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Medico-Legal Implications of Traumatic Fatalities Related to Animal Husbandry

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Abstract

Blunt or penetrating lesions and crush asphyxia resulting from attacks by large animals, and poisoning by or an anaphylactic reaction to hymenoptera stings, are a significant cause of death in agricultural occupations. Medico-legal investigations should accurately evaluate the scene of death, the related circumstances and the autopsy evidence in order to reconstruct the dynamics of the fatal event, to confirm that the attack was accidental and to exclude a hypothesis of suicide or homicide. Agricultural workers should be educated about the potential risks involved in animal husbandry and need appropriate training on preventive measures and safety procedures.

Keywords: Animal husbandry, Animal attacks, Trauma, Farm fatalities

Introduction

Attacks on humans by large domestic animals or small insects, such as honey bees, are quite common in rural settings and may cause traumatic injuries, anaphylaxis or envenomation and may have fatal consequences. A number of authors have highlighted the frequency of accidents involving agricultural workers which result in serious injury, permanent disability or death.

In addition to the mechanical risks associated with animal husbandry on farms, other specific risk factors include the use of pesticides, the presence of biological toxins and contaminants and explosions in biomass or biogas plants [1-4].

Medico-legal aspects of fatalities linked with animal husbandry

Karttunen et al. reported that 55% of fatal accidents in agricultural contexts were linked with animal husbandry, 20% with harvesting and cropping, 10% with forestry work and 9% with building work. The study showed that injuries most frequently involved the upper and lower limbs, the spinal column and the musculoskeletal system, and that more than half of all Finnish farm workers experienced an occupational injury during their working careers [5].

Karttunen et al. also reported that 45% of accidents involve people working in beef or dairy farming, 5% involve workers on pig farms and 2% involve people working in horse husbandry [5].

Forrester et al. reported US mortality data, from 1999 to 2007, amounting to 1802 animal-related fatalities, 60% of which were due to non-venomous animals (nearly half of these were caused by large farm mammals) while 28% were caused by hymenoptera (bees, hornets, wasps) [6].

Lower et al. studied lethal accidents in agricultural settings and reported that 8% of deaths, were the result of interaction between the farm worker and beef or dairy cattle [7].

Casey et al. reported that fatal accidents on farms involved bulls (42%), dairy cows (14%), agricultural machinery (28%) or crushing by hay bales (14%), and underlined the importance of preventive inspections by the relevant authorities and the adoption of preventive procedures and the use of protective equipment [8].

Accidents involving beef and dairy cattle or bulls, generally occur, according to Langley and Karttunen, when animals are being accompanied or assisted in breeding facilities or when animals escape from direct control (e.g. animal-vehicle collisions or vehicle-vehicle collisions due to attempts by drivers to avoid an animal on the road), or when milking dairy cows, feeding cattle or moving cattle feed [5-9].

Cattle, cows and bulls, may appear to be docile but when provoked, especially when the farm worker walks or stands near the animal in an unsafe position (in a stable or while the animal is grazing outdoors in a field, often at the end of the working day when the level of attention is low due to tiredness), the animal may suddenly attack the herdsman or handler [10].

Langley reported US data showing 1943 farm animal-related fatalities between 1991 and 2001, with an average of 177 deaths per year, due to encounters both with venomous and non-venomous animals and affirmed that 39% of all fatalities were caused by venomous animals, 70% of which were hymenoptera such as bees, hornets and wasps [11].

Multiple stings can lead to death by envenomation, through the direct toxic effects of venom especially in children or ill, elderly subjects. The most common cause of death following hymenoptera stings, however, is anaphylactic shock [12]. Fatalities caused by animals often occur when the victim is working in isolated conditions, both in open spaces (fields or forests) or enclosed spaces, where there are no witnesses and where it is difficult to call for medical assistance or transfer the victim to hospital. It should also be pointed out that farm workers who are elderly or under the influence of drink or drugs may display reduced reaction time and be more vulnerable to attack. When a fatality occurs in an agricultural context, pathologists and medical examiners may be required by the courts to evaluate the cause and manner of death and to differentiate between accidental death, suicide or homicide [12].

