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Non-accidental injuries in dogs and cats: review of post-mortem forensic assessment and the social significance of small animal practice

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ABSTRACT: The co-existence of animal abuse cases and domestic violence are well established today. Many studies worldwide have identified that pet dogs and cats are commonly harmed or killed by an abuser who may be a member of the family. In fact, the abuse of pets is an indicator that human members of a family are also at risk for interpersonal abuse. The abusers may show a variety of motivations and mental health disorders, resulting in a variety of abuse forms. The animal victims may be presented alive or dead to a veterinary clinic. The post-mortem differential diagnosis and forensic evaluation of pet dogs and cats with non-accidental injuries (NAI), caused by the physical violence of the abuser and items commonly found in a household environment are presented in the current review, according to the main type of abuse: a) blunt force trauma; b) sharp-force injuries; c) gunshot injuries; d) asphyxiation and drowning; e) thermal injuries; and f) poisoning. The recognition and mandatory report of pet cruelty in the family is a complex issue, causing ethical dilemmas for veterinarians concerning professional confidentiality to the client, obligation to protect the human probable victims and the probability of prosecution when the law has been broken. The key-role of veterinarians in the identification and report of pet abuse to appropriate state authorities for animal and human welfare is discussed. Also, ethical issues are highlighted in this paper.

Keywords: *Dogs, cats; non-accidental injuries; necropsy; veterinary forensics, intrafamily violence*

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INTRODUCTION

Over the last half-century, the role of companion animals in human society has changed rapidly. Where these animals were once seen as replaceable objects, they have now come to be viewed as “members of the family” by most people who have developed strong emotional bonds with their pets in the household environment (Newberry, 2016; Rollin, 2018).

Animal abuse is defined as a socially unacceptable and illegal behavior that causes unnecessary distress, suffering, pain, injury and/or malicious killing of an animal (Vermeulen and Odendaal, 1993; Ascione et al., 1997; McGuinness et al., 2005). This umbrella term encompasses physical, sexual, and emotional abuse as well as neglect (Tong, 2016; Almeida et al., 2018). It is also reported that, more than one type of abuse can occur concurrently in pets (Almeida et al., 2018).

The term of non-accidental injuries (NAI) is used as a synonym of physical abuse, including any bodily trauma or injury caused by malicious actions of a person (McGuinness et al., 2005; Tong, 2016; Almeida et al., 2018). Wounds may be single or multiple, concentrated in an anatomic region, or present throughout the body (McEwen, 2017; Almeida et al., 2018).

Although research into NAI in pets is increasing, current data are still limited compared to human forensics (de Siqueira et al., 2012; Almeida et al., 2018; Newland, et al., 2019). Types of NAI which may be encountered by veterinarians have been recorded as: asphyxiation or drowning, burns or scalds, blunt force trauma (e.g. bruising or abrasions, fractures, head trauma, ocular injuries, internal thoracic and abdominal injuries), sharp-force injuries (e.g. knife wounds), gunshot injuries, embedded collar or binding injuries, injuries due to dog fighting, poisoning and starvation. Physical injuries inflicted on sexual organs, the anus or rectum must be considered as potential cases of sexual abuse. Repetitive traumas at different stage of healing are a strong indication of chronic cases of NAI (Tong, 2016; Almeida et al., 2018; Newland, et al., 2019).

Many cases of small animal abuse take place in the family environment of the abuser (Hensley et al., 2011; Van Wijk et al., 2018). The co-existence of companion animal abuse and intrafamily violence has been the focus of much international research, especially in recent years. The link between animal abuse

and violence against humans is now well established, and highlights that animal abuse, child abuse, elder abuse, and intrafamily violence frequently coexist (Onyskiw, 2007; Monsalve et al., 2017). The abuse of pets is an element of the complex network of domestic violence and may be an indicator that members of the family are also at risk (Newberry, 2016; Monsalve et al., 2017).

Studies worldwide have identified that: a) dogs and cats are commonly harmed or killed as a form of family violence, and b) a significant number of women and their children remain in intrafamily abusive relationships due to concerns for the safety of their pets (Roguski 2012; Monsalve et al., 2017). Moreover, several intrafamily violence victims reported that companion animals were one of their main sources of support, and many chose to stay in an abusive relationship because shelters for human victims of domestic violence did not have the facilities to house their pets (Newberry, 2016).

