



The Role of Veterinarians in Forensic Science: A Review

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ABSTRACT

Forensic science plays an important role in solving lawsuits involving human beings, such as assault, homicide, or poisoning cases. It combines scientific principles and techniques with legal procedures. Regarding past and present animal cruelty issues, many countries have passed stringent legislation to penalize individuals who abuse animals. Such animal cruelty protection acts are practiced in many countries, including Thailand, the United States, and Australia. Therefore, forensic science has been applied in the veterinary field, classified as a branch called veterinary forensic science. This field of study examines abnormalities in unnatural death in animals, collecting evidence from animals according to the chain of custody (crucial for documenting evidence) and the laws related to crimes against animals. This article gathers information by searching international databases (Scopus and Pubmed). The results of the search revealed the role of veterinarians in forensic science, the types of animal abuse that have led to legal actions (such as physical abuse and poisoning), and the laws seeking to prevent animal cruelty, each with its unique set of penalties, as implemented by different countries. The results revealed that veterinarians play a crucial role in animal forensic science by examining abused animals and ensuring the precise collection of samples, which serves as essential support for legal cases. It is important to involve specialized experts in these examinations, as their involvement substantially enhances the reliability of the results. Countries with laws to prevent animal cruelty, such as Malaysia, Thailand, Turkey, and Australia, punish animal abusers with varying fines and imprisonment. However, some countries still do not have practical laws to prevent animal cruelty directly, such as China and Iran. In this context, veterinarians should know the animal cruelty prevention laws in their area and educate animal owners to be aware of appropriate animal welfare management and reduce the incidence of animal cruelty.

Keywords: Animal, Cruelty, Forensic Science, Law, Veterinarian

INTRODUCTION

Veterinarians play an important role in animal-related lawsuits related to drug abuse, assault, and cruelty (Parry and Stoll, 2020). Animal abnormalities are often more discernible to veterinarians than to the general public due to their extensive knowledge of animal physiology (Newbery et al., 2016). Many countries have laws for the prevention of animal cruelty, including the Prevention of Animal Cruelty and Provision of Animal Welfare act in Thailand in 2014 (Dorloh, (2017, The Animal Welfare Act in California, the United States in 1966 (Nowicki, 1998), the Prevention of Cruelty to Animals Act in Australia in 1979 (Blache and Maloney, 2009) and the Companion Animal Act in Australia in 1998 (Blache and Malone, 2009). The acts issued in each country aim to prevent animal cruelty and increase awareness of the animals' lives.

Despite the presence of laws aimed at preventing animal cruelty, instances of such cruelty continue to occur. For instance, a man in Germany sexually assaulted a female sheep in 2009. The post-mortem examination revealed multiple perforations and significant hemorrhage in the animal's vagina and anus (Imbschweiler et al., 2009). In 2013, it was reported that dogs died during grooming in Brazil. The cause of death in these cases was determined to be blunt-force trauma to the head, pulmonary edema, and hemorrhage (Maria et al., 2013). Furthermore, in 2015, intentional and accidental poisoning in dogs and cats was reported in Thailand (Lorsirigool et al., 2022a). Therefore, veterinarians play an important role in determining whether injury or death results from animal cruelty or other causes.

The majority of forensic science cases concern human cases rather than animal-related ones. Consequently, many veterinarians may not have a comprehensive understanding of their responsibilities within the realm of veterinary forensic science. The current study aimed to elucidate the pivotal role that veterinarians play in the forensic sciences. It also delved into various manifestations of animal abuse, encompassing physical harm and poisoning, leading to legal proceedings. and laws that strive to prevent animal cruelty, which have different penalties in each country.

Definition of animal cruelty and animal welfare

Animal cruelty is any deliberate act of neglecting to harm animals, resulting in their suffering, illness, or injury. Perpetrators may engage in such actions for personal enjoyment, such as using fire to burn a cat's tail for fun and pulling the dog's tail until it gets injured (Rowan, 2006). On the other hand, animal welfare is defined by the state in which

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animals enjoy freedom from physical and mental distress, living without hunger, discomfort, or fear, while being able to express their natural behaviors within their environment (Carenzi and Verg, 2009; Figure 1). Given their expertise and role in caring for animals, it is crucial for veterinarians to understand the definition of animal cruelty and welfare.