Careful analysis of the death scene and all relevant circumstantial/background information, and autopsy data must be carried out if accidental death is to be correctly diagnosed. Pathologists and medical examiners may also be required to evaluate whether the victim had, prior to the fatal accident, correctly used all the recommended protective equipment.

In addition, the medico-legal reconstruction of the dynamics of accidents and the morphological features of injuries suffered by farm workers plays a crucial role in determining which preventive measures should be employed in agricultural contexts, so as to prevent death or serious permanent disability.

In such cases of fatalities associated with farm animals, at post-mortem the medical examiner is confronted with accidents involving large livestock, such as cows, bulls or horses, and injuries caused by blunt traumatic forces (collision, crushing, trampling or kicking) or penetrating traumatic forces (goring and biting). Various areas of the anatomy can be affected, including the head, face, chest, spinal column, abdomen, arms and legs, where lesions of single or multiple vital organs such as the brain, lungs, heart, liver, spleen or blood vessels lead to the rapid demise of the victim.

The animal's weight and speed of movement, due to their significant muscular strength, may, in cases both of blunt and penetrating traumas, produce high amounts of kinetic energy, which are unleashed upon the victim's body, causing lethal injuries or permanent disabilities.

As a consequence of these large amounts of kinetic energy produced by the attacking animal, the victim may also be violently thrown to the ground, and be repeatedly butted, kicked, trampled, gored or crushed by the animal so that, after the initial attack, he/she may be subjected to multiple secondary traumatic lesions [12].

In cases of repeated kicking or trampling, distinctive hoof, shoe or nail marks may be detected at autopsy which will allow the type of animal involved to be identified.

When the victim is a child, the consequences of the blunt trauma on a small body with a less robust bone structure are devastating. Where children are, for example, kicked and thrown by horses, death, generally due to head or spinal trauma, follows rapidly.

Collision or crushing, especially involving the head, chest, abdomen or limbs, may result in serious muscoloskeletal lesions or bone fractures and fatal internal injuries (perforations, lacerations or the rupturing of solid or hollow organs) leading to acute functional failure or haemorrhagic shock, especially originating from the head or organs in the thorax or abdominal cavities.

Death may occur due to the disruption of internal organs or traumatic asphyxia brought about by compression of the chest.

An excited animal might launch multiple attacks on the victim after the initial collision, thereby applying repeated contusive or biting forces up to thousands of kilograms per square centimeter, which result in death of the victim [12].

Goring produces deep penetrating wounds involving the solid or hollow organs, which may prolapse externally, or affecting restricted musculoskeletal areas or bones.

Wounds caused by horns generally present a conical morphology in that they are broader at the point of entry and then become progressively narrower [10].

Sometimes horns may be curved and can produce penetrating, lacerating and tearing wounds not unlike those inflicted by cold steel weapons. This may mislead the forensic investigator into considering it to be a case due to the use of a cold steel weapon by third persons [10]. Goring wounds are generally found at the same level as the animal's horns at the moment of the attack and therefore involve the abdomen, perineum or pelvis. The pattern of lesions tend to differ from those

inflicted by cold steel weapons used in homicides or causing accidents, which are often found in the upper body, at the neck, thorax or arms and often in association with defense injuries.

Where there are lesions with unclear features in the genital area, the possibility of a sexual assault by another person must be considered and excluded or differentiated [12].

Obviously the removal and cauterization of horns in young animals or the dehorning of adult animals would be appropriate preventive measures [10].