Thus, taking into consideration the above-mentioned data, veterinarians in companion animal clinics will be confronted at some time in their careers with pet abuse cases. A pet victim with NAI may be presented alive or dead to a veterinary clinic by the perpetrator or another family member (who may be a victim himself/herself), or a third party under some coercion from the person who caused the injury (Munro and Thrusfield, 2001c; de Siqueira et al., 2012; Arkow, 2015). The common types of physical abuse of small animals inside household may include injuries due to punching, kicking, throwing (e.g. out of windows, against walls), stabbing, beating with instruments, burning and asphyxiation. Sometimes abuse is performed by the domestic equipment such as a microwave oven into which the pet is placed (Munro and Thrusfield, 2001a & 2001b; Henderson et al., 2011; Almeida et al., 2018).

The current review is focused on the post-mortem diagnosis and forensic evaluation of pet dogs and cats with NAI, caused by physical strength of the abuser and/or items commonly found in a household environment. Nevertheless, data for NAI cases concerning stray companion animals, illegal commercial exploitation (e.g. dog fighting, puppy mills) or working dogs (e.g. shepherd dogs, hunting dogs) abuse are not included.

THE ABUSERS OF FAMILY DOGS & CATS

Just as for any crime, people have different motives for abusing animals. Moreover, animal cruelty is a sign of psychopathology of the perpetrator who may be either a child or an adult member of the family (Schwartz et al., 2012; Bright et al., 2018). The companion animal veterinarian may act as a forensic veterinarian. For that, it is helpful to be aware of the range of animal abusers' motives to better generate scenarios to evaluate during a veterinary forensic investigation (Lockwood and Arkow, 2016).

Pet abuse by children family members

Non-adult animal abusers could be divided into three categories, in accordance with their age (Hensley et al., 2011). The first category includes preschool children who were poorly supervised and not trained in the care of pets. These children are exploratory or curious animal abusers (Hensley et al., 2011; Doukas et al., 2018).

The second category includes school aged children and young adolescents (Hensley et al., 2011). Animal abuse among them is more indicative of conduct disorder and/or exposure to domestic violence. These young abusers are more likely to abuse animals in the family and the community. They may also engage in cruelty to animals out of imitation, because they have been desensitized to violence, have decreased empathy or lack of attachment, are perpetrators or victims of bullying in their school or even because they find amusement in these acts. In extreme cases, children living in a violent home may kill their pet to prevent it from sustaining further injury (Bright et al., 2018; Doukas et al., 2018; Johnson 2018).

The third group is primarily composed of adolescents who may have been under the influence of alcohol and/or drugs while committing acts of animal cruelty. This category includes delinquent animal abusers who often need judicial and clinical interventions (Hensley et al., 2011; Doukas et al., 2018).

Pet abuse by adult family members

The most of adult animal abusers are characterized by an antisocial or other personality disorders. As far as their motivations, both male and female adult perpetrators use threats to harm and kill pets in order to control human members of the family. They commit acts of physical abuse to incite and perpetuate fear and submission in their human victims (Schwartz et al., 2012; Johnson, 2018; Newland et al.,

2019). Family pet perpetrators tend to engage in more severe forms of violence including intimate partner violence, elder abuse, child maltreatment, and emotional violence. They also utilize more controlling behaviors and economic extortion. Some men abuse pets in order to confirm their power over others such as to terrorize; teach submission; and to discourage their partner from leaving the relationship. Jealousy of partner's relationship with the pet as well as the perceived misbehavior of the pet has also been identified as motive. Moreover, some of animal abusers are sadists. They may abuse the animals before moving to human victims or concurrently. Many human victims of intrafamily violence report that pets were harmed or killed by their abuser (Febres et al., 2014; Bright et al., 2018; Johnson 2018).

Less commonly, animal abuse by adult perpetrators has been linked to addictive disorders or Munchausen syndrome by proxy, in which the animal caregiver causes a non-fatal injury in his/her pet, in order to obtain sympathy and attention of other people (Munro and Thrusfield, 2001c; Doukas et al. 2018).

