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Thanatognomonic substantiation of the forensic veterinary diagnosis in the death of dogs and cats due to haemodynamic disorders and hypoxaemia

Roman Kazantsev*
Postgraduate Student
State Biotechnological University
62341, 1 Akademichna Str., v. Mala Danylivka, Ukraine
https://orcid.org/0000-0002-4479-1516

Ivan Yatsenko
Doctor of Veterinary Sciences, Professor
State Biotechnological University
62341, 1 Akademichna Str., v. Mala Danylivka, Ukraine
https://orcid.org/0000-0001-8903-2129

Abstract. At present, there are no legally consolidated, regulated procedures for conducting forensic veterinary examination of animal cadavers in Ukraine, which makes it difficult for law enforcement agencies to objectively qualify forms of administrative and criminal offences within the framework of pre-trial investigations. Therefore, scientifically sound research results in the field of animal treatment are of particular relevance. The purpose of this study was to substantiate the cause-and-effect relationships in the genesis of violent death of animals caused by mechanical injuries, thermal trauma, and mechanical asphyxiation with the identification of thanatognomonic patterns according to a two-level system of evidence. Methods of comprehensive forensic veterinary examination of animal cadavers were employed, followed by logical and epistemological processing of the results. It was argued that the main links of thanatogenesis in the case of death of animals from these species are irreversible haemodynamic disorders and acute hypoxemia. Based on this approach, an estimate of the area of pathological damage to internal organs incompatible with life is proposed, followed by an "expert hypothesis" regarding the determining cause of the animal's death. The morphological positions of the forensic veterinary diagnosis in the form of thanatognomonic positions inherent in a certain subspecies of violent animal death were distinguished by two levels

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*Corresponding author

of evidence and their criterion informativeness was proved. Patterns of rapid death of animals of the first level of evidence common to the fatal consequences of mechanical and thermal trauma and mechanical asphyxiation were established: "asphyxiated heart", congestive venous hyperaemia of internal organs, Tardieu's spots, alveolar emphysema of the lungs. Patterns of the second level of evidence were selectively randomised and their species specificity was presented. The circumstances under which animals suffer fatal mechanical and thermal injuries and asphyxiation were detailed, and the mechanisms of death were substantiated. The study focused on the specific features of argumentation in concluding the necessary direct causal link between the genesis of violent death and the cause of death. The findings obtained following the standard of evidentiality "study of the object of forensic veterinary examination at different morphological levels" are recommended for implementation in the practice of forensic veterinary examination of animal cadavers

Keywords: bodily injury; thermal trauma; mechanical asphyxia; animal thanatogenesis; argumentation of an expert opinion

Introduction

In Ukraine, the national legislation regulates the issues of organising and conducting forensic examinations in a fairly comprehensive manner. However, the procedures for conducting a forensic veterinary examination of animal cadavers are currently not legally consolidated. Therefore, as reported by A. Yashchenko (2022), the development of concrete issues of forensic veterinary examination is essential to assist law enforcement agencies in the correct qualification of forms of animal abuse offences during pre-trial investigation, trial of crimes against animal health, and imposition of sanctions for grave consequences. To eliminate the gaps in this area of expertise, the study analysed the possibilities of forensic veterinary examination as a new type of forensic examination, its current state and prospects for development in Ukraine, and forensic cases of examination of animal cadavers with signs of violent death from mechanical injuries, asphyxiation and overall cruel treatment. Therewith, M. Yushkov (2022) focuses on the prevention of administrative offences in the field of animal treatment: an individual who keeps an animal is obliged by law to ensure the prompt provision of veterinary services, including examination and treatment, to immediately notify state medical or veterinary institutions of cases of injury to humans or other animals by an animal and, in this case, to immediately bring it to a veterinary medical institution for examination.

If the investigating authorities establish objective circumstances that, individually or in combination, give grounds to believe that the cause of the animal's death was bodily injury or mechanical asphyxiation, a forensic veterinary examination is ordered. The purpose of the latter is to establish the initial (determinative) cause of death and the final forensic veterinary diagnosis based on a comprehensive examination of the case file and objects of examination.

J.K. Serdioucov & D.Yu. Shkundia (2021) found that in the practice of forensic veterinary examination, there are often cases of statutory forms of animal abuse: killing animals with firearms or bladed weapons, sharp instruments or blunt objects, as a result of falling from a height, drowning, death in road accidents, etc. Among the most popular methods for determining the age of death of animals, the

researchers cite the following: visual-palpatory, thermometry, morphometric, and morphological (including histochemical, histological, and micromorphometric examination), biophysical (including the adhesive method, measurement of the water-binding capacity of tissues), and a wide range of biochemical methods aimed at determining the content of certain chemicals – products of decay and breakdown of tissues – in the tissues and fluids of an animal cadaver.

Based on the specific features of the pre-trial investigation and the principles of legal proceedings, during which only a direct link between the actions of a particular person and the consequences that have occurred is accepted as evidence of an offence, one of the difficult tasks of forensic veterinary examination is to establish a causal link between animal trauma and adverse outcomes. After all, the objective side of the crime regulates the need to establish a causal link between the actions of a particular person and the consequences that have occurred.

Establishing the cause of death during the forensic veterinary examination of an animal cadaver is important, and, in the context of forensic veterinary examination, the cause of death of an animal should be interpreted in the same way by forensic experts and law enforcement agencies. The conclusion as to the cause of death (accident or violent injury) is the prerogative of law enforcement agencies, but in some cases, a forensic veterinarian may point to signs inherent in a particular type of death. Therewith, law enforcement agencies mainly identify direct causal links between the unlawful act and its consequences, which is also related to the position of the customers of the expertise. At the same time, the direct link between cause and effect must be clear to all parties. The latter, in contrast to a possible connection, is characterised in all cases by the constant occurrence of consequences with other qualitative characteristics.

Therefore, if the forensic veterinary examination of the cadaver does not establish a direct causal link between the injury and the condition that directly caused the death of the animal, law enforcement agencies will have no grounds to establish a direct causal link between the violent actions of the person who caused the injury and the death of the animal.

As practice shows, professional mistakes by veterinary specialists performing diagnostic autopsies of animal cadavers occur precisely during their detailed description, which is arguably caused by the lack of an accepted unified algorithm. In this context, V. Delgado *et al*. (2021) and R. Munro (2022) believe that for the scientific solution of these problems, it is necessary to continue the search and substantiation of standardised algorithms and criteria in the forensic veterinary examination of animal cadavers.

The purpose of this study was to substantiate the cause and effect relationships in the genesis of violent death of animals due to haemodynamic disorders and hypoxemia based on the findings of original research based on the proposed approach with the identification of thanatognomonic patterns (the definition "thanatognomonic pattern" should be understood as specific signs inherent in a particular type of violent death of animals), which will increase the level of reasonableness of the conclusion of a forensic veterinary expert.

Literature Review

N.M.A. Parry & A. Stoll (2020) note that various issues in the field of forensic veterinary medicine are constantly discussed in the pages of periodicals. Among the studies of Ukrainian researchers on the problem of establishing causal relationships in animal cadavers in criminal cases, one can distinguish the studies of V. Lemishevskyi (2021), who detailed the case of a forensic veterinary examination of a dog cadaver

with signs of violent death, Yu. Fedyk & I. Besaha (2023), who highlighted the evidentiary value of the veterinary medicine specialist's opinion during legal proceedings, I. Yatsenko & R. Kazantsev (2021) showed the features of the structure of the conclusion of a forensic veterinary expert based on the findings of the study of poultry cadavers. In the corpus of currently accumulated data, B. Borysevich *et al*. (2024) summarised information on mechanical asphyxia in small animals, while M. Skrypka *et al*. (2023) established the pathomorphogenesis of mechanical injuries of the axial skeleton of animals in case of fatal polytrauma.

