

ORIGINAL RESEARCH

Occupational fatalities due to animal-related events

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Objective.—To better understand the extent of animal-related fatalities in the workplace.

Methods.—This study utilized Census of Fatal Occupational Injuries files from the US Department of Labor for the years 1992–1997 to describe the events surrounding human workplace fatalities associated with animals.

Results.—During the 6-year time period, 350 workplace deaths could be associated with an animal-related event. Cattle and horses were the animals primarily involved, and workers in the agricultural industry experienced the majority of events. Many deaths involved transportation events, either direct collision with the animal or highway crashes trying to avoid collision with an animal. Exotic animals, primarily elephants and tigers, were responsible for a few deaths. A small number of workers died of a zoonotic infection.

Conclusions.—We found that approximately 1% of workplace fatalities are associated with an animal-related event. Methods to decrease the frequency of an animal injury are suggested.

Key words: animal, fatality, occupational injury or illness, workplace

Introduction

Injuries due to animal-related trauma, such as bites and stings, are significant events in the United States in terms of mortality, morbidity, and financial cost. It has been estimated that more than 4 million dog bites occur annually.¹ Of these dog bites, 756 000 require medical attention. An average of 15 to 16 deaths from dog attacks occur in the United States annually.¹ Medical costs for treating dog bites are estimated at more than \$100 million annually. Additionally, thousands of other individuals are bitten, stung, or injured by a wide variety of animals, including bees, ants, wasps, hornets, snakes, scorpions, and other mammals. Several of these individuals develop serious infections as a result of their injuries.² Additionally, hundreds receive prophylactic rabies immune globulin and vaccine after an animal attack. In some of these cases, rabies treatment may not be indicated, increasing medical cost and possibly causing adverse sequelae from the vaccine.³

The burden of fatal occupationally related animal in-

juries has not been thoroughly evaluated in the United States. Many occupations involve direct or indirect exposure to a variety of domestic and wild animals. This exposure includes both venomous and nonvenomous animals. Examples of occupations (and hobbies) in which the worker is routinely exposed to animals include farmers, cowboys, rodeo riders, fishermen, slaughterhouse employees, researchers, veterinarians, entomologists, herpetologists, zoologists, and laborers in animal-confinement facilities. Additionally, many other outdoor jobs have the potential for coming into contact with animals. Dogs often attack mail delivery workers. Other workers, such as telephone linesmen and landscapers, may stumble into nests of ants or wasps. Tragically, a few individuals die each year due to massive trauma, envenomation, or anaphylaxis.⁴

The extent of animal-related injuries is very apparent in the agricultural industry. From 3% to 40% of farm injuries have been reported to be animal-related, and animals are responsible for an estimated 40 deaths annually on farms.^{5–7}

One previous study⁸ utilized data from the US Department of Labor to evaluate occupational fatalities from nonvenomous animals from 1992 to 1994 in the United States. In that study, Austin⁸ found 144 animal-related occupational fatalities, with the vast majority being due to cattle and horses.

The views expressed in this paper are the authors' and may or may not reflect the views of the Department of Health and Human Services.

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The present study expands on Austin's work. We include both venomous and nonvenomous animal fatalities to better evaluate the magnitude of animal-related occupational fatalities in the United States.

Methods

The Census of Fatal Occupational Injuries (CFOI) database was obtained from the Bureau of Labor Statistics of the US Department of Labor.⁹ Each state collects information on occupational injuries from a variety of sources and forwards the compiled data to the US Department of Labor. Statistics for the nation on occupational fatalities can then be compiled and analyzed. States use a variety of sources, such as newspapers, workers compensation reports, and medical examiner and coroners' reports to obtain comprehensive data on the frequency of work-related deaths.

Information obtained from CFOI data include the following: year, month, day, and time of injury; narrative, nature, event source, and secondary source of injury; region of country (Northeast, Midwest, South, West); and occupation/industry, gender, race, and Hispanic origin of the victim. The CFOI database for the years 1992 to 1997 was used for the analysis. The Department of Labor reported the 1997 data based on provisional analysis. From the narrative, the animal species involved leading to the fatal event was determined for the vast majority of cases. Separate analysis using the animal species was also conducted. Descriptive statistics are reported.

