as 1.2/1,000 starts.\(^8\) This also stresses the importance of considering the methods used to calculate rates. For example, when we considered only race starts as the denominator and racing-related CMIs that fit inclusion criteria as the numerator, the incidence was < 1.2/1,000 starts.

Incidence of CMIs was calculated for overall incidence, racing-related incidence, and training-related incidence. An advantage of the use of overall incidence was that results could be compared with those of other studies. Disadvantages of the use of overall incidence were that only race starts were used as a denominator despite the fact that some injuries occurred during training and that not all race starts may have been included in the denominator. An advantage of the use of training-related CMIs and racing-related CMIs was that both of these limitations were accounted for by considering only the appropriate type of events as denominators and by specifying inclusion criteria for numerators.

Unfortunately, data were missing for the overall training population, particularly pertaining to Woodbine Racetrack for the 2004 season. Therefore, it is possible that the incidence of training-related CMIs was overestimated and, quite likely, the estimate of the incidence ratio for racing versus training was underestimated.

In comparing racing versus training, conditions may differ in terms of exercise intensity and distance. Unfit or lame horses are unlikely to continue training at the level required for racing unless therapeutic intervention makes continuation of training possible. Although it seems logical that horses that train sufficiently to enter a race are actually fit to race, the higher incidence of CMIs during racing compared with training may reflect failure of the racing system at a racetrack to prevent unfit horses from starting a race. Alternatively, the higher incidence may also have been caused by greater exercise intensity or other factors such as racing conditions (ie, surface conditions, surface type, and interference with other horses). However, the incidence of CMIs did not differ significantly between the 2 racetracks.

In agreement with other studies,\(^6,12,13\) the third metacarpal-metatarsal bones and carpus were the most common locations of CMIs, especially the third metacarpal bone. Preexisting lesions in these locations have been reported.\(^11,13,17\) In another study\(^18\) that used the same horses reported here, a high prevalence of joint disease was detected, and preexisting injuries have been detected in horses with condylar fractures.\(^19\) The high prevalence of metacarpophalangeal joint problems and subchondral bone changes in the horses reported here suggested the existence of a large population of racehorses at increased risk for bone failure. It is possible that the use of intra-articular joint medication\(^30\) at racetracks may also be

### Table 3—Incidence of workout-related CMIs in specific months for Thoroughbred racehorses with CMIs that occurred during racing or training in 2004 and 2005 at 2 racetracks in Ontario, Canada.

<table>
<thead>
<tr>
<th>Month</th>
<th>2004 No. of horses</th>
<th>2004 Incidence*</th>
<th>2004 95% CI</th>
<th>2005 No. of horses</th>
<th>2005 Incidence*</th>
<th>2005 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>0</td>
<td>2,151</td>
<td>0.00</td>
<td>0.00–1.72</td>
<td>0</td>
<td>2,403</td>
</tr>
<tr>
<td>April</td>
<td>1</td>
<td>2,717</td>
<td>0.37</td>
<td>0.01–2.05</td>
<td>2</td>
<td>5,803</td>
</tr>
<tr>
<td>May</td>
<td>0</td>
<td>2,195</td>
<td>0.00</td>
<td>0.00–1.68</td>
<td>4</td>
<td>4,475</td>
</tr>
<tr>
<td>June</td>
<td>3</td>
<td>1,728</td>
<td>1.74</td>
<td>0.36–5.07</td>
<td>0</td>
<td>3,741</td>
</tr>
<tr>
<td>July</td>
<td>1</td>
<td>1,201</td>
<td>0.83</td>
<td>0.02–4.64</td>
<td>1</td>
<td>3,808</td>
</tr>
<tr>
<td>August</td>
<td>0</td>
<td>972</td>
<td>0.00</td>
<td>0.00–4.04</td>
<td>1</td>
<td>3,376</td>
</tr>
<tr>
<td>September</td>
<td>0</td>
<td>87</td>
<td>0.00</td>
<td>0.00–42.40</td>
<td>3</td>
<td>3,134</td>
</tr>
<tr>
<td>October</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>2,267</td>
</tr>
<tr>
<td>November</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>1,935</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>239</td>
</tr>
</tbody>
</table>

*Represents the number of CMIs/1,000 racing starts or training workouts. NA = Not applicable.
masking premonitory signs of bone failure, and its practice should be reevaluated.