Analysing systematic reviews by foreign researchers published in recent years, there is some limited information on the use of algorithms, and those that are used are mainly represented by literature on forensic medicine, which does not specify the range of issues addressed by forensic veterinary examination. Clearly, this is associated with a certain conservatism in the argumentation and formulation of the forensic veterinary diagnosis for certain subtypes of violent death of dogs and cats. Among the publications of foreign researchers in this context, it is worth highlighting the systematic review by N. Kulnides & A. Lorsirigool (2023), which outlines general approaches to the forensic veterinary examination of animal cadavers affected by cruelty. All these researchers argued for fatal consequences mainly in the context of certain types of violent animal deaths and emphasised the need to use professional knowledge in forensic veterinary examination, while S. Monsalve *et al*. (2021) in a separate report stressed the need to improve the theoretical and practical training of specialists in forensic veterinary examination.

Notwithstanding the above, the reasoning behind the conclusion of a forensic veterinary expert in criminal proceedings for animal deaths caused by acute haemodynamic disorders and hypoxia has not yet received proper coverage. Specifically, the main links in the thanatogenesis of mechanical, thermal trauma, and certain subtypes of mechanical asphyxiation are not generalised, since the establishment of the mechanism of death and the necessary causal link between the injuries and the cause of death of an animal substantially affects the outcome of the pre-trial investigation of criminal offences.

Considering the above, there is every reason to state the existence of a significant empirical body of work, which should form the theoretical framework for further scientific research towards solving fundamental and applied problems of forensic veterinary medicine.

In summary, one of the key tasks of forensic veterinary examination is to argue the necessary causal link between the lifetime injuries of an animal and its death, which is also emphasised by D. Doukas (2022). The development of new methods, techniques, and means of forensic veterinary examination of animal cadavers in various types of violent death and their implementation in expert practice can positively affect the efficiency and effectiveness of forensic veterinary examination, providing a reliable, substantiated. and objective expert opinion in a categorical form, which directly affects its assessment as evidence and, accordingly, the court decision.

Materials and Methods

This study is a fragment of the research work of the National Scientific Centre "Hon. Prof. M.S. Bokarius Forensic Science Institute", Kharkiv (state registration number 0121U100299). The methods of extrapolation and logic were applied retrospectively based on the results of the analysis of 300 veterinary medical opinions during 2013-2023. In each sectional case, the study of experimental

animal cadavers was performed following the methodology approved by the Ministry of Justice of Ukraine (Yatsenko & Kazantsev, 2023).

The methods employed were those of a modern clinical trial standard: objects, patterns, inclusion, and exclusion categories, statistical sampling, representativeness, randomisation, levels of the pyramid of evidentiality. The objects of the study were selected by random sampling – examinee dogs and cats and examinee dog and cat cadavers (170 dogs and 150 cats aged from 1 day to 10 years), forensic veterinary experts' opinions. Inclusion criteria: mechanical injuries, thermal injuries, and mechanical asphyxia in dogs and cats with *exitus letalis*. The exclusion criteria were non-fatal mechanical injuries, thermal injuries, and mechanical asphyxiation of dogs and cats.

A randomised prospective study was conducted in the inpatient setting of veterinary medical institutions in Kharkiv (2021-2023; cats, n = 100; dogs, n = 100) by clinical observation of the posttraumatic period for seven days. All animal manipulations were carried out in strict compliance with the principles of bioethics regulated by the Procedure for Conducting Experiments and Experiments on Animals by Scientific Institutions following the Law of Ukraine No. 3447-IV (2006). In case of death of dogs and cats, their cadavers were autopsied no earlier than two hours postmortem. According to the Law of Ukraine No. 287-VIII (2015), the cadavers of all animals were classified as Category III by-products.

For histomorphological studies of the loci of pathological lesions and/or injuries, cylindrical necropsies were taken from them during *sectio* using Panch (China), then histological preparations were made from them according to the generally accepted method (Horalskyi *et al*., 2015) and then stained with haematoxylin and eosin. The obtained histotopograms were evaluated in the field of view of a 10×40 optical microscope "Granum R50" (China). The most representative changes were photographed using a ToupCam UCMOS03100KPA camera (China) integrated with a microscope and analysed following the recommendations (Raskin *et al*., 2022).

Macro photographs of dog and cat cadavers were taken with an Olympus E-450 SLR camera (Japan). Digital radiographic images were obtained using the X-ray Device PCMAX-40HP (Korea), magnetic resonance imaging – ECHELON Smart 1.5T (Japan), X-ray tomography – 32GE Optima CT 540 (Netherlands), and endoscopy – Olympus CLV-160 (Japan).

Photographic screens obtained during radiological and endoscopic examinations of forensic veterinary objects were detailed using the RadiAnt DICOM Viewer 2023.1 software package. All photos were processed in Photo Frame Studio 3.0 on a personal computer. The photogrammetry was performed using a forensic ruler designed for large-scale photographic recording of objects. The statistical analysis of the original data was performed by calculating the percentage of expert cases.

Results and Discussion

When analysing the forensic veterinary case files, it was noted that the tasks to be solved by the investigating authorities vary depending on the case. However, questions about the cause of death are always encountered in the examination of an animal cadaver.

Our expert practice shows that each traumatic case is a consequence of a concrete cause, while the pathomorphogenesis of a traumatic disease materially reflects the cause of the animal's injury. Death caused by the adverse effects of a traumatic animal disease is the result of a sequential chain of concrete cause-and-effect relationships. However, it is important to emphasise that this sequence requires a sufficient set of conditions that further determine

the development of the consequences. Thus, only a comprehensive determination of the pathomorphogenesis of the injury can confirm or refute the existence of a causal relationship between a particular event and the death of an injured animal.

Authors argue that the forensic veterinary diagnosis, as the quintessence of an autopsy with the statement of changes that have arisen as a result of the impact of certain damaging factors from the beginning of their action to the fatal outcome, is based only on this principle, and allows clearly tracing the links between the root cause of death, its fatal complication, and the immediate cause of death. To establish a forensic veterinary diagnosis, it is first of all advisable to identify the underlying disease (the initial cause of death), which in a monocausal diagnosis is represented by one nosological unit, and in a bicausal diagnosis – by two (competing, combined, or primary and background diseases). The main nosological entity that includes the fatal complication (the immediate cause of death) should be given as the second item of the diagnosis. Background conditions (if any) that aggravate the underlying cause should be outlined at the end. We believe that unfavourable complications of the underlying cause of death in the form of morphological positions should be considered as natural manifestations of the underlying cause of death, combined by a common thanatogenetic mechanism. At the same time, the immediate cause of the animal's death with the corresponding manifestations as a result of an independently completed pathogenesis becomes the basis for the development of the dying process and leads to a premorbid state.

Authors state that the forensic veterinary diagnosis should be based on a set of objective evidence obtained during a comprehensive, thorough examination of the animal cadaver, even in cases of seemingly obvious direct cause of death, including morphological positions, and must be supplemented by the results of microstructural tissue analysis. For instance, in the case of acute blood loss syndrome, we note morphological changes in the lung parenchyma, which are equally likely to characterise both haemorrhagic shock and congestive venous hyperaemia, depending on the duration of the terminal period, circulating blood volume deficit, etc. Thus, to determine the mechanism of death in this condition in each case, it is necessary to conduct additional verification of the locus of the lesion at different levels of structural organisation.

During the forensic veterinary autopsies of the examinee cadavers of animals whose death occurred rapidly from mechanical injuries or mechanical asphyxiation, the presence of characteristic common morphological positions was established. Authors propose to refer such non-specific signs to general asphyxial signs (patterns of the first level of evidence) in the diagnostic algorithm for differentiating the direct cause of animal death.