Post-mortem investigations into cases of death due to collision or crushing caused by large animals or in cases of goring should look for both the external signs of trauma on the surface and deeper lesions involving solid or hollow organs. Internal examination can also reveal whether significant blood loss has occurred due to injured organs or blood vessels in the head, neck, thorax or abdominal cavities while typical signs of hypoperfusion during the terminal phase of haemorrhagic shock are detectable in the spleen, liver, kidneys or other mesenteric areas. Bury et al. also referred to infrequent accidents in which zookeepers or animal handlers engaged in the moving or feeding of elephants, rhinoceros, hippopotamuses, giraffes, or camels are trampled, kicked or crushed. Such accidents inflict severe blunt trauma and cause sudden death due to the disruption of internal organs, evisceration or crush asphyxia [12].

Blunt traumas or crush injuries may also be associated with attacks by large omnivorous animals such as pigs or boars on breeding farms, by alligators or carnivorous mammals in zoos or by sharks or seals in aquariums or in fishing areas which are capable of producing significant bruising, compressive and cutting forces with their jaws [12].

The action of teeth produces typical penetrating injuries with a characteristic "hole and tear" pattern described by Bury et al. with the "holes" caused by the penetration and gripping of the teeth and the "tears" resulting from the cutting action the animal's teeth, together with violent shaking movements of its head [12]. A typical fatal attack on humans by pigs or boars can occur when, in addiction to repeated penetrating injuries caused by tusks and consequent serious injury to internal organs and exsanguination, arms and legs may present multiple fractures or amputation, caused by the animal's teeth repeatedly biting down on the limb [12]. When carnivorous mammals attack, they tend to immobilize victims by biting them around the head, face, neck, arms or legs and await the victim's death. This type of attack, particularly to the head or neck (where the laryngeal cartilages may be fractured) is designed to force the prey to submit but may in the process cause the laceration of large arterial or venous vessels, leading to fatal exsanguination or air embolism [12-14]. Fatal attacks on infants or babies, with devastating injuries to the maxillo-facial area, are sometimes carried out by carnivorous mammals, especially if attracted by the smell of milk around the victim's mouth [12].

Animals sometimes repeatedly attack the victim's corpse causing post-mortem lesions which must be differentiated from vital lesions and vital homicidal wounds [12].

Coroners may be requested to evaluate fatalities caused by insects: deaths due to hymenoptera may involve bee breeders or other agricultural workers (occasionally stung by bees or hornets or wasps).

It is extremely difficult for the forensic pathologist to diagnose anaphylaxis or envenomation as a result of hymenoptera stings post-mortem owing to the difficulty of localizing and identifying insect stings and the paucity of specific post-mortem signs and reliable laboratory markers. Where the death is witnessed or during attempts at saving the victim's life, the evaluation of pre-mortem symptoms such as acute reactions of the skin or mucosal areas, laryngeal oedema or asthma, and serious hypotension or shock, could suggest an anaphylactic fatality [15].

The evaluation of the death scene is essential in cases where anaphylactic shock or envenomation is suspected in the demise of a beekeeper or an agricultural worker in open spaces, fields or farmland, which are normally inhabited by a variety of insects including hymenoptera.

The deceased may have been wearing brightly coloured clothes or a strong perfume which attract insects more easily. One or more hymenoptera may be found alive or dead near the corpse, or on the clothes or skin. Where there are suspicious signs on the skin or mucosal areas, such as angio-oedema, erythema, wheals, papulas or blistering, it is good practice to look for stings inside the lesions. The support of an entomological consultant may help in identifying the type of insect responsible for the allergic reaction, when one or more stings are found [15].

Laboratory investigations to identify total and specific IgE serum levels (RAST, ELISA procedures) may confirm the victim's immunological sensitization to the hymenoptera venom. Sometimes a cross allergy may involve different hymenoptera venoms causing a complex sensitization (bee, hornet, wasp).

When one or more lesions are observed on the skin or mucosal areas (angio-oedema, erythema, wheals, papulas or blistering) or when stings are found, but without significant laboratory markers, the pathologist should exclude anaphylactic death and assume that death resulted from a toxic reaction induced by the hymenoptera stings [15].