RECOGNIZING NON-ACCIDENTAL INJURIES DURING FORENSIC NECROPSY

The companion animal veterinarian should consider that it is not necessarily a single incident leading to a raised index of suspicion, but rather a variable combination of factors, pattern of actions and behaviors, or injuries which are not clearly or adequately explained, e.g. repetitive injuries or injuries affecting more than one pet in a single household (Munro and Thrusfield, 2001a & 2001b; McGuinness et al., 2005; Arkow, 2015). In animals which have been presented alive to veterinary clinics with repetitive physical trauma e.g. burns, the veterinarian may suspect NAI during the clinical examination, and moreover, based on medical records, anamnesis and the observation of relationship between animal and the client (Newbery and Munro, 2011; Arkow, 2015; Tong, 2016). In animal cases presented dead, either dying during first aid care or euthanized because of severe injuries, a veterinary forensic necropsy should be performed to evaluate whether the physical trauma lesions present accidental or non-accidental patterns (Almeida et al., 2018; de Siqueira et al., 2012; McEwen, 2017). A proper veterinary forensic investigation of a suspicious violent death requires a full necropsy, in order to clarify the cause, mechanism and manner of death.

The information required for a complete veteri-

nary forensic investigation, in order to find the cause and manner of death, should include not only the evidence from the dead body during necropsy, but also details of the animal's environment and items of evidence present on the crime scene (Tourou and Fitch, 2016). However, it is rare or impossible for a forensic veterinarian to attend a crime scene, due to absence of an infrastructure like the medical forensic examiner system. Therefore, in a suspect case of animal abuse, it is up to the veterinarian to evaluate the complete history or animal medical records in order to start his/her effort to differentiate accidental injuries from NAI (Almeida et al., 2018; de Siqueira et al., 2016; McEwen, 2017).

Aside from the presence of injuries that seemed consistent with physical abuse (e.g. gunshot wounds, stab wounds, cigarette burns), multiple factors raise the suspicion of NAI in companion animals. These include: (1) the behavior and comments of the client and/or other family member; (2) the behavior of the pet, if it has been presented alive; (3) a history that is vague or incompatible with the types of injury; (4) a history of pets that disappeared or died suddenly in the past or from families with known history of interpersonal violence; (5) a conspicuous lack of concern of the injuries in animals' body or a delay in seeking veterinary care for them; and (6) the presented injured animal has also been examined by other veterinarian (-s) and the owner seems to be greatly dissatisfied with the diagnosis (Munro and Thrusfield, 2001a&2001c; McGuinness et al., 2005; McEwen, 2017).

Especially, the evaluation of NAI lesions during the veterinary forensic necropsy can confirm the suspicions of physical abuse of small animals, whose case histories give rise to concern that their injuries are not purely the result of an accident (Almeida et al., 2018; de Siqueira et al., 2012).

Blunt force trauma

Non-accidental blunt force trauma is a very frequent form of physical animal abuse with single or repetitive cases. In general, actions of blunt force violence may cause many types of injuries (abrasions, fractures, external and internal contusions and lacerations), showing diverse degree of severity (mild, moderate, or severe). Depending upon the tissue affected and the energy imparted by the force, injuries may resolve, repair, or may kill the animal (Munro and Thrusfield, 2001a; Munro and Thrusfield, 2001b; McEwen, 2017).

Cutaneous and subcutaneous traumatic lesions are very common in blunt force trauma cases. The typical lesion patterns are abrasions, contusions, and lacerations (Ressel et al., 2016). However, the thick hair coat, thick skin, and epidermal pigmentation of many animals may minimize or obscure external injuries. The forensic veterinarian should search meticulously for evidence of superficial blunt force trauma. Therefore, the entire skin should be removed from the body in order to identify traumatic lesions in the subcutis. Sometimes, clipping of the hair coat is also needed to reveal abrasions (Gerdin and McDonough, 2013; Ressel et al., 2016; McEwen 2017).

Muscle trauma is also a common lesion in blunt force trauma cases. The most common lesions in muscles are contusions and lacerations. Grossly, muscle trauma can range from small focal bruises between muscle fibers to large bruises with hematoma formation. Considering the resistance that the heavily haired skin of domestic animals offers, careful examination of the underlying muscles can often clarify whether a severe blunt trauma has been applied (Ressel et al., 2016; McEwen 2017).