To follow the principle of objectivity in substantiating the conclusion of a forensic veterinary expert, authors consider it necessary to distinguish specific signs of traumatic injury (patterns of the second level of evidence), namely, the presence of body damage, the pleomorphism of the manifestations of which depends on the location and nature of the injury; acute blood loss; general anaemia (background condition in the form of circulatory anaemic hypoxia). It was established that the variants of transformation of cadaveric phenomena largely depend on thanatogenesis, the features of which differ depending on the species and conditions of animal death.

Objectification of the cause-and-effect relationship between severe mechanical trauma of an animal and the onset of death in a hospital of veterinary medicine based on the

analysis of clinical and morphological epicrisis requires a retrospective reproduction of the development of the premortem state and a conclusion on the adequacy of the amount of veterinary care provided. Based on the analysis of case files, clinical and sectional epicrisis reports, and direct clinical observation, we emphasise that most often the adverse effects of traumatic disease in animals occur, specifically, due to causes that can be systematised into two groups. Firstly, this is morphological damage. These include life-threatening injuries: a) gross anatomical destruction (crushing or separation) of the body; b) considerable damage to vital organs (e.g., cardiac tamponade with blood due to extra-mural infarction, brain and/or heart contusion); c) acute bleeding: 1 – external, 2 – internal; d) obstruction of the main vessels by traumatic emboli (air, tissue, etc.); e) mechanical asphyxia: 1 – aspiration of the respiratory tract with blood, 2 – traumatic laryngeal oedema; f) combined polytrauma. The second group include life-threatening functional disorders caused by acute organ failure and/or pain shock. Fatal complications of traumatic animal disease include, specifically, anaerobic/purulent infections and intoxication (infectious toxic shock). An injury that does not cause death on its own can be a condition for the aggravation of another factor that causes an adverse outcome.

As a result of the clinical observations of the course of traumatic animal diseases in the inpatient conditions of veterinary medical institutions, we found that within a week of the post-traumatic period, the death of animals occurs depending on certain causes. Thus, in the first day after the injuries, death was caused primarily by acute systemic disorders, specifically, by a violation of the volume and redistribution of circulating blood. Considering this, a complete diagnosis of such disorders should include an assessment of clinical data, the nature and morphological features of injuries, and other pathological changes that affect the pathogenesis of traumatic illness. On Days 2-3, the onset of cerebral thanatogenesis in the form of destructive cerebral oedema and pulmonary insufficiency, in the form of pneumonitis and non-cardiogenic pulmonary oedema against the background of acute respiratory distress syndrome was observed. On Days 4-5 of the observation period, the manifestations of the systemic coagulopathy phase in the form of disseminated intravascular coagulation syndrome prevailed. After Day 6 of traumatic illness, death occurred with the development of septic conditions, which suggests a prognostically unfavourable outcome of the traumatic injury.

Authors argue that a direct, necessary causal link should be substantiated in all successive links of the (patho)tanatogenesis of traumatic disease. However, it is not possible to establish at what point during a traumatic illness the triggering thanatogenic link is implemented, since aspects of thanatogenesis (its types and mechanisms) differ substantially depending on the concrete type of trauma. This circumstance clearly leads to a high probability of expert error in determining the cause of death and aggravating factors, especially in the case of fatal complications. Undoubtedly, the transition of the pathogenesis of a traumatic animal disease to its fatal outcome occurs gradually, but it is also impossible to clearly define the clinical manifestation that reflects such a mechanism, while the thanatological analysis of a particular expert case during comparison is complicated by the lack of common principles of interpretation of the main thanatological principles among veterinary medicine specialists.

In such conditions, it is advisable to focus, firstly, on functional changes that trigger the chain of links in thanatogenesis and, secondly, on morphological patterns that contribute

to the onset of the fatal outcome of traumatic illness. It is recommended to establish the types of thanatogenesis during a forensic veterinary autopsy using a comprehensive morphological approach to the study of internal organs and to assess the organ whose function has decreased to a critical level and made further ontogeny of the animal impossible. Based on this approach, it is necessary to assess the area of pathological changes in internal organs incompatible with life and build an "expert hypothesis" about the cause of death.

Probably, irreversible metabolic disorders associated with oxygen consumption deficiency are still a key link in the thanatogenesis of animals in critical condition and directly cause death in the early post-traumatic period. The systemic inflammatory response that develops after a week is a reflection of the immunological conflict caused by the inability to control the localisation of the infection against the background of consumption coagulopathy, cytopathic hypoxia, which causes mono/multiorgan failure during the development of general inflammation. Endogenous intoxication caused by acute or chronic kidney disease substantially increases the risk of mortality in the long-term post-traumatic period. Therewith, acute kidney damage was diagnosed in 50% of animals admitted to veterinary hospitals with a history of traumatic illness.

The development of acute heart failure plays a crucial role in thanatogenesis after concussions of the corresponding reflexogenic chest area. The most common cause of pulmonary end-stage disease is mechanical asphyxia. The cerebral type of terminal condition is inherent in death occurring in the first hours due to traumatic brain injury, massive blood loss on an intact premorbid background, carbon monoxide poisoning, and mechanical asphyxiation. However, in our practice, we most often had to observe a combined type of thanatogenesis of the terminal state, with predominantly hypoxemic, dysmicrocirculatory, and coagulopathic accents, which often had independent thanatogenetic significance due to the interrelated consequences.

A retrospective analysis of the conclusions of veterinary specialists after diagnostic examinations of animal cadavers revealed quite significant, sometimes contradictory, discrepancies between the results of the examination and synthesis parts, which may be due to a low level of professional competence. However, it is reliably known that the largest number of deceased dogs and cats subjected to sectional examination were those that died suddenly, including outside/within veterinary medical institutions, and without evident signs of violent death, which accounted for 40% of the total number of autopsies (Table 1).

Table 1. Retrospective analysis of the leading causes of death of dogs (n = 150) and cats (n = 150) in 2013-2023 in Kharkiv

Type of animal death	Number of cases		Percentage share, %	
	dogs	cats	dogs	cats
I. Sudden death	60	60	40.0	40.0
II. Mechanical damage (by subtypes):				
1. Effects of a sharp object	15	14	10.0	9.3
2. Effects of firearms	8	7	5.3	4.7
3. Rail-associated injury	2	1	1.3	0.7
4. Motor vehicle associated injury	16	18	10.8	12.0
5. Catatrauma	9	11	6.0	7.3
6. Effects of a blunt object	11	9	7.3	6.0

Table 1. Continued

Type of animal death	Number of cases		Percentage share, %	
	dogs	cats	dogs	cats
III. Thermal injury (by subtypes):				
1. Generalised hypothermia	5	4	3.3	2.7
2. General thermoplegia	5	4	3.3	2.7
IV. Mechanical asphyxia (by subtypes):				
1. Aspiration	8	12	5.3	8.0
2. Strangulation	6	5	4.1	3.3
3. Obstruction	3	2	2.0	1.3
4. Compression	**2**	**3**	**1.3**	**2.0**

***Source**: developed by the author of this study*

Table 1 shows that the total array of mechanical injuries and mechanical asphyxiation manifestly demonstrates the onset of death in 80 (53.4%) dogs and 82 (54.6%) cats, which together accounts for more than half of all cases studied. However, there was no significant relationship between the distribution of mechanical injuries or asphyxiation in dogs and cats by season. It should also be emphasised that there is no significant difference in the statistical distribution by species and subspecies in the overall structure of dog and cat mortality, expressed in the number of registered cases and their percentage. The analysis of the sub-sample of mechanical injuries indicates that 61 (40.8%) dogs and 60 (40%) cats died from them. As for open mechanical injuries caused by sharp and firearms, such cases were observed in 23 (15.3%) dogs and 21 (14.0%) cats.