In this study, we utilized the following codes (source, nature, event) to capture deaths due to an animal. Source codes identify the object, substance, bodily motion, or exposure that directly produced or inflicted the previously identified injury. Nature codes identify the principal physical characteristic(s) of the injury. Event codes describe the manner in which the injury was produced or inflicted.

Source codes included the following:

5100—animal, unspecified
 5120—bird/fowl, unspecified
 5121—birds except fowl
 5122—chickens
 5123—ducks
 5124—geese
 5125—turkeys
 5129—birds/fowl NEC (not elsewhere classified)
 5130—fish/shellfish
 5140—insects, spiders, scorpions, ticks
 5150—mammals, unspecified
 5151—cats

5152—cattle
 5153—dogs
 5154—horses
 5155—rats/rodents
 5156—sheep
 5157—swine
 5159—mammals NEC
 5160—reptiles
 5170—animal waste products
 5190—animals NEC

Codes used to classify by the nature of the event included:

0320—animal/insect bites/stings (nonvenomous)
 0951—venomous bites

Codes used to classify by the event included:

3430—injection/sting or venomous bite, unspecified
 3432—bees/wasp/hornet
 3433—other sting or venomous bite
 3439—injection/sting NEC

After the initial data were categorized, additional criteria were used to include or exclude sources or events. Cases were included if the proximate cause of injury was due to an animal or a direct animal event (either from direct contact with the animal or the animal knocks an object, usually a gate, into the worker or from a vehicle collision with an animal or vehicle crash trying to avoid collision with the animal). Excluded were injuries inflicted by humans, lightning strikes, equipment injury in an animal area (eg, tractor rollover while carrying feed, fans, or electrocution), hypothermia or hyperthermia when going to feed the animals, fall into manure pits, and falling off hay bales within animal housing facilities.

Animal-related fatalities were analyzed by sex, age, race, month of injury, day of injury, animal species involved, and region of country. The narrative description for each case briefly described the circumstance of the injury.

For purposes of analysis, CFOI describes 4 regions of the country based on the Census Bureau region designation. The regions are Northeast, Midwest, South, and West. States within these regions are listed as follows:

Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
 Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
 South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Mary-

Table 1. Animals involved in work-related fatalities in the United States 1992–1997

<i>Animal</i>	<i>No. of Fatalities</i>
Cattle	142
Horses/mules	95
Insects	42
Birds	26
Deer	15
Dogs	9
Elephants	5
Tigers	3
Hogs	3
Other*	10
Total	350

*Other category includes fish, water buffalo, snake, giraffe, bat, antelope, and unidentified farm animals.

land, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

The mechanism of death was obtained from the narrative in most cases. In situations in which there may have been more than 1 mechanism (eg, thrown off and then run over), the initial event is recorded. In a few cases, the event mechanism could not be determined. In many cases, only the word *attacked* or *mauled* was used to describe the injury. In cases in which a drowning occurred, only events not involving being thrown in or falling off the animal into the water are noted as drownings. These drownings usually occurred when the person was walking an animal along a body of water and slipped and fell in or the person was trying to rescue an animal in the water. Drownings that occurred after falling off or being thrown in are classified as falling off or thrown.

Results

Using the CFOI database for the years 1992 to 1997, 37 875 total work-related deaths were reported in the United States. Of this number, 350 (0.9%) fatalities were attributable to an animal as the source of the injury. Of the victims, 90% were male, compared to 93% of all occupational fatalities. For the animal-related fatalities, by age group, the percent distribution is as follows: 0–19 years (5%), 20–24 years (4%), 25–34 years (13%), 35–44 years (18%), 45–54 years (16%), 55–64 years (20%), and ≥65 years (24%). Males older than 65 years