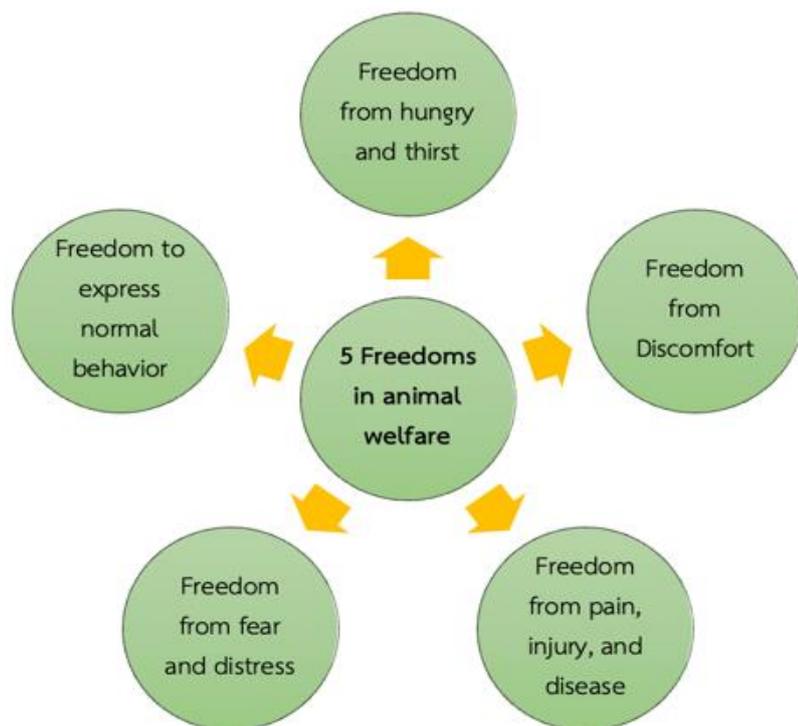


Figure 1. The five freedoms criteria for animal welfare (Source: Carenzi and Verg, 2009)

Definition of forensic science and veterinary forensic science

Forensic science refers to the application of scientific principles (such as chemistry, biology, or physics) and relevant techniques to examine or analyze physical evidence to help decide legal justice (Ristenbatt et al., 2022). Veterinary forensic science (VFS) refers to using scientific methods to prove non-accidental injury in animals. This process includes collecting evidence from animals while maintaining a strict chain of custody, which documents every step of the crime scene examination, animal physical examination, animal evidence collection, and the results of sample analysis, all of which can impact legal proceedings. Additionally, VFS involves a study of the animal cruelty prevention laws of the country where the investigation is conducted (Parry and Stoll, 2020). In many countries, the significance of VFS has grown as it adapts forensic examination techniques traditionally applied to humans to investigate cases involving animals. This approach aims to underscore the importance of addressing animal cruelty, ultimately contributing to an improved quality of life for animals (Newbery et al., 2016; Parry and Stoll, 2020).

Understanding patterns and collecting samples

The veterinarian should be aware of abnormal patterns unnatural to the animal to collect appropriate evidence (Lockwood and Arkow, 2016). Assessment should be based on forms of animal cruelty or animal welfare, for example, reported cases of sexual animal abuse. The veterinarian must perform an external physical examination, examining any wounds or tears in the animal's genitals, swab the vagina, and stain cells where human sperm may be found, as well as detecting human DNA from the fluid in the animal's genital area (Imbschweiler et al., 2009). In cases where pet owners intentionally starve their animals, it can lead to malnutrition and severe health issues for the animals. In such cases, a veterinarian should perform a complete physical examination, evaluate the body condition score of the animal, collect blood samples to assess dehydration, malnutrition, or other complications in the body, and evaluate the overall impact of malnutrition on animal health (Fabretti et al., 2020). In cases involving animal assaults with weapons, it is crucial to investigate and assess the injuries to determine the nature of the attack and potentially identify the weapon used. In one case, the dog owner claimed that a fish harpoon had been stabbed through the abdomen, but the perpetrator was never found (Figure 2).

In situations where no weapons were discovered on the animal or at the crime scene, veterinarians must determine the pattern of wounds and try to match it with potential weapon designs. For instance, an injury caused by an axe may result in a chop wound) Table 1(.