In the forensic veterinary practice, we have increasingly encountered cases of animal injuries caused by objects commonly used in everyday life. Thus, monitoring studies of the nosological structure of open mechanical trauma of animals admitted to veterinary medical institutions suggest that such injuries are caused by owners or third persons using various tools. The consequences of exposure to such weapons in dogs and cats are comparable – skin damage in the form of wounds that penetrate deeper than the papillary layer. All cases of overt mechanical injuries of dogs and cats were systematised and listed according to the number of diagnosed cases (Table 2).

Table 2. Retrospective analysis of open mechanical injuries of dogs (n = 170) and cats (n = 150) for 2021-2023 in Kharkiv

Type of animal wounds	Statistical distribution						
	Number of cases				Dynamics by years, units		
	dogs	share, %	cats	share, %	2021	2022	2023
scalped	4	2.4	1	0.7	1	1	3
chopped	5	3.1	4	2.9	3	4	2
stabbed	7	4.2	6	3.7	4	5	4
shot by firearm	10	5.9	10	6.9	3	14	3
crushed	16	9.6	16	10.5	8	14	10
bludgeoned	16	9.7	16	10.7	7	11	14
combined	18	10.5	17	11.3	9	12	14
cut	25	14.5	21	14.1	13	15	18
torn	29	16.8	23	15.6	17	19	16
bitten	40	23.3	36	23.6	23	21	32

***Source**: developed by the author of this study*

According to the obtained numerical data (Table 2), the anthropogenic factor was determined to be aetiological with varying degrees of presence in all types of injuries, except for bite wounds spontaneously induced by other animals. With such injuries, the skin flap had a characteristic bitemark. F. Iarussi *et al*. (2020) proposed to transfer the nosology of injuries caused by dog bite wounds to the objects of forensic veterinary research, since the consequences of such injuries can be not only civil but also criminal in nature. The same opinion was shared by C.L. Hsiou *et al*. (2022), who identified the pleomorphism of bite wounds on cat cadavers. The researchers agree with both theses, because this type of injury, according to the data obtained, significantly prevails over other types of wounds among both dogs and cats.

The statistical distribution of cases of open mechanical injuries in animals suggests that the largest number of cases were lacerations (16.8% among dogs, 15.6% among cats), and the smallest number were scalped wounds (2.4% among dogs, 0.7% among cats). Both types of injuries were caused by soft tissue sprains. Depending on the mechanism of traumatic impact of the weapon, typical injuries were observed. Thus, the formation of cut (14.5% among dogs, 14.1% among cats), stabbed (4.2% among dogs, 3.7% among cats), and chopped (3.1% among dogs, 2.9% among cats) wounds is typical of sharp objects. The morphological features typical of such injuries were established in the form of their smooth edges, smooth walls, limited locus of injury, and the absence of connective tissue membranes in the wound channel. The combined type of wounds (10.5% among dogs and 11.3% among cats) was observed under conditions of combined simultaneous exposure to traumatic factors. Most often, combined injuries were recorded in several anatomical areas of the animal body during transport accidents or falls from a great height. The formation of firearm wounds (5.9% among dogs and 6.9% among cats) is associated with the impact of high-speed kinetic projectiles, such as bullets, shell fragments, shrapnel, etc. During a collision with a sufficiently large solid surface, animals sustained bruises (9.7% of dogs, 10.7% of cats) and crushed wounds (9.6% of dogs, 10.5% of cats) as a result of compression. The morphological features of these types of wounds in the form of uneven, blood-soaked edges and pronounced connective tissue membranes in the lumen of the wound canal were noted.

In terms of the dynamics of mechanical damage, during 2021-2023, certain types of damage were evenly distributed between years. However, in 2022, there was a rapid increase in cases of gunshot wounds and shrapnel injuries among animals, which is clearly related to the hostilities in the monitored area, as dogs and cats were injured during mass shelling with shells and their fragments. At the same time, it was found that there is no correlation between the time of year and the number of cases of animal injuries.

In terms of the topography of lesions in dogs and cats, the characteristic features of localisation were established. Thus, among dogs, wounds were most often recorded in the pelvic limbs, neck, and torso, while among cats – in the neck, torso, and head. There was also a correlation between the type of wound and its location in animals: bitten and torn wounds were most often observed in the neck and torso, while bruises were mostly observed in the head. Mostly cut and puncture wounds were diagnosed on the animals' limbs, apparently because these areas of the body are the first to come into direct contact with various cutting and piercing objects (glass, nails, etc.) in the soil. However, the localisation of cut and stabbed injuries in other parts of the body could have been caused by cruel treatment. There were also isolated

cases of isolated open injuries of other parts of the animal body, but no regular relationship between their location was established.

In forensic veterinary tanatology, when reconstructing the conditions of injury, one of the key tasks is to establish the fact that the injury was caused by a certain instrument, and not by any other, because the identification of this object substantially assists law enforcement agencies in recreating a reliable picture of the event.

Thus, the presented retrospective analysis of the type, location, and nature of open bodily injuries most often diagnosed among dogs and cats will allow, in the future, to pay special attention to law enforcement agencies to search for traumatic instruments when investigating crimes against animal health. This was also emphasised by E.J. Bartelink *et al*. (2022), who investigated the cadavers of dogs with signs of ante-mortem blunt force trauma. The distribution and severity of injuries, including fractures, were mainly localised to the axial skeleton (skull, thorax, spinal column, pelvis), which is partially consistent with the data obtained from our studies and with documented cases of non-accidental injuries (NAI) among domestic animals.

Using the analysis of the examination sections of the forensic veterinary experts' opinions, a certain similarity in the macromorphological pattern of animal injuries was found, which depended on the aetiological factor. We present an algorithm for formulating a forensic veterinary diagnosis and its substantiation based on the established thanatognomonic patterns of certain subtypes of violent animal death caused by bodily injury, thermal injury, and mechanical asphyxia in typical cases.

During the external examination of the cadaver of cat No. 1, scissors were found sticking out of the right ventral abdomen at an angle of 30° (Fig. 1).

Figure 1. Cadaver of a cat with scissor injuries
Notes: *macro photo*
Source: *developed by the author of this study*

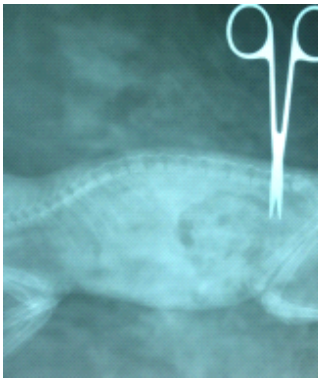

Figure 2. Cadaver of a cat with scissor injuries
Notes: *photographic screen of radiograph in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

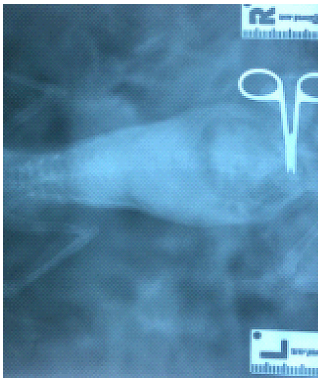

Figure 3. Cadaver of a cat with scissor injuries
Notes: *photographic screen of radiograph in DV projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

The plain radiographs of the cat's cadaver, performed in RL (Fig. 2) and DV (Fig. 3) projections, show a section of the traumatic canal located 2.5 cm to the left of the *linea mediana anterior* at the level of the pelvic bones at a distance of 13.7 cm from the hip joint. The

oblique-vertical wound formed on the skin *in situ,* 6.3 cm deep and 0.8 cm long, has smooth, sharply bevelled edges, and is saturated with blood. The subcutaneous base is visible in the lumen of the wound. On the wound walls, numerous dark brown blood particles ranging in size from 0.4×0.6 cm to 0.6×0.8 cm were observed. The wound canal begins on the lateral surface of the trunk, located in the soft tissues from right to left and from top to bottom at an acute angle. The X-ray examination shows no signs of haemorrhage, thus, on the one hand, death probably occurred shortly after the injury, and on the other hand, the blood saturation of the ribs and wound edges suggests that they were formed pro vita. The injuries found on the cat's body caused severe short-term pain before it died. Considering the facts, the initial cause of death of cat No. 1 was a single penetrating stab wound to the abdomen, while the immediate cause of death was traumatic pain shock.