As far as thoracic cavity, acuminate blunt objects can perforate the intercostal muscles, causing severe deep damage such as pneumothorax or hemothorax. Moreover, when the abdomen is forcefully compressed by heavy objects that produce high intra-abdominal pressure laceration of the diaphragm can result in herniation of abdominal organs. The liver is the abdominal organ that is most commonly and most severely affected by blunt force trauma, showing lacerations which lead to life-threatening abdominal hemorrhage. Depending on the applied blunt force, spleen trauma could be seen as subcapsular tears only or, in the extreme, complete laceration (Ressel et al., 2016).

Typically, whole body radiographies should be applied in order to evaluate any skeletal trauma due to blunt force violence (Intarapanich et al., 2016). The following five radiographic findings should raise the index of suspicion and support a diagnosis of NAI: (1) multiple fractures; (2) fractures occurring on more than one body regions; (3) transverse fractures; (4) fractures presenting at a later stage of healing (fractures with delayed presentation), and (5) multiple fractures at different stages of healing (Tong, 2014).

In many veterinary forensic cases blunt force injuries involve not only animal's body, but also head

anatomical structures. Skull fractures may be seen or be absent. Hemorrhages in brain are the most characteristic gross lesions resulting from blunt force trauma, but contusions and lacerations could also be seen (Ressel et al., 2016). Eyes of animal victim can be the direct target of blunt force trauma. Ocular injuries and hemorrhages are common findings. In some cases, these types of injuries may be the only external gross evidence of a blunt force trauma to the head. On the other hand, in cases with severe cranial injuries eye bulb protrusion (traumatic proptosis) and multifocal orbital ecchymoses are seen (Ressel et al., 2016; McEwen 2017).

NAI should be differentiated from accidental injuries. Accidental blunt force injuries in companion animals are common due to struck by motor vehicles, falls from heights and, less commonly, due to bites from aggressive dogs or predators (Finnie, 2016; Ressel et al., 2016).

Motor vehicle traumas are differentiated from NAI by the location and distribution of the fractures and in the context of the reported clinical history and examination findings (Finnie, 2016; Intarapanich et al., 2016). Fractures of the skull, teeth, ribs, and vertebrae, as well as injuries to the claws are more often associated with NAI, whereas fractures of the pelvis, pulmonary contusions, and pneumothorax are more often secondary to a motor vehicle accident. Rib fractures may occur more frequently in NAI than motor vehicle accidents, because the surface area of the body to which force is applied is generally smaller in cases of NAI than in motor vehicle accidents, as the animal is usually punched, kicked, hit with a flexible object, or swung into or thrown against an object. When rib fractures do occur from a motor vehicle accident, the distribution is primarily on one side of the body. On the contrary, bilateral rib fractures predominate in NAI cases (Intarapanich et al., 2016).

Feline high-rise syndrome is characterized as a fall from the second or higher floor, associated with facial, thoracic, and orthopedic trauma. Death in high-rise syndrome has been determined to be related to shock and respiratory distress from thoracic trauma (Liehmann et al., 2012, Bonner et al., 2012). Orofacial findings include bilateral epistaxis, facial soft tissue injury, hard palate fracture, tear and bruising of soft palatal tissue, mandibular fracture and/or mandibular symphyseal separation, dental trauma, tongue and other oral soft tissue injuries (Bonner et al., 2012). Thoracic trauma typically involves rib fracture, ster-

num fracture, and pneumothorax. Extremity injuries include fractures of the limbs, pelvis and vertebrae, and luxation of joints (Bonner et al., 2012). Moreover, lacerations of the heart may be a rare consequence of blunt force trauma in animals. Heart lacerations are seen via dissipation of an applied force to the sternum, such as falls from a considerable height or motor vehicle accidents (Ressel et al., 2016; Piegari et al., 2018). High-rise syndrome can also lead to hemoperitoneum and other abdominal trauma, including pancreatic rupture. In live survived cats, pancreatic rupture results in severe pancreatitis and peripancreatitis (Liehmann et al., 2012).

Sharp force injuries

Sharp force injuries are caused by a mechanical force using sharp shaped objects against the skin, subcutaneous tissue, still to muscles and bones or internal organs of animals. A variety of instruments causing sharp-force injuries could be used by perpetrators. These instruments are not only knives, but also axes, machetes, scissors, screwdrivers, needles, barbecue forks, broken glass. In general, stab wounds injuries in animals seemed consistent with NAI. Sharp-force injuries may or may not be lethal, and this can be determined only by performing a detailed forensic necropsy with a careful external and internal examination. The cause of death should be stated as a sharp injury with an indication of the topographical region (s) affected (Munro and Thrusfield, 2001b; de Siqueira et al., 2016). In a study of NAI found in dogs and cats, the thorax and the abdomen were the most frequently areas with sharp-force traumas (Munro and Thrusfield 2001b). In addition, sharp-force injuries in the neck and thorax are most likely to be fatal (de Siqueira et al., 2016).