Table 2. Mechanism of death underlying horse/mule and cattle injuries

<i>Mechanism</i>	<i>Horse/ Cattle Mule</i>	
	<i>Cattle</i>	<i>Mule</i>
Maul, attack, charged, struck, knocked down	41	...
Fell off	...	24
Thrown by or off	5	14
Crush, trample, fall on, stepped on, stomped	29	19
Kicked	10	15
Gored	6	...
Rammed/pinned against	14	...
Struck by gate/panel	6	1
Hanging/dragging	1	6
Butted/bumped/nudged	7	1
Drowned	2	2
Stun gun	1	...

accounted for the largest percentage of male fatalities (23.7%). Females older than 65 years accounted for 23.5% of female fatalities. By race, 82% of all occupational fatality victims were white, 11% black, and 7% other races, compared to 95% white, 3% black, and 2% other races for animal-related deaths. By ethnic group, 82% were non-Hispanic, 10% were Hispanic, and no information was reported in 8%. Most animal-related injuries (69%) occurred between May and October, with September having the highest frequency of injuries at 17% of the total. The fewest injuries occurred on the weekend (16%), whereas the most occurred on Fridays (21%).

Where identified, 43.4% of injuries occurred in urban counties, compared to 55.1% in rural counties based on Metropolitan Statistical Areas. By region of the country, 10% of fatalities occurred in the Northeast, 31% in the Midwest, 32% in the South, and 27% in the West.

Seventy-seven (22%) of the deaths involved a motor vehicle crash (MVC), either collision with the animal or swerving to avoid collision with the animal and wrecking, or being run over by an animal-drawn wagon. Of the vehicle deaths, 40% occurred on Friday, and the vast majority (36%) occurred in September, while the frequency in other months ranged from 3% to 12%. By race, 95% of the victims were white, 87% non-Hispanic, and 90% were male. Fifty-one percent of the injury events occurred in rural counties. Fifty percent of the deaths occurred in victims 25 to 44 years of age. Only 9% occurred in the oldest age group.

Fatalities were analyzed by the animal involved in the injury event (Table 1). Cattle were responsible for 142 deaths (40%), horses for 95 deaths (27%), insects (primarily Hymenoptera) for 42 deaths (12%), birds for 26

deaths (7.4%), deer for 15 deaths (4.2%), and other for 33 deaths (9.4%). In the other category were deaths attributed to dogs, tigers, elephants, hogs, sheep, giraffes, water buffalo, fish, bears, antelope, and bats.

Ten individuals drowned after being thrown off their horses or by slipping into a pond while walking their horses. All were males, 70% white, 40% non-Hispanic, 40% Hispanic, and 20% of unknown ethnicity. By month, 60% of deaths occurred in 2 months, May and September, and 60% of deaths occurred on Wednesday and Friday.

Exotic animals or unusual animal-related events were noted in 56 cases (Table 1). Twenty-six people died as a result of airplane collisions with birds (24 of 26 due to a single plane striking a flock of birds). Nine died as a result of dog-related events (7 were MVCs). Five people died of injuries from an elephant attack, 3 from tiger attacks, 3 from hogs (method of injury unknown), and 10 from other animal-related events, including fish (method of injury unknown), sheep ramming, water buffalo goring, snakebite, giraffe kick, bear mauling, deer (non-motor vehicle) goring, bat (rabies), and antelope (MVC). Five people died as a result of infection after an animal injury. Four cases of sepsis occurred after a kick or bite, and 1 case of rabies was reported.

Of the 142 cattle-related deaths, 48% occurred from May to August. The terms *bull* or *steer* were mentioned in the narrative in 75 cases (52.8%). Vehicle-cattle events were noted in 15 cases. Two victims drowned when trying to rescue cows, and 1 apparently died of cardiac arrest when injured by a stun gun used to move cows. Most deaths occurred on Fridays (19%) or Tuesdays (18%), with the fewest occurring on Sundays (6%). The majority of deaths occurred in workers 65 years and older (41%). Of the victims, 96% were white and 91% were male. All female victims were white. By region of the country, 44% occurred in the Midwest, 31% in the South, 18% in the West, and 7% in the Northeast.