During the external examination of the experimental cadaver of cat No. 2, it was found that a knife with a one-sided blade was sticking out of the area of the 3rd intercostal space of the chest on the left at an angle of 45° (Fig. 4).

Figure 4. Cadaver of a cat with injuries caused by a kitchen knife
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 5. Cadaver of a cat with knife injuries
Notes: *photographic screen of X-ray in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

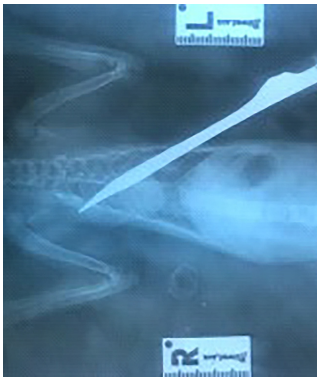

Figure 6. Cadaver of a cat with knife injuries
Notes: *photographic screen of X-ray in DV projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

Plain radiographs of the cat's cadaver, performed in RL (Fig. 5) and DV (Fig. 6) projections, show a section of the traumatic canal located 5.3 cm to the left of the *linea mediana anterior* at the level of the scapula at a distance of 15.9 cm from the shoulder joint. A 2.0 cm long rectilinear penetrating wound is found on the skin with convergent edges, soaked with blood. The ends of the wound are oriented at 8 and 14 o'clock on the conventional dial, without connective tissue bridges. The wound edges are clear, the edges are relatively smooth, not incised, the walls are smooth, and bevelled. On the wound walls, numerous dark brown blood particles ranging in size from 0.3×0.5 cm to 0.5×0.7 cm were observed. The subcutaneous base *in situ* revealed a rectilinear wound channel with a depth of 11.3 cm. In the chest cavity, the knife blade touches the heart and penetrates through the lobes of the left and right lungs. The X-ray examination showed no signs of haemorrhage, thus, on the

one hand, death occurred shortly after the injury, while on the other hand, the blood saturation of the ribs and wound edges indicates that they were formed pro vita. The injuries found on the cat's body caused severe short-term pain before it died. Considering the above data, the initial cause of death of cat No. 2 was determined to be a single penetrating stab wound to the chest, while the immediate cause of death was traumatic pain shock.

During the external examination of the experimental cadaver of cat No. 3, it was noted that a sewing needle was sticking out of the left eye at an angle of 25° (Fig. 7).

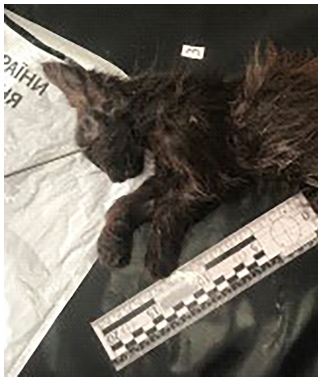

Figure 7. Cadaver of a cat with needle injuries
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 8. Cadaver of a cat with needle injuries
Notes: *photographic screen of radiograph in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

Figure 9. Cadaver of a cat with needle injuries
Notes: *photographic screen of radiograph in DV projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

The overview radiographs of the cat's cadaver, performed in RL (Fig. 8) and DV (Fig. 9) projections, showed that the needle penetrated the brain substance through the brainstem in an oblique-aboral direction, forming a wound channel. During the enucleation of the injured eye, retrobulbar haemorrhage was detected, and the injury was a rounded wound with a diameter of 0.3 cm, which corresponds to the diameter of a foreign object. The wound canal was straight, its walls were even, crossing the arteries of the arachnoid membrane of the brain and, as a result, bleeding into the subdural space. Due to a puncture wound, minor visual damage was accompanied by a violation of the anatomical integrity of deeply located tissues. Thus, the diagnosis of a stab wound was difficult, because, depending on the topographical area, such wounds cause health damage of varying severity. Proceeding from the above, it was concluded that the death of the cat submitted for forensic veterinary examination was caused by compression with gross destruction of the brain matter, instantaneously.

During the external examination of the cadavers of dogs with injuries caused by *cutting tools*, typical morphological signs of such injuries were found: their length always exceeds their width and depth, which clearly depends on the sharpness of the blade, the pressure, and the density of the tissues. Due to the pressure of the blade on the skin and underlying tissue while pulling, the tool separates the soft

tissue, causing a laceration. Thus, the incised wound of the experimental dog cadaver in the ventral abdomen (Fig. 10) with entrapment of the greater omentum was characterised by straight, clear edges with a smooth surface, 23.3 cm long and 12.5 cm wide.

Figure 10. A wound in the umbilical region of the dog's abdomen
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 11. Wound in the distal region of the right thoracic limb of a dog cadaver
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 12. Wound in the area of the lower leg of the left pelvic limb of a dog cadave
Notes: *macro photo*
Source: *developed by the author of this study*

On the wound walls, numerous rounded dark brown blood particles ranging in size from 0.1×0.1 cm to 0.3×0.3 cm were observed. In this regard, it was concluded that the wound was caused by a cutting object with a sharp blade, as indicated by its somewhat tortuous shape, smooth unabraded edges, relatively flat walls with no signs of active bleeding.

As for the *cutting injury* of the distal thoracic limb (Fig. 11) of the experimental dog cadaver, it occupies an intermediate place between cut and bruised injuries and combines their features in its morphological patterns. The gaping of such a wound in an animal cadaver is visually pronounced, the edges are uneven, there are no signs of external bleeding, but areas of necrosis are visible on the wound ribs and skin flaps. The instrument of injury is a massive yet sharp object with a limited cutting surface. Such an object in this expert case could be a garden shovel. The patterns of wound contracture indicate that the wound was formed 5-7 days prior, which is explained by the formation of granulation tissue with epithelialisation. Considering the above, there is no direct necessary causal link between the injuries in the form of a cut wound in the ventral abdomen of the examinee dog cadaver and a chopped wound in the distal segment of the right thoracic limb of the examinee dog cadaver and the death of the animals.

Injuries to animals caused by the design features of electric transport tracks (*rail-associated injury*) are rarely recorded, but deserve attention, as the thanatogenesis of this type of violent death is still controversial. The factual injury occurs when the animal's limb hits the railway switch necessary to shift the moving elements of the transport to another railway track (Fig. 12). It is known that such a device consists of frame rails, switch points, and a transfer mechanism. Clearly, the mechanogenesis of this injury is caused, on the one hand, by

compression and overstretching of soft tissues, and, on the other hand, by traumatic amputation of the limb. The specificity of this amputation is probably conditioned by the animal's attempts to free the limb, which was clamped between the rails, while the points clutch. Macromorphological patterns of the pelvic limb fragment of a service dog, separated from the body, submitted for forensic veterinary examination, indicate stripe-shaped skin tears in the form of wide flaps, a wedge-shaped defect of the greater tibia with an overlay of black oily substance in the centre of the bone grind and polished edges with a "metallic sheen". M. Smith-Blackmore & J. D. Bethard (2021), in their report on the analysis of dog bone injuries at different stages of healing, pointed out the expediency of collaborating with forensic anthropologists in resolving the issue of the age of such an injury. It is not possible to answer the question of the cause of death and the lifetime of the injuries in a categorical manner, as the researchers also emphasise. According to our expert hypothesis, the damage to the *v. saphena* is undoubtedly fatal. However, the soft tissues of the stump look somewhat anaemic, while the blood saturation of the edges of the crushed wound is not visually evident. Such haemostasis can be lifelong, provided that skeletal muscle fibres contract reflexively. The researchers believe that the time of fatal outcome is determined by two parameters: a decrease in the volume of circulating blood to a critical level or the time of direct collision with the moving elements of electric vehicles. Thus, in this expert case, the direct necessary causality is two-linked, since the initial cause of death is traumatic amputation at the level of the lower leg, the fatal complication is anaemia of internal organs, and the immediate cause is traumatic pain shock.