In small animal cases where there is suspicion of abuse, the forensic veterinarian should consider radiographic examination for bone fractures, which may be found commonly in such cases, and also examination for blade fragments, which may exist if the blade entered the bony structure. Radiographic investigation may also indicate distinct tool marks, which may match or indicate the crime weapon (de Siqueira et al., 2016).

During forensic necropsy, each open wound should be individually photographed before and after shaving the skin in the affected body regions. The underlying tissues and muscles should be assessed by reflecting the skin. An analytical description of the in-

juries should include the edges, shape, color and marks of lesions have been caused by sharp instruments. In contrast to blunt force injuries, sharp force injuries do not show lacerations or bridges of soft tissue between the edges of the wound. In fact, the edges of sharp injuries are linear or angular (de Siqueira et al., 2016; Ressel et al., 2016).

The cut of stab or incised wound have been caused by a knife may exhibit characteristics that identify the direction the knife was moved in, because the cut may be more superficial at the terminal segment of the wound. The shape of the resulting skin wound is affected by the nature of the tissue, the movement of the animal victim, the force of the push, and the sharpness of the instrument. The angle of the lesion may indicate the positioning between the animal and the perpetrator. In some cases, the attacker may cause superficial marks or miss the stab due to the movement of the animal (de Siqueira et al., 2016). In each body region with sharp force injuries the coat looks matte with presence of dry blood material (McEwen, 2017). Moreover, when a stab wound occurs deeply in the neck body region, cutting larynx or trachea, the mechanism of death may be asphyxiation due to blood aspiration (de Siqueira et al., 2016; McEwen, 2017). Deep stab wounds affecting the lungs may lead to hemothorax and/or pneumothorax. Deep stab wounds may also affect the heart or some of abdominal organs e.g. the liver and gut (de Siqueira et al., 2016).

Chop wounds are showing characteristic patterns primarily seen on bones. The used instruments may cause striations on bones that are unique to each type of weapon. Axes cause crushing of the bones, while machetes produce small bony fragments inside wider and irregular wounds. When multiple chop wounds are present, they may exhibit distinctive depths, sizes, and shapes. For example, barbecue forks with 2 or 3 prongs can cause sharp injuries, which are identified as groups of 2 or 3 wounds, with regular or irregular distances between them caused by each prong depending on the angle of the stabbing. Finally, when wounds produced by glass are suspected, these wounds should be inspected for glass fragments (de Siqueira et al., 2016).

Gunshot injuries

Gunshot injuries are almost invariably evidence of NAI, and since a weapon must be made ready, such injuries always involve a degree of premeditation (Lockwood and Arkow, 2016). High-velocity bullets

usually produce a perforating trauma, showing both entry and exit wounds. On the other hand, lower-velocity bullets often produce a penetrating trauma, with the projectile being retained within soft tissues or bones (Finnie, 2016).

Before performing a forensic necropsy, animal victims should routinely undergo full body radiography to reveal the details of the presenting injuries (Lockwood and Arkow, 2016). The objectives of necropsy are to (1) identify the entry wounds and, if present, exit wounds; (2) document the extent of internal injury; (3) recover the bullets and the projectile (s) if there is no exit wound; and (4) if a firearm was used, determine the direction and range of fire.

Projectile wounds may be perforating (i.e. pass completely through the body) or penetrating, with the projectile coming to rest in the body, where the forensic veterinarian may recover it. An entry wound is often characterized by a perfectly circular to oval shape, with finely abraded margins, while an exit wound may show any shape (round, oval, stellate, crescent, etc). Also, an exit wound is generally irregular in outline without abrasion of the skin margins. Finally, the exit wound is often, but not always, slightly larger compared with the entry wound (Gerdin and McDonough, 2013).