More CMIs occurred in the forelimbs than in the hind limbs. This was in agreement with other studies\(^a\),\(^b\),\(^c\),\(^d\) and is likely related to the load distribution among the limbs when a horse is at racing speed, when the forelimbs seem to be preferentially loaded.\(^e\) The main limb affected differed between the 2 years of the study, indicating that the limb affected may not be associated with the direction of racing or other fixed events. This was in agreement with another study\(^f\) in which no association was detected between racing direction and affected limb. It is possible that the lead limb is more important than direction of racing with regard to injuries. However, in the study reported here, the event immediately before fracture and whether the fractured limb was the lead limb at the moment of failure was not recorded. In 1 study,\(^g\) investigators indicated that the lead limb was more important than the direction of racing, and in another report,\(^h\) > 70% of horses injured their lead forelimb, which could be attributable to increased peak vertical forces in the lead forelimb during galloping.\(^i\)

With regard to racing surface, the distribution of CMIs in Ontario reported here was similar to others, with most of the injuries occurring on a dirt surface, although incidence of CMIs did not differ between surfaces. Many other potentially confounding factors make it difficult to detect an association between race surface and injury. In the literature, it is unclear which surface may be associated with a higher injury rate.\(^j\) The lack of significance could be related to several factors, including the small number of horses in our study. Variability in the condition of a surface may confound any association between surface type and injury. It is also possible that previous exposure to a particular surface, such as dirt or synthetic materials, may have a stronger association with incidence of CMIs than the short-term exposure to a different surface during racing.

Distribution of CMIs on the basis of age for our study was also in agreement with other studies.\(^k\),\(^l\),\(^m\),\(^n\),\(^o\) The 3- and 4-year-old horses sustained most of the injuries. Differences associated with sex in our study were similar to those found in another study\(^p\) in which sexually intact males were more commonly affected than females. The market value of geldings is substantially less than that of mares or highly priced stallions. Thus, owners may retire mares and stallions from racing at an early age or may be more inclined to seek repair of an injury that could predispose a horse to a CMI and euthanasia. Fractures in racehorses are potentially related to fatigue and accumulated work, and geldings have a longer racing career than females or stallions.\(^r\) Additional studies of other risk factors and their interactions with sex are necessary to evaluate associations between sex and CMIs.\(^s\)

In the study reported here, associations between other variables and CMIs were not detected and the epidemiologic characteristics of CMIs were not significantly different from those reported elsewhere in North America.\(^t\) Characteristics of the racing industry in Ontario are not substantially different from those of other racing jurisdictions in North America. Racing structure, purses, speeds, race distances, and horse quality are similar, and many of the horses that race in Ontario during the summer months also race in warmer climates (eg, Florida and California) during the Canadian winter.

In Ontario, where there is typically racing only during 32 weeks of the year, CMIs resulted in approximately 1.5 horse deaths/wk. It is probable that injuries requiring euthanasia of a horse represent only a small percentage of the wastage in the industry. The cost of nonfatal musculoskeletal injuries is probably large and more insidious than the cost of CMIs. In other studies, it has been estimated that 20% of horses leave racing because of orthopedic injuries in England\(^u\) and 19% to 33% of horses leave training within a 3-month period in North America.\(^v\),\(^w\)

Unfortunately, it can be difficult to investigate nonfatal injuries. In another study\(^x\) conducted by our laboratory group, the incidence of joint disease in this population of racehorses was evaluated, and a high rate of critical joint disease was found. The combined information points us toward aggressive action to curtail a rate of wastage that has substantial financial implications and potentially devastating effects to the industry because of a lack of public support of racing. In summary, the study reported here described characteristics of catastrophic musculoskeletal failure in Canadian racehorses. Our results appeared to be in agreement with those reported for other racing jurisdictions. However, the attrition rate may still be considered large for the general public, which may take into account that a horse has no decision-making power for participating in this sport. Minimizing and managing risk factors for this type of injury should be a priority of all who are involved in this industry.

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References