Fatal *transport-associated injury* was recorded in 18 (12.1%) dogs and 19 (12.7%) cats with combined injuries of different parts of the body. In the total number of fatalities caused by blunt objects, the statistical distribution of the number of such cases in dogs and cats is the same. Blunt force injuries (including catatrauma) were mostly bludgeoned and crushed wounds, which is clearly related to the mechanism of their formation.

Car-associated injury caused by the impact of a large blunt object has always been associated with cranial injury and/or brain contusion in dogs and cats. Damage to certain parts of the animals' bodies was accompanied by the formation of scalp wounds (Fig. 13). Admittedly, rapid death is directly caused by gross anatomical damage to the animal's body that is incompatible with life, such as defragmentation of the head and torso, and damage to vital organs (Fig. 14). Thus, in the case of a combination of gross anatomical destruction of the body of a cat whose death occurred as a result of a complete collision with the wheels of a motor vehicle (Fig. 15), it was not possible to isolate a fatal injury. Therefore, it is necessary to state the death of the animal from the totality of the injuries found, expressed in the following formulation: the cause of death of the cat whose cadaver was submitted for forensic veterinary examination was a combined injury to the head, torso, thoracic, and pelvic limbs caused by a blunt object with a large surface. According to the results of the forensic veterinary examination, a direct and necessary causal link was established between the injuries caused by the pressure of high kinetic energy at high speed on the entire area of the animal and the consequences that occurred in the form of the cat's *exitus letalis*. In this expert case, the causality is one-link, because the initial cause of death was also the immediate cause of death, which occurred due to gross anatomical destruction of body parts incompatible with life.

Figure 13. Scalped wound of the right pelvic limb in a cat cadaver following a car accident
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 14. Gross anatomical destruction of the head of a cat cadaver caused by a vehicle collision
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 15. Anatomical destruction of the torso of a cat cadaver after being hit by a vehicle
Notes: *macro photo*
Source: *developed by the author of this study*

The structure of fatal road traffic injuries to animals has always included severe combined body trauma, which in the vast majority of cases was combined with craniocerebral trauma.

Thus, during the X-ray examination of the experimental cadaver of a dog injured in a road accident as a result of a collision with a moving vehicle, signs of diaphyseal fractures of the long tubular bones of two segments of the pelvic limbs (thigh and lower leg) with distraction of bone fragments into skeletal muscles were found (Fig. 16). The internal examination of the dog's cadaver revealed injuries inherent in a tangential collision with a vehicle: considerable haemorrhage in the mediastinal organs (Fig. 17), contusion, and focal haemorrhage in the soft tissues of the neck (Fig. 18).

Figure 16. Dog cadaver fragment with diaphyseal fractures of the femur and tibia
Notes: *photographic screen of X-ray in LL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

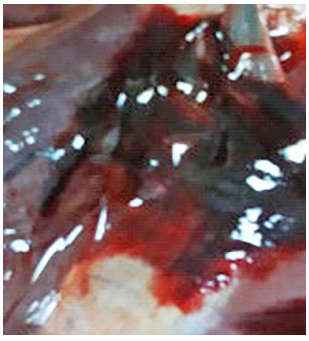

Figure 17. Haemorrhage into the mediastinum of a dog cadaver in case of death from a tangential collision with a motor vehicle
Notes: *macro photo*
Source: *developed by the author of this study*

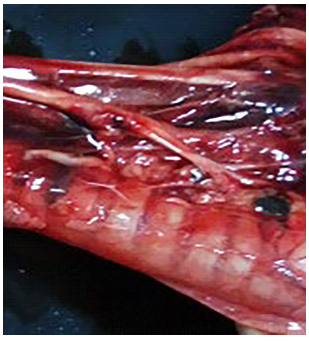

Figure 18. Focal haemorrhages in the soft tissues of the neck of a dog cadaver in case of death from a tangential collision with a motor vehicle
Notes: *macro photo*
Source: *developed by the author of this study*

The cause of death of the dog, whose cadaver was submitted for forensic veterinary examination, was a combined trauma in the form of open fractures of the left femur with a ruptured femoral vein, an open fracture of the left tibia, traumatic lung injuries, contusion of the spleen and liver parenchyma with ruptured capsules of these organs, numerous tears of the soft abdominal wall muscle tissue with entrapment of internal organs under the skin of the left lateral abdominal wall. The severe injuries found on the cadaver of the experimental dog were accompanied by the development of traumatic shock and led to its death. We argue that the nature and multifocal localisation of the injuries indicate their formation as a result of a single impact followed by compression with a large surface of a hard blunt object, specifically, a moving vehicle.

Considering the above, the main (initial) cause of death of the animal was a combined trauma with damage to the main vessel, and the immediate cause of death was anaemia of internal organs due to haemorrhagic shock. In this expert case, there is a direct, necessary, single-link causality between the injury sustained by the animal and its death, because the rupture of the main vessel, without any outside veterinary assistance, certainly causes the death of the animal.

In the expert case of a cat *falling from* a nine-storey building, the animal died on the first day of the post-traumatic period in a veterinary hospital. During the external examination of the cadaver's oral cavity, the following injuries were noted: oronasal fissure (Fig. 19), open fracture of the vault bones with violation of the integrity of the dura mater and the anatomical base of the skull (Fig. 20).

Figure 19. Oronasal fissure of a cat cadaver in case of death from catatrauma
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 20. Bone structure of the calvaria and skull base of a cat cadaver in case of death from catatrauma
Notes: *photo screen of X-ray tomography (32GE Optima CT 540)*
Source: *developed by the author of this study*

Figure 21. Cerebral cavity of a cat cadaver in case of death from catatrauma
Notes: *1 – subdural haemorrhage. Photoscreen of magnetic resonance imaging (ECHELON Smart 1.5T)*
Source: *developed by the author of this study*

Magnetic resonance imaging images of the cadaveric brain indicate a subdural haemorrhage into the cranial cavity (Fig. 21.1), tear of the *articulatio atlantooccipitalis* ligaments, as evidenced by increased unnatural head mobility and a compression fracture of the antrum. No other injuries were diagnosed during the autopsy. The factual patterns together explain