Asphyxiation and drowning

According to the mechanism of injury, death due to asphyxia can occur with manual or ligature strangulation, hanging, suffocation, and mechanical asphyxia (McEwen, 2016). All forms of intentional asphyxia involve close contact with the companion animal victim. Often this includes binding, taping, or other restraint. Evidence of such actions can indicate a high degree of premeditation. Frequently, small animals with ligatures or those that have been manually strangled also have localized abrasions and contusions, other lesions of physical (blunt force trauma, sharp force trauma, projectile wounds) and/or sexual abuse (Lockwood and Arkow, 2016; McEwen, 2016).

The interpretation or opinion that the death was due to asphyxia requires definitive and compelling evidence from history, death scene investigation and forensic necropsy of the dead companion animal. Unlike medical examiners, veterinarians rarely attend a crime scene and therefore may lack some of the crucial information required to confirm death due to an asphyxia mechanism. Animals dying due to various

types of asphyxia may or may not have macroscopic lesions. It is also possible that in some cases of asphyxia some gross lesions may be due to other causes, e.g. blunt force trauma to the head, and they could be considered as a contributing cause of death (McEwen, 2016; Almeida et al., 2018).

Obstructive asphyxia due to accidental inhalation of foreign bodies, e.g. food or toys, inside larynx or trachea is usually a straightforward postmortem diagnosis. The diagnosis may be problematic, if the foreign body was removed prior to postmortem examination, although there may be intraluminal trace evidence of the object, focal edema, congestion, hemorrhages, erosions, or ulceration at the obstructed site (Roach & Krahwinkel 2009; McEwen, 2016).

In cases of manual strangulation, the intermittent pressure and release on the neck increases the likelihood of petechiae. Contusions, hemorrhages, congestion are seen subcutaneously as well as in muscles of the neck. The jugular veins and the carotid arteries should be examined in situ for lacerations. Pulmonary edema, congestion, hemorrhage, and/or atelectasis may occur. Scleral congestion and/or conjunctival petechiae in eyes may be observed (McEwen, 2016).

In cases of suspected ligature strangulation and hanging, edema of the proximal neck and head may be visible as well as scleral congestion (Gerdin and McDonough, 2013; McEwen, 2017). Contusions, abrasions, hemorrhages of the neck and base of the head involving the subcutaneous tissue, musculature, airway, and esophagus and/or disruption of thyrohyoid-thyroid cartilage junctions are observed (McEwen, 2016; Almeida et al., 2018). Many types of material, e.g. collars, leashes, ropes, chains, cords, clothing, towels, fabric, and wire, may have been used as ligatures. The ligature mark is the most relevant lesion in ligature strangulation and hanging, although it may be absent depending on the type of ligature used, the duration, and the characteristics of the animals' fur (Gerdin and McDonough, 2013; McEwen, 2016). The skin should be shaved as the indentation made by the ligature may be more apparent. In practice, it is easier to identify the ligature placement following reflection of the skin as a dark line of compression (McEwen, 2016).

External pressure on the chest and/or lungs pressure by an acquired posture are types of mechanical asphyxia, resulting in respiration restriction and non-specific lesions. If the companion animal has

been crushed, fractures, lacerations, and internal hemorrhage due to trauma are likely to be present (McEwen, 2016).

Finally, in cases of suspected drowning, the diagnosis usually one of exclusion, requiring information from the deathscene (e.g. a swimming pool), recovery scene, the medical history or accounts given by reliable witnesses. Distended, heavy, congested and edematous lungs that fail to collapse and stable froth in the trachea, larynx, nasal passages or mouth are characteristic gross lesions, but they are not specific. Right ventricular distension, pulmonary hemorrhages, pulmonary emphysema and mucus at the base of the tongue or in larynx have also been observed in some cases. Additionally, contusions or bruising in skin or subcutaneous tissues and other traumatic lesions e.g. fractures may be seen in cases of forcible submersion of the animal (McEwen and Gerdin, 2016).

Thermal injuries

Thermal injuries in companion animals may be due to exposure to fire and radiant heat, contact with hot items including hot liquids or steam, inhalation of hot air, and exposure to extremely high or cold temperatures. Forensic questions concerning thermal injuries represent relatively infrequent animal cases, concerning mainly alive victims of suspected cruelty (Tong, 2016; Wohlsein et al., 2016). However, the forensic evaluation of live animals is not the aim of the present review and only few examples are mentioned.