Horses were responsible for 95 deaths. May, June, and September were the months with the most fatalities (13% each month). Most deaths occurred on Thursdays (19%), followed by Tuesdays (17%). The lowest number of deaths occurred on Saturdays (11%) and Sundays (11%). Most deaths occurred in the 35- to 44-year-old (22%) and 45- to 54-year-old (21%) groups. Of the victims, 95% were white, 3% black, and 2% other. Males accounted for 86% of deaths. By region of the country, 33% occurred in the West, 32% in the South, 19% in the Midwest, and 16% in the Northeast.

The mechanism of injury, where described, is reported for cattle and horse-related events in Table 2. Most deaths from cattle were from attacks or mauling from the animal, especially bulls, followed by the animal fall-

ing on and crushing the victim. On the other hand, horse-related events usually were the result of falling off the horse, followed by being crushed by the horse. Twenty-five deaths were the result of being kicked, frequently to the head.

Hymenoptera caused 42 deaths, most of which were thought to be anaphylactic reactions. All victims were male, 90% were white, and 10% were black. Of the deaths, 64% occurred in July through September. Most deaths occurred on Friday (31%), with no deaths reported on Sunday. By region, 43% occurred in the South, 33% in the Midwest, 14% in the West, and 10% in the Northeast. Most deaths (52%) occurred in individuals between 45 and 64 years of age.

Motor vehicle crashes were responsible for the majority of deer-related deaths. Eighty percent of the victims were male and 87% were white. Most deaths occurred in March, April, and October (20% each month). The Midwest and South each accounted for 40% of the fatalities, followed by the Northeast (13%) and the West (7%). Most injuries occurred on Monday (27%) or Wednesday (27%), with the fewest on Friday and Saturday. Most deaths (46%) occurred in people between 35 and 54 years of age.

Major occupation and industry classification of the deceased workers was also evaluated. For deer-related events, the occupation most frequently cited was truck driver (5 victims). No single industry was dominant. For insect-related fatalities, farmer/farm worker/farm managers was listed as the occupation for 14 victims; groundskeeper/gardener was listed for 4 victims. The industries most frequently listed were general farm, primarily crop, and animal specialty NEC. The overwhelming number of fatalities from bird-related events occurred among military workers, and the industry was recorded as national security. Farmers/farm worker/farm managers were the victims of 59 horse-related fatalities, followed by athletes (14 victims) and then animal caretakers except farmers (6 victims). By industry, general farm, crop and livestock; animal specialty service; and racing including track were the predominant categories cited for the horse-related fatalities. Cow-related deaths occurred in 104 farmer/farm worker/farm managers, 11 truck drivers, and 7 nonconstruction laborers. Industries most frequently cited were general farm, primarily crop; dairy farm; beef cattle; general farm, primarily livestock; livestock operation; and amusement/recreation services.

Discussion

Intentional attacks or nonintentional injuries from animals are responsible for millions of nonfatal human injuries and scores of deaths each year in the United

States.^{1,7,8,10,11} Langley and Morrow¹¹ found that approximately 157 deaths occur in the United States yearly from venomous and nonvenomous animal injury. The epidemiology of work-related animal fatalities, however, has not been well described. The purpose of this study was to further evaluate animal-related fatalities at work using a comprehensive data source. This study found that, on average, 58 workers die each year from an animal-related event. These events may result from direct physical trauma (bites, scratches, kicks, crushing, goring, trampling, stinging, bucking, throwing, or dragging), from a zoonotic infection contracted from the animal, or from a vehicular injury as the result of collision with the animal or collision with other vehicles or earthworks when trying to avoid collision with the animal. From this study, it appears that approximately 1 out of 100 occupational fatalities is due to an animal-related event.

Males and the elderly individuals appear to be at highest risk for fatal events from working around animals. Males are more likely to work in occupations that would place them in contact with animals, and male gender appears to be a risk factor for mortality in trauma patients.¹² The elderly, due to decreased physiologic reserve and a high incidence of preexisting medical conditions, also have a higher mortality rate from injury.¹² The majority of deaths occurred during mid-spring to mid-fall months, when planting and harvesting agricultural activities usually occur. Additionally, children and adolescents are usually out of school during the late spring and summer months. Many of these individuals will find summer employment in outdoor jobs, potentially exposing them to animals. Farm workers are increasingly Hispanic and may have cultural and language barriers that increase their risk of an injury due to large farm animals if they do not understand how to properly handle animals.