a certain mechanogenesis of the injuries: trauma to the skull bones with fractures of the calvaria and skull base and tears and haematomas of soft tissues in the corresponding area, which indicates contact of the animal's head with a blunt object with a large surface area or an animal hitting a hard surface (such an object, for instance, may be dense soil or asphalt pavement). All the injuries found on the expert's cadaver were caused during its lifetime, simultaneously, as a result of a catatrauma with a gravitationally accelerated fall velocity, and death occurred instantly. It was found that such a macromorphological picture is typical for catatrauma. In this expert case, the main (initial) cause of death was an open head injury with contusion of the brain matter, while the immediate cause was the destruction of the animal's medulla oblongata due to the distraction of the first cervical vertebrae. When presenting arguments for the cause of death of an animal, attention should also be focused on the presence of a fatal complication – a subdural haematoma. At the same time, V. Lemishevskyi (2021), based on the findings of a sectional study using complete evisceration of the organs of the cadaver, argues that in cases of catatrauma, even with premortem diagnosed craniocerebral contusion of an animal, a strong blow to the chest during a fall from a great height causes bludgeoning of the lungs and heart, which is potentially life-threatening in itself, which must be considered in the presence of competing causes of death. The expert established the following injuries to the cat's cadaver: blunt trauma to the chest with blood imbibition of muscle tissue, haemorrhages in the muscle fascia, ligament rupture, and compression fracture of the transverse rib process of the fifth cervical vertebra. An in-depth analysis of the results of the examination of the cadaver of this animal indicates that the necessary causality between the injuries and the death of the cat is direct, but two-linked. The initial cause of death and its complications are phenomena that are not tanatogenetically related, which is consistent with the data of M. Skrypka *et al*. (2023), who showed methods for identifying and differentially diagnosing spinal injuries and found out the pathomorphogenesis of cervical vertebral distraction in polytrauma in criminal proceedings. In explaining the mechanogenesis of cervical spinal cord injuries caused by sharp traumatic neck flexion, researchers have noted partial or complete ruptures of the intervertebral disc and destruction of vertebral ligaments. It was found that hyperaemia of the vessels of the meninges of the brain was a consequence of blood circulation disorders in the occipital and caudal arteries of the meninges, and mechanical destruction of intervertebral discs or rupture of cervical vertebrae ligaments led to disorders of innervation of various organs and systems of the body and was fatal for the animal. It was proved that distraction trauma of the cervical spine led to oedema and haemorrhage in the caudo-ventral part of the brain substance. A direct correlation between vagus nerve irritation and hyperaemia of large (aorta and pulmonary artery trunk) vessels, caudal mesenteric artery and, accordingly, hyperaemia of the thoracic and abdominal cavities was demonstrated. Thus, the findings obtained by the researchers coincide with observations presented in this study. However, such contradictory information indicates that when addressing the questions of the investigating authorities regarding catatrauma, it is important to determine the landing zone and the impact of the applied force vector.

The trend towards an increase in the number of cases of *firearms-associated injuries* in animals is noteworthy, which undoubtedly reflects certain processes in society and certainly indicates the recent spread of firearms among the population. The number of wound holes in animals caused by this type of weapon in some

expert cases indicates particular cruelty in the treatment of the animal, and the location of the wound holes indicates their chaotic localisation.

Thus, during the external examination of the scalp of a dog (Fig. 22), whose cadaver was submitted for forensic veterinary examination, numerous injuries, round and oval in shape, with a diameter of 0.5 cm to 0.9 cm, were visually noticeable, while the skin itself was covered with red spots appearing to be blood.

Figure 22. The skin of the left lateral surface of the dog's head with wound holes located in a concentrated manner
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 23. The head of a dog cadaver with objects of "metallic" density
Notes: *photographic screen of radiograph in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

The X-ray comparison of the relevant anatomical area proves the presence of more than twenty objects with a cylindrical shape and pyramidal contact surface, X-ray contrast, "metallic" density in the soft tissues of the dog's head (Fig. 23). The X-ray shows that they are topographically localised mainly in the soft tissues of the vault of the skull and, to a lesser extent, in the nasal bones and skull base, in the skeletal muscles of the neck, and correspond to the location of the wound holes on the skin. As for the skin of the pelvic limbs of the experimental dog cadaver (Fig. 24), it also shows numerous wound openings, alike in their macromorphological features to those found during the external examination of the head.

Analysing the X-ray images of the dog's head and pelvic limbs taken in RL (Fig. 25) and DV (Fig. 26) projections, it was found that all the bullets were located in the soft tissues of the body at different angles, which may indicate shots from different directions from a relatively short distance. Considering this, we agree with the opinion of M. Grela *et al*. (2021) on the expediency of using the radiological method of examining an animal cadaver along with a classical autopsy to assess the fatal consequences of gunshot wounds to dog cadavers. Furthermore, the researchers note that damage caused by gunshots is correlated with the calibre, kinetic energy of the projectile, and its initial velocity, as well as the distance between the muzzle of the gun and the object of the shot.

Figure 24. The skin of the lateral surface of the right pelvic limb of a dog cadaver with rounded wound openings
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 25. Fragment of the right pelvic limb of a dog cadaver with objects of "metallic" density
Notes: *photographic screen of radiograph in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

Figure 26. Fragment of the back of a dog cadaver with objects of "metallic" density
Notes: *photographic screen of radiograph in DV projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

During the internal examination of the dog's cadaver, it was found that the through soft tissue damage began with a rounded entrance wound with a 0.9 cm diameter soot rim located on the skin in the middle third of the right thigh along its lateral surface (Fig. 27). When a bullet enters soft tissue, it destroys the skin and denser tissue due to its high kinetic energy, forming a rounded hole. It was found that the local defect of the skin of the "minus tissue" type is probably caused by hydrodynamic and contusion effects on the tissue along the trajectory of the traumatic weapon, which is confirmed by our observations. Next, the wound channel is located through the subcutaneous tissue and muscles in the direction from top to bottom, from front to back, and ends with an oval-shaped wound with irregular edges in the distal third of the right thigh along its medial surface (Fig. 28). Thus, the above bodily injuries have morphological signs of wounds, each of which was separately caused by a shot from a firearm with a compact projectile (bullet) that had a relatively low contusion-dynamic impact on the inner surface of the skin of the dog's cadaver when it left the body.

Explaining the mechanogenesis of the injuries, we argue that the wounds of the right thigh were caused by the penetrating effect of a projectile with high kinetic energy made of metal compounds typical of a jacketed bullet fired in the specified tangential direction. The wounds found are not in the required direct causal relationship with the death of the animal. Considering the above, we believe that even if the pain and suffering experienced by the animal before death did not cause the development of a shock state, the large number

of haemorrhages caused by numerous bullet wounds, together with the systemic changes in the animal's haemodynamics, can be considered a variant of haemorrhagic syndrome, which may have independent thanatogenetic significance and be the cause of the animal's death.

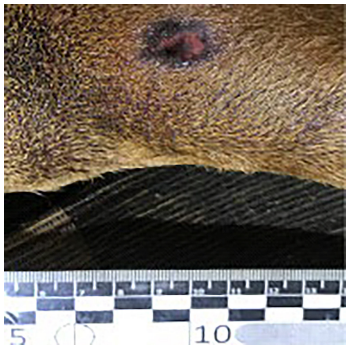

Figure 27. Entrance wound of a dog cadaver with a skin defect of the "minus tissue" type
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 28. Exit wound of a dog cadaver
Notes: *macro photo*
Source: *developed by the author of this study*

Thus, in the expert practice of mechanical trauma, there is often a combined simultaneous effect of pathogenic factors, which, admittedly, significantly complicates the analysis of further thanatogenesis in each case. It is advisable to point out that despite the diversity of the macromorphological picture of the lethal consequences of mechanical trauma in animals, acute haemodynamic disorders are the basis of thanatogenesis. Such premortem conditions are explained by a decrease in the intensity of hemoperfusion, against which hypovolaemic shock occurs with specific causes in the form of mechanical injuries, specifically, contusion of internal organs with violation of their anatomical integrity, distraction of limbs with soft tissue damage. Notably, in such cases, there was usually considerable blood loss caused by extensive injuries. Haemorrhage plays a triggering role in the thanatogenesis of traumatic shock, as acute blood loss causes an imbalance between the circulating blood volume and the blood vessels. M. Skrypka *et al*. (2024) reached analogous conclusions within the framework of a pre-trial investigation into cruel treatment that led to the death of an animal (forensic veterinary examination of a dog cadaver with signs of polytrauma). According to the results of the forensic veterinary examination, it was established that the injuries were caused by repeated mechanical interaction (blows) of the left side of the body with a blunt object. The serious injuries included, specifically, disruption of the connection between the bones of the hyoid skeleton and laryngeal cartilage, cerebral haemorrhage, disruption of the integrity of the ligamentous apparatus of the atlanto-occipital joint, fracture of the arch of the first cervical vertebra, mechanical trauma to the subclavian and internal thoracic artery with disruption of their anatomical integrity. Thus, the injuries caused (multiple combined trauma) are in direct causality with the death of the animal. Experts argue that the fatal outcome was the result of hypovolaemic shock caused by violation of the integrity of the subclavian artery and internal thoracic artery by rib fragments. Progressive hypovolaemia clearly reduces

venous pressure in the vessels and provokes the development of transient arrhythmia, which results in a decrease in the minute output of the heart pump. Decompensation of such conditions against the background of acute hypoxemia occurs due to the supra-threshold effect of catabolic products on the vital centres of the animal's medulla oblongata. Excessive exposure to extreme temperatures, according to the data obtained, caused death in 10 (6.6%) dogs and 8 (5.4%) cats.