The lethal toxic effects of hymenoptera venom, especially in children and ill, elderly people, are the result of the specific enzymatic activity of various compounds, such as Mellitin 50%(interference with neuro-muscular and ganglionic synapses with respiratory paralysis and haemodynamic instability - hemolysis – increased capillary permeability - histamine release), A2 Phospholipase 10% (interference with blood coagulation processes - Prostaglandine release - hemolysis - inhibition of oxidative phosphorylation - antigenicity), Hyaluronidase 3% (degradation of conjunctive tissue - antigenicity), Apamin 1% (central neurotoxicity - release of heparin - increased capillary permeability) MDP proteic unit 1% (Mastocyte Degranulation Peptide), Catecholamines, Dopamine, and Noradrenaline 4%, Aspecific Immunogenic Peptides 15%, Pheromone 8%, Phosphatase 1%, Glucosidase 1% [15].

Pumphrey et al. reported that autopsy evidence of anaphylactic death is only detectable in 59% of cases as skin or mucosal oedema, upper airway oedema, pulmonary congestion and oedema or bronchial mucosal congestion, owing to the rapid onset of cardiorespiratory complications associated with an anaphylactic crisis, where death follows within a few minutes [16]. This is too short a time for the characteristic necroscopic features to appear in all cases of anaphylactic death. In the absence of macroscopic signs of anaphylaxis it is advisable to look for eosinophilia in the lung, heart or other parenchymal areas and to evaluate significant serum levels of total and specific IgE antibodies [15-16].

Obviously, the examination of the death scene must determine whether the beekeeper was wearing a helmet and veil or any other protective equipment at the moment of the accident, as well as whether there was a medically prescribed epinephrine kit available.

In short, fatal blunt force injuries, penetrating force injuries or crush asphyxia attributable to an attack by large animals or the poisoning or anaphylactic effects of honey beestings therefore account for a wide range of farm deaths.

Conclusions and perspectives

Forensic pathologists are consequently required by the courts to examine such fatalities in order to determine whether death is attributable to an animal attack, a non-animal related accident, homicide, suicide or an unidentified cause. There is also the question of liability for deaths resulting from an attack by animals: does responsibility lie with the farm owner, farm management or the victim? By determining whether all preventive safety measures were taken and safe working procedures adopted it can be determined whether the death was preventable or not.

Careful investigation of the scene of death and the post-mortem examination of lesions caused by the animal are essential in reconstructing the dynamics of the fatal event and understanding how the resulting injuries influenced the victim's demise.

Expert veterinary help must be sought when attempting to match the features and patterns of observed injuries to the actions of a specific animal.

Examination of the animal in question should also be considered, with the support of a licensed veterinary surgeon, in order to evaluate the body mass characteristics of the animal, the morphology and dimensions of its jaws, teeth, limbs, hoofs, shoes or nails. Odontological comparison of the bite wounds on the victim's body with the suspected animal is an essential part of the process of identifying the culprit.

Traces of the victim's clothing fibres, hair, tissue or blood found on the suspected animal's mouth, hoofs, shoes or nails may, in the absence of witnesses, prove to be of crucial importance. Traces of the animal's hairs or fur may also be found on the victim's body. The animal's stomach may also contain tissue fragments from the victim [12].

Farm-related fatalities are frequent events and highlight the importance of promoting the use of preventive and safety procedures, the correct use of all agricultural machineries and prompt intervention by rescue and emergency personnel.

Bee breeders should be equipped with protective clothing, masks and gloves especially when they are immunologically sensitized. Bee breeders or other agricultural workers who experienced a previous anaphylactic reaction should be equipped with adrenaline auto-injectors and undergo adequate allergen immunotherapy.

Close interaction between farmers and farm safety advisers against a background of ongoing research and training are of vital importance [8].

Farm workers should be made aware of potential injuries and trained on how to avoid them, to identify the risk of accidents and aid victims in agricultural settings where prompt medical assistance is unavailable [17].

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