Numerous native species of animals in the United States are capable of causing severe injuries or envenomations to humans. Some examples include livestock, bees, wasp, hornets, fire ants, dogs, rats, snakes, spiders, scorpions, jellyfish, sharks, and stingrays. Additionally, more than 50 zoonotic diseases are known to occur in the United States, resulting in a few fatalities each year.² Exotic animals are also responsible for several fatalities each year, especially in circus workers and zookeepers.

Numerous workers are at risk from an animal-associated injury. Farmers and farm workers, veterinarians, cowboys and rodeo riders, animal caretakers, hunters and trappers, pet store operators, farriers, and even researchers are at risk from a traumatic injury or a zoonotic infection. Activities that individuals working with animals perform and that may put them at risk include feeding, grooming, riding, branding, training, tagging,

milking, shearing, transporting, dipping, docking, shoeing, trapping, skinning, slaughtering, and diagnosing and treating illnesses in animals.

Studies of farmers have found that animals are the first or second leading cause of nonfatal injury on the farm.⁶ Most severe injuries and deaths occur from large animals, such as horses, bulls, and swine.¹³ The National Safety Council estimates that approximately 40 deaths are caused by animals on farms yearly.⁵ This study found that agricultural production and services were the industries with the highest number of fatalities among insect-, horse-, and cow-associated deaths. This finding is most likely related to the size of the animal or due to frequent outdoor work where insects are likely to be encountered.

Cowboys and rodeo riders also have frequent injuries. Approximately 12 000 professional rodeo cowboys compete in about 850 rodeos in the United States and Canada each year.¹⁴ The injury rate is estimated to be 2.4 to 19.7 per 100 exposures, with saddle-back, bareback, and bull-riding events having the highest injury rates.¹⁵

Studies among veterinarians found that 12% to 68% reported a major animal-related injury during their careers.^{16–19} Zoonotic infections have been reported in 13% to 64% of veterinarians.^{16–19}

People suffering large animal injuries can present with polysystem trauma from blunt and/or penetrating energy transfer injuries.²⁰ Horse-related injuries are responsible for an estimated 2300 annual hospital admissions in persons less than 26 years of age in the United States.²¹ Horseback riding was the leading cause of sports-related brain injury in Oklahoma.²² Norwood et al²³ studied 145 patients with large animal-related injuries. They found the predominant species-specific mechanisms of injury were falls (horses), trappings (bulls), and kicks (cows). Brain/craniofacial injuries were most common from horse-related events, whereas exposure to bulls and cows usually resulted in torso injuries. Fractures of the upper extremity were more often associated with torso and head/craniofacial injuries than were lower extremity injuries. Due to the frequency of brain injury after a fall from horseback riding, helmets have been recommended.

The results of our study indicated that large animals (cows and horses) caused the majority of deaths (67%) among workers. In addition to the agricultural industry, we found several deaths caused by large animals among workers in the amusement and recreation services (racing). Head injuries are not uncommon among jockeys.^{24,25} In rural areas throughout the world, cows and horses are used in many agricultural activities. In Sweden during 1975–1984, horses and cows accounted for 93% of nonvenomous animal deaths.^{26,27} In a study of

domestic animal fatalities in Finland (1957–1968), the greatest number of deaths involved horses, then cows and bulls.²⁸

Hymenoptera were responsible for 12% of worker deaths. In a previous study, approximately 30% of animal-related deaths in the general US population were attributed to the Hymenoptera.¹¹ It is estimated that 0.3% to 3% of the population may experience an anaphylactic reaction after an insect sting.²⁹ Any individual with a history of severe reactions to insect stings should be evaluated by an allergist and consider desensitization therapy. Also, such individuals should always carry an insect sting anaphylaxis treatment kit.