Table 1. The type of wound, the characteristics, and the weapons expected to be used in animals

Type of wound	Characteristics	Examples of weapons in use
Sharp force trauma (Injuries typically arise from objects that can cut or stab)		
Stab	The wound has a deep groove and smooth edges (Stern, 2020).	Kitchen knife (de Siqueira et al., 2016), Ice picker (Stern, 2020)
Incised	Wounds are distinguished by length rather than depth (Stern, 2020).	Knives (Eze and Ojifinni, 2022), Glass (de Siqueira A et al., 2016)
Chop	Wounds are similar to incised wounds, but most appear to be crush injuries (Stern, 2020).	Axes (de Siqueira et al., 2016), Machetes (de Siqueira et al., 2016)
Blunt force trauma (Injuries typically result in a blunt object impacting the body and causing damage)		
Abrasion	Wounds are superficial injuries to the skin and mucous membranes within the body (Shrestha et al., 2023).	Hit by a motor vehicle (Ressel et al., 2016)
Contusions	Wounds are tissue injuries caused by external direct force, usually without resulting in lacerations (Powell et al., 1999).	Hit by a motor vehicle (Intarapanich et al., 2016)
Laceration	Wounds are tears in which the skin and underlying tissue have been sliced or torn (Newman and Mahdy, 2019).	Blunt axe (Ressel et al., 2016)



Figure 2. A 2-year-old, mixed breed dog with a wound from a fish harpoon on the side of its body. Sharp force trauma's defining feature (stab wound, the photo is taken in Ban-Rak-Sat-Khaoyai Animal Clinic, Thailand)

Assessing clinical signs in poisoned animals

Due to frequent nonspecific symptoms, veterinarians may find it challenging to examine and diagnose symptoms in poisoned animals (Lorsirigool et al., 2022a). Therefore, determining if an animal has been intentionally poisoned requires history taking, scene examination, and testing for toxins from the animal's body (Modrá and Svobodová, 2009). Reported types of poisonous agents commonly found in animals vary in different countries. For example, in Thailand, a survey in some provinces conducted between 2016 and 2020 indicated the use of organophosphate-carbamate and acetaminophen in dogs and cats as poisoning agents (Figure 3; Lorsirigool et al., 2022a). Considering a study in Italy, anticoagulant rodenticides are commonly used in dogs and cats (Avolio et al., 2021). Observing the animal's clinical symptoms or conducting a physical examination alone cannot confirm poisoning. Different toxins can produce similar symptoms (Lorsirigool et al., 2022a), and the same substance can lead to different symptoms in animals (Valchev et al., 2008). Therefore, laboratory examination is necessary to confirm poisoning, taking into account factors, such as the quantity ingested, the route of exposure, and the animal's physical condition before exposure to the poison.

Examination of animal samples

Veterinarians should assess the type of poisoning suspected and collect appropriate specimens to determine whether humans intentionally poisoned the animal and whether they are considered cruel and guilty actions (Table 2; Lorsirigool et al., 2022b).

Table 2. Examples of poisonous substances in dogs and cats, the animal's clinical signs, median lethal dose (LD₅₀), (and the method of detection of poisonous agents)

Poisons	Clinical signs	LD ₅₀ (oral)	Method of detection
Anticoagulant rodenticides	Dogs: Tachycardia, vomiting, hematemesis, and weakness (Lorsirigool et al., 2022a) Cats: Tachycardia and fever (Lorsirigool et al., 2022a)	Warfarin (11-323 mg/kg in dogs, 20-50 mg/kg in cats) (Valchev et al., 2008)	HPLC-MS/MS, LC-MS/MS (Avolio et al., 2021; Zhu et al., 2022)
Amphetamine/Methamphetamine	Dogs: Aggression, tremor, mydriasis, and seizures (Oster et al., 2023) Cats: Dilated pupil, tremor, and ataxia (Chłopaś-Konowalek et al., 2022)	Amphetamine (20-27 mg/kg in dogs, less than 1 mg/kg in cats) (Stern and Schell, 2018; Oster et al., 2023), Methamphetamine (9-100 mg/kg in dogs) (Stern and Schell, 2018)	LC-MS (Chłopaś-Konowalek et al., 2022)
Marijuana	Dogs: Ataxia, hypersalivation, and mydriasis (Fitzgerald et al., 2013) Cats: Aggression, mydriasis, and change behaviors (Janeczek et al., 2018)	Tetrahydrocannabinol (more than 3 g/kg in dogs and unknown for cats) (Fitzgerald et al., 2013; Janeczek et al., 2018)	GC-MS, ELISA, MS (Fitzgerald et al., 2013)
Organophosphate	Dogs: Hypersalivation, tremor, and seizure (Lorsirigool et al., 2022a) Cats: Weakness, ataxia, and recumbency (Klainbart et al., 2022)	Malathion (500 mg/kg in dogs and cats) (Bell et al., 1955)	GC-MS, LC-MS/MS (Avolio et al., 2021)

LC-MS: liquid chromatography-mass spectrometry, LC-MS/MS: Liquid chromatography-tandem mass spectrometry, HPLC-MS/MS: High-performance liquid chromatography-tandem mass spectrometry, GC-MS: Gas chromatography-mass spectrometry, ELISA: Enzyme-linked immunosorbent assay, MS: Mass spectrometry, LD₅₀: Lethal dose that could kill 50% of population



Figure 3. A cat whose owners administered acetaminophen (paracetamol), resulting in observed clinical manifestations, such as facial swelling, cyanosis, and weakness (This photo is taken from TerdThai Love Pet Clinic, Thailand).