In general, besides detailed information from the history about the circumstances under which the pet has been injured, a thorough gross and forensic histopathological investigation must be performed with respect to the patterns of lesions that may be due to thermal injuries (Wohlsein et al., 2016). For example, cigarette burns on live animals in most cases represent acts of NAI. In some of them, because of the presence of long fur and skin pigmentation, it could be relatively difficult to observe cigarette burns (de Siqueira et al., 2012). Acute lesions are characterized by circular, well circumscribed hyperemic areas of 6 to 8 mm diameter often with a full-thickness necrosis of the skin, resulting in a crater-like lesion. Hairs are singed and show yellowish discoloration. Chronic lesions exhibit thin scar tissue on the surface of the sunken area. On the contrary, accidental cigarette burns are typically superficial lesions due to brief contact (Wohlsein et al., 2016).

In pets that were put inside a microwave oven, tissue damages are directly related to the tissues water content as well as the duration of exposition and the power of the microwaves. At necropsy, the skin may show fragility, splitting with well-defined edges, hair and claw loss, crumpling and reddening of the tips of the pinnae, but no charring or singeing of hairs. Histopathological examination may show abrupt transition of affected and unaffected tissues depending on their water content; for example, an unchanged subcutaneous fatty tissue in contrast to coagulative necrosis of the adjacent musculature and skin may be seen. Pulmonary congestion with or without edema, and internal organs with a cooked appearance and odor due to coagulative necrosis are also common post-mortem findings (Wohlsein et al., 2016).

Poisoning

There are few data examining the links between companion animal poisoning cases and crimes of interpersonal and especially intrafamily violence, although some dog and cat poisoning cases have been reported to occur inside the household environment. Intentional poisoning includes malicious intent or misuse of a toxic substance. However, it is necessary to consider that intentional poisoning may be mistakenly assumed when in fact the animals are exposed accidentally to household items with toxic action (Lockwood and Arkow, 2016; Almeida et al., 2018).

Forensic evaluation of dead animals suspected of being poisoned should entail performance of a thorough necropsy examination and toxicological analysis of biological (e.g. stomach content) in a Toxicology Laboratory (Volmer and Meerdink, 2002; Gwaltney-Brant 2016). The diagnosis of intentional in contrast to accidental poisoning should be based on laboratory results in conjunction with the findings in the companion animal's environment. However, the investigation of a household as a possible crime scene by the veterinary forensic examiner is not possible in practice. Forensic evidence most appropriate for risk assessment of perpetrators of intentional companion animal poisoning is more likely to be based on the number of cases attributed to a single offender i.e., serial pet poisoning cases into the same family (Volmer and Meerdink, 2002; Gwaltney-Brant 2016; Lockwood and Arkow, 2016).

ETHICAL ISSUES & CONCLUDING REMARKS

Animal abuse is not only a crime. It is part of the

spectrum of intra-family and community violence which should be viewed as a leading worldwide public health problem (Arkow, 2015).

Veterinarians must be aware of aspects of abuse, and especially the interaction between animal abuse and domestic violence (Gallagher et al 2008; Williams et al., 2008; Woolf, 2015). The link between human violence and companion animal abuse is well documented, and a history of animal abuse can be a predictor of current and future violence directed against people. This connection between human violence and companion animal abuse makes it clear that animal abuse is a problem that affects more than just pets and emphasizes the importance of reporting instances of animal abuse and punishing the perpetrators (Babcock and Neihsl, 2006; Monsalve et al., 2017).

Veterinarians have dual obligations, both to their animal patients and their human clients (Fawcett, 2016). Given that human victims of domestic violence often seek veterinary first aid for their pets, veterinarians may act as frontline health professionals in the recognition of the link between companion animal abuse and domestic violence (Babcock and Neihsl, 2006; Newland et al., 2019). In fact, veterinarians, like human physicians, are often the ones to become aware of the abuse and the only ones in a unique position to identify and report it when their human clients are unwilling to do so (Benetato et al., 2011; de Siqueira et al., 2012).

Veterinarians are bound by a professional code of ethics and encouraged by professional organizations to report animal abuse (Benetato et al., 2011; Almeida et al., 2018). In some states of USA, veterinarians have already a legal duty to report suspected cases of animal abuse to the proper authorities. These states have enacted legislation to protect veterinarians from potential civil or criminal liability arising from reporting suspected animal cruelty. Interest in efforts to draft similar legislation in other states is growing (Babcock and Neihsl, 2006). In addition, other countries worldwide are moving in the same directions (Robertson, 2010).