Exotic animals are responsible for a few deaths each year in the United States. These animals are often very large (elephants, rhinoceros, buffalo) or venomous. Zoo veterinarians and animal caretakers in zoos and circuses are the groups most likely to be exposed to a variety of exotic animals. A comprehensive hazard evaluation of procedures and practices related to animal handling, including treatment with various medications and/or surgery, should be performed, and training on use and selection of personal protective equipment should be instituted.^{30,31,32,33}

Collisions with animals are unfortunately very common. The transportation industry (primarily truck drivers) was most frequently involved in fatal deer crashes in this study. The National Highway Safety Administration estimates that 130 deer-related fatalities occur each year, with the majority involving MVCs.³⁴ In North Carolina, deer caused 5.4% of all reportable driving accidents in 1998.³⁵ An estimated 11 500 automobile crashes with deer were reported in North Carolina, with 8% of these causing injury to the driver or passengers. A previous study of reported deer-vehicle collisions in Kentucky during 1987–1989 found 6813 collisions; 3% of the passengers in these collisions were injured.³⁶ Twelve percent of these injuries were classified as incapacitating by the reporting police officers. Most MVCs with deer appear to occur on rural roads and usually happen at night. Methods that have been used to prevent MVCs with deer include warning signs, deer whistles, speed restrictions, fencing, underpasses for animals, roadside mirrors and reflectors, and reduction in the deer population.^{36,37} Obviously, more research is needed to decrease the magnitude of these collisions.

This study utilized a very useful data source (CFOI) to obtain information on fatal occupational animal-related events. In cases in which the primary or secondary source of injury coded on CFOI may not have listed an animal, especially in MVCs not involving direct collision with the animal, the case would not have been detected by this study. This omission may result in an un-

dercounting of cases that could be attributed to an animal. For example, if a person had an MVC with a tree because the driver was attempting to avoid collision with an animal, the primary and secondary sources may have been coded *motor vehicle* and *tree*. Otherwise, we found the database to be user friendly and one of the few sources available on occupational fatalities for the entire population.

In conclusion, animals are responsible for approximately 1% of occupational fatalities in the United States. Males and the elderly appear to be at higher risk of fatal injuries from animals.

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References

1. Sacks J, Kresnow M, Houston B. Dog bites: how big a problem? *Inj Prev*. 1996;2:52–54.
2. Weber D, Rutala W. Zoonotic infections. *Occup Med*. 1999;14:247–284.
3. Moran G, Talan D, Mower W, et al. Appropriateness of rabies postexposure prophylaxis treatment for animal exposures. *JAMA*. 2000;284:1001–1007.
4. Langley R. Physical hazards of animal handlers. *Occup Med*. 1999;14:181–193.
5. National Safety Council. *Accident Facts, 1987 ed*. Chicago, IL: National Safety Council; 1987.
6. Purschwitz M. Epidemiology of agricultural injuries and illnesses. In: Langley R, McLymore R, Meggs W, Roberson G, eds. *Safety and Health in Agriculture, Forestry and Fisheries*. Rockville, MD: Government Institute Press; 1997:215–231.
7. Waller J. Injuries to farmers and farm families in a dairy state. *J Occup Med*. 1992;34:414–421.
8. Austin C. Nonvenomous animal-related fatalities in the United States workplace, 1992–1994. *J Agromed*. 1998;5: 5–16.
9. US Department of Labor. *Census of Fatal Occupational Injuries CFOI Research File User Reference*. Washington, DC: Bureau of Labor Statistics, US Department of Labor; October 1998.
10. Langley R. Fatal animal attacks in North Carolina over an 18-year period. *Am J Forensic Med Pathol*. 1994;15:160–167.
11. Langley R, Morrow W. Deaths resulting from animal attacks in the United States. *Wilderness Environ Med*. 1997; 8:8–16.
12. Morris J, MacKenzie E, Damiano A, Bass S. Mortality in trauma patients: the interaction between host factors and severity. *J Trauma*. 1990;30:1476–1482.
13. Busch H, Cogbill T, Landerscaper J, Landerscaper B.