Specialists' consultant

When a veterinarian detects a case of animal abuse, it is crucial to involve specialized experts in each field to confirm the abuse through a comprehensive evaluation. This confirmation process typically includes assessing the clinical signs, conducting a physical examination, and performing laboratory analysis to investigate the nature of the abuse. For example, when an animal dies unnaturally, a veterinary pathologist should perform a necropsy to determine the actual cause of death (de Siqueira et al., 2016). If an animal is suspected of being poisoned, it should be confirmed by a veterinary toxicologist who can help determine whether the poisoning was intentional or unintentional (Turkmen et al., 2022). On the other hand, if an animal is shot with a firearm, bullets, cartridges, and gunshot residues in the wounds should be inspected by the police forensic department to help identify the type of firearm and the gun owner (Grela et al., 2021). Therefore, consulting with experts in the field will help ensure reliable and accurate test results, which can be valuable in cases involving animal cruelty lawsuits.

Penalties for crimes under the Animal Cruelty Prevention Act

Veterinarians must be knowledgeable about the nature of animal cruelty in their country since each country has different penalties. For example, Thailand has the Prevention of Animal Cruelty and Provision of Animal Welfare Act, 2014 (Dorloh, 2017). For those who abuse animals, the law stipulates that the punishment for committing an offense is imprisonment for no more than 2 years, a fine of not more than 40,000 Baht, or both (Dorloh, 2017). Germany has the German Animal Welfare Act (Ofensberger, 2002), a law for animal abuse that stipulates penalties of up to 3 years imprisonment or a fine of up to 50,000 (Deutsche Mark; Ofensberger, 2002). The United Kingdom has the 2006 Animal Welfare Act (Nurse, 2016), which stipulates that those who abuse animals may face penalties, including imprisonment

for up to 51 weeks and a maximum fine of up to 20,000 pounds)Nurse, 2016(. Punishments in other countries for animal cruelty are shown in Table 3. Increasing veterinarians' knowledge of laws intended to prevent animal cruelty and improving their communication with animal owners or caregivers can potentially enhance animal welfare management.

Table.3 Penalties for animal cruelty in various countries for animal cruelty

Countries	Name of Act	Penalty	References
Malaysia	Animal Act 1953	A fine of 20,000 to 100,000 (Ringgit), imprisonment for 3 years, or both	Zolkipli (2022)
China	<i>No legislation protecting animal cruelty</i>		Tobias and Morrison (2014)
Iran	<i>No legislation protecting animal cruelty</i>		Favre (2016)
Turkey	The Animal Protection Law (Law 5299, 2004)	Imprisonment for 4 months, a fine up to 100 (Lira)	Özen (2017)
Philippines	The Animal Welfare Act 1988	Imprisonment not more than 2 year, a fine not more 5,000 (Pesos), or both	Aquino (2018)
South Africa	Animal Protection Act 1962	Imprisonment up to a year, fine of up to 4,000 (Rand)	Boniface (2016)

CONCLUSION

Veterinarians play a notable role in animal forensic science through investigating different forms of animal cruelty, such as inappropriate pet care, animal welfare management, physical abuse, and poisoning. Veterinarians should notify relevant authorities when they encounter animal cruelty, collect evidence from animals following the chain of custody principle, and report instances of animal abuse to appropriate organizations. Veterinarians should provide animal owners with knowledge and understanding on how to correctly care for their animals, including an overview of relevant laws and penalties for offenses against animals. Future studies should focus on assessing the awareness and understanding of veterinarians in different residential areas regarding their roles in forensic science knowledge and animal cruelty laws.

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Authors' contribution

Narong Kulnides drafted writing guidelines and wrote the draft of the manuscript. Athip Lorsirigool designed ideas, collected information, and contributed to writing the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors have no conflicts of interest to declare.

Ethical consideration

All authors have checked for plagiarism, fabrication and/or falsification, dual publication and/or submission, and redundancy.

Availability of data and materials

The authors confirm that the data supporting the findings of this study are available.

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