Moreover, a discovered animal abuse case may cause an ethical dilemma for veterinarians between the professional confidentiality to the client and the duty to protect victim (or victims) and facilitate prosecution when the law has been broken (Babcock and Neihsl, 2006; Robertson, 2010; de Siqueira et al., 2012; Lachance, 2016). Veterinarians are also con-

cerned that reporting animal cruelty will have an impact on their practice and business (Babcock and Neihsl, 2006). The barriers for a veterinarian to reporting to the police or other specific authority an animal abuse case may include: fear of losing income, perceptions that no action will be taken as a result of reporting, fear that reporting may compromise the safety of the alive animal victim or other animals and lack of knowledge of the link between animal abuse and the other forms of intrafamily and interpersonal violence (Green and Gullone, 2005; Williams et al., 2008; Robertson, 2010).

In a recent survey in USA, the most of responding veterinarians were unaware of the current legislation status in their state regarding animal abuse reporting. They have reported that the most common reasons for reporting cruelty must be ethical beliefs and the need to protect the abused companion animal, as well as other animals in the household. On the contrary, they have reported that the most common reasons for not reporting cruelty were their uncertainty that the pet had been abused, their belief that the animals' injuries were accidental versus intentional, and belief that client education would be a better way of action (Kogan et al., 2017).

Therefore, the recognition and mandatory report of NAI in a family pet is a complex issue (Robertson, 2010; Fawcett, 2016). Mandatory reporting can only be supported in a context in which veterinary professionals are (1) trained to recognize the signs of animal abuse; (2) trained to elicit a history sensitively from clients - who may themselves be victims of abuse - or supported in doing so; (3) supported by appropriate, responsive authorities; (4) and reasonably protected from legal recriminations (Robertson, 2010; Woolf, 2015; Fawcett, 2016).

Veterinarians could have an important educative role in promoting animal welfare (Green and Gullone, 2005). They could be an essential part of One Health and One Welfare approaches to break the cycles of violence affecting animals and human members of the family and community (Arkow, 2015; Pinillos et al., 2016). Information gathered from veterinary forensic examination of companion animal victims can help illuminate possible motives for the abusive action and aid in assessing the potential risk for other family pets and family persons posed by perpetrators (Lockwood and Arkow, 2016). Therefore, the One Welfare approach could help to reduce the incidence of crime and violence internationally in a common concern for

all vulnerable, victimized, and at-risk creatures (Arkow, 2015; Pinillos et al., 2016).

The need for state veterinary and humane-law enforcement organizations to increasing communication and education efforts on animal protecting legislation and animal abuse recognition and reporting by veterinarians has been recognized (Kogan et al., 2017). Beyond the vital role of veterinarians in detection of problems in the human-animal bond, changes to policies for domestic violence prevention are needed (Newberry, 2016; Monsalve et al., 2017). Policies must enable sharing of information on suspected pet and human abuse cases in the family context between medical professionals (veterinarians, physicians), police, state authorities for family protection and animal welfare organizations. Additionally, policies must enable increasing of public awareness in order to encourage the human victims to overcome fear and ask for help both for them and their pets (Onyskiw 2007; Roguski 2012; Newberry, 2016; Doukas et al., 2018).

However, animal abuse is not always emphasized in the education programme of Veterinary Schools. As a result, not all veterinary students and graduates feel comfortable to recognize clinical signs and/or lesions during necropsy of an abused animal and may not be aware of the resources that are available to them when considering animal cruelty reporting (Englar, 2018). Veterinary undergraduate student education is needed to prepare veterinarians for their response to companion animal abuse and intrafamily violence in practice (Woolf, 2015; Englar, 2018; Newland et al., 2019).

Conclusively, further publications are required to emphasize the link between pet abuse and domestic violence, both delivering content in the veterinary student education programme and expanding the veterinarians' knowledge/ attitudes. In our opinion, more specific guidelines and/or brochures regarding the recognition of NAI and reporting of pet abuse in connection to intra-family domestic violence within the veterinary literature are needed.

CONFLICT OF INTEREST STATEMENT

None of the authors have any conflict of interest to declare.

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