- Blunt bovine and equine trauma. *J Trauma*. 1986;6:559–561.
14. Butterwick DJ, Nelson DS, LaFave MR, Meeuwisse WH. Epidemiological analysis of injury in one year of Canadian professional rodeo. *Clin J Sport Med*. 1996;6:171–177.
 15. Centers for Disease Control. Bull riding-related brain and spinal cord injuries—Louisiana, 1994–1995. *MMWR Morb Mortal Wkly Rep*. 1996;45:796–798.
 16. Hill D, Langley R, Morrow W. Occupational injuries and illnesses reported by zoo veterinarians in the United States. *J Zoo Wildlife Med*. 1998;29:371–385.
 17. Hafer A, Langley R, Morrow W, Tulis J. Occupational hazard reported by swine veterinarians in the United States. *Swine Health Production*. 1996;4:128–140.
 18. Langley R, Pryor W, O'Brien K. Health hazards among veterinarians: a survey and review of the literature. *J Agromed*. 1995;2:23–52.
 19. Wiggins P, Schenker M, Green R, Samuels S. Prevalence of hazardous exposures in veterinary practice. *Am J Ind Med*. 1989;16:55–66.
 20. Conrad L. The maul of the wild: animal attacks can produce significant trauma. *Emerg Med Serv*. 1994;23:71–72.
 21. Christey G, Nelson D, Rivara F, et al. Horseback riding injuries among children and young adults. *J Fam Pract*. 1994;39:148–152.
 22. Centers for Disease Control and Prevention. Horse-back-riding associated traumatic brain injuries—Oklahoma, 1992–1994. *MMWR Morb Mortal Wkly Rep*. 1996;45:209–211.
 23. Norwood S, McAuley C, Vallina V, Fernandez L, McLarty J, Goodfried G. Mechanisms and patterns of injuries related to large animals. *J Trauma*. 2000;48:740–744.
 24. Waller A, Daniels J, Weaver N, Robinson P. Jockey injuries in the United States. *JAMA*. 2000;283:1326–1328.
 25. Paix B. Rider injury rates and emergency medical services at equestrian events. *Br J Sports Med*. 1999;33:46–48.
 26. Bjornstig U, Eriksson A, Ornehult L. Injuries caused by animals. *Injury*. 1991;22:295–298.
 27. Ornehult L, Eriksson A, Bjornstig U. Fatalities caused by nonvenomous animals: a ten-year summary from Sweden. *Accid Anal Prev*. 1989;21:377–398.
 28. Karkola D, Mottonen M, Raekallio J. Deaths caused by animals in Finland. *Med Sci Law*. 1973;13:95–97.
 29. Reisman R. Insect stings. *N Engl J Med*. 1994;331:523–527.
 30. Grandin T. Safe handling of large animals. *Occup Med*. 1999;14:195–212.
 31. Casey GM, Grant AM, Roerig DS, et al. Farm worker injuries associated with bulls: New York State 1991–1996. *AAOHN J*. 1997;45:393–396.
 32. Casey GM, Grant AM, Roerig DS, et al. Farm worker injuries associated with cows: New York State 1991–1996. *AAOHN J*. 1997;45:446–450.
 33. National Institute for Occupational Safety and Health. *Guidelines for Protecting the Safety and Health of Health-care Workers*. Washington, DC: Department of Health and Human Services; 1996. Publication 88-119.
 34. Garth G. Dangerous deer. *Field and Stream*. March, 1996: 92.
 35. Williamson D. New UNC analysis of N.C. accident records show growth in motor vehicle-deer crashes. University of North Carolina, Chapel Hill, News Service. March 30, 2000; No. 191.
 36. Centers for Disease Control and Prevention. Effectiveness in disease and injury prevention injuries from motor-vehicle collisions with deer—Kentucky, 1987–1989. *MMWR Morb Mortal Wkly Rep*. 1991;40:717–719.
 37. Bjornstig U, Eriksson A, Thorson J, Bylund P. Collisions with passenger cars and moose, Sweden. *Am J Public Health*. 1986;76:460–462.