During forensic veterinary sectional examinations of animal cadavers whose deaths were caused by *general hypothermia*, two permanent non-random macromorphological signs were found in each expert case. Firstly, the dog's non-trivial "compact" body position, which stayed unchanged after death, is noteworthy (Fig. 29). Forensic veterinary autopsy of animal cadavers indicates small-dot haemorrhages in the apical parts of the gastric mucosa folds (Wischnewsky spots), which are usually linearly sinuous and small in size (up to 0.3×0.5 cm), against the background of general erythema (Fig. 30). Histomorphological examination of the stomach samples of the experimental dog cadaver taken from loci with visually pronounced hyperaemia of the mucous membrane revealed that it was covered with a single-layer foveal epithelium, with changes manifested in the form of desquamation of cylindrical and prismatic cells (Fig. 31.1). Beneath the epithelium is a submucosal layer consisting of loose connective tissue, blood vessels, and dilated glandular excretory ducts. Glands with moderate secretion are located in the lamina propria in the direction from the gastric mucosa to its muscular lamina, which separates the mucosa from the submucosa. The mucosal lamina propria between the glandular ducts and the submucosa are reactive, intensely infiltrated with conglomerates formed by erythrocytes and neutrophils.

Figure 29. Appearance of a dog cadaver in case of death caused by general hypothermia

Notes: *macro photo*

Source: *developed by the author of this study*

Figure 30. Diapedetic haemorrhage in the cardiac part of the stomach of a dog cadaver in case of death caused by general hypothermia

Notes: *macro photo*

Source: *developed by the author of this study*

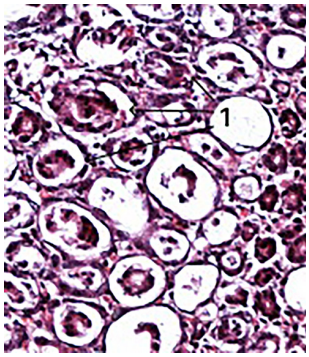

Figure 31. Histotopogram of the gastric mucosa epithelium of a dog cadaver

Notes: *1 – foci of epithelial desquamation with erythrocyte conglomerates. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*

Source: *developed by the author of this study*

Considering the above, we believe that at the onset of general hypothermia, the changes occurring in the animal's body are hypothetically reversible and limited to systemic

circulatory disorders. In this case, it is crucial to establish the duration of the state of emergency. As a result of the examination, it was established that death from cold injury occurs as a result of vasomotor collapse without icing of the body, and, therefore, the cadaver freezes after the animal's death. Proceeding from this expert hypothesis, the identified patterns of cold injury in animals are always postmortem in nature, conditioning the mechanogenesis of hypothermia. A certain resistance to the effects of low temperature on the animal body necessitates the development of microscopic damage by a sufficiently long exposure to low temperatures. Under such conditions, the animal takes a specific "compact" posture to maintain thermoregulation, followed by the mobilisation of reserve capabilities to maintain homeostasis, specifically, skeletal muscle glycogen is utilised. However, prolonged exposure to extremely low ambient temperatures is likely to cause a gradual overall decrease in the animal's body temperature against the background of anoxia and anaemia of peripheral tissues, including skeletal muscles, with a characteristic inhibition of the relevant biochemical processes in the body.

Thus, a direct, necessary causal link is logically argued between the established changes that occurred in the cadaver of an animal with a cold injury and its death. In the case of animals whose death was caused by *generalised overheating*, specifically burn injuries, an expert hypothesis about the conditions and cause of death can be built at the stage of external examination of such cadavers. Thus, the burnt hair of the experimental cat cadaver was caused by direct contact with the flame (Fig. 32).

Figure 32. General view of a cat's cadaver in case of death caused by burn injury
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 33. Swelling of the brain of a cat cadaver
Notes: *macro photo*
Source: *developed by the author of this study*

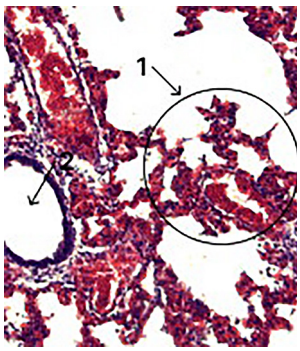

Figure 34. Histotopogram of the lungs of a cat cadaver with alveolar emphysema caused by burn injury
Notes: *1 – destruction of the alveolar septa with numerous diapedeses; 2 – intact alveolus. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*
Source: *developed by the author of this study*

Damage to animal carcasses associated with exposure to, for instance, a burning house, may conceal other changes. Therefore, it is necessary to verify the vital nature of their formation and substantiate the forensic veterinary diagnosis. The animal's open mouth indicates

terminal tachypnea and the development of respiratory failure caused by inhalation of toxic smoke against the background of hypercapnia and carbon monoxide poisoning. Erythema of the mucous membrane of the oral cavity and the back of the pharynx confirms an acute lesion of the animal's respiratory tract.

The autopsy of the cat's cadaver revealed patterns of cerebral oedema: the furrows of the hemispheres were visually smoothed, while the vessels were markedly blood-filled (Fig. 33), which was explained by hypoperfusion of the nervous tissue and fluid leakage from the narrowed vessels in the interstitium beyond the neurocytes caused by general hypovolaemia. Histomorphological examination of the lungs suggests the development of acute alveolar emphysema, because among the single intact alveoli (Fig. 34.2), numerous lesions of the membranes of the parenchyma with microdiapedeses (Fig. 34.1) were found due to their overstretching by air, which confirms the vital formation of these changes.

Thus, the above signs found in a cadaver with a burn injury, specifically, acute disorders of the haemocirculation of the brain and respiratory tract, are specific to establishing the cause of death of an animal due to general overheating.

In the overall structure of mortality, according to the sub-sample, *asphyxial death* was diagnosed in 19 (12.6%) dogs and 22 (14.6%) cats. Obtained by D. Araújo *et al*. (2021) analogous statistical information. Specifically, according to the researchers, most of the animals that were violently attacked were dogs (87%), outbred (55%), medium-sized (57%), male (58%), and died due to various causes, including asphyxiation (15%). It is known that the asphyxiated state is accompanied by decompensated hypoxia of vital organs, specifically, the brain and heart, which over time leads to the cessation of respiratory excursions due to central nervous system depletion, transient arrhythmia and, as a result, the onset of animal death.

Authors state that the mechanism of death of animals from mechanical asphyxiation, despite the variety of instruments of trauma, is the same. Based on the mechanogenesis, we consider mechanical asphyxia to be a traumatic injury, with the only difference being that the mechanical factor affects the locus of injury throughout the entire period of death, thereby constantly irritating the corresponding receptors of the reflexogenic zone and exacerbating the pathological manifestations of hypoxia in the animal's body. This hypothesis is confirmed by the subcutaneous dark red haematomas of the pelvic limbs, which were apparently formed as a result of the animal's body hitting hard surfaces during agonal convulsions at the time of the terminal pause.

Considering the above, we propose to detail the classification of animal deaths from mechanical asphyxiation depending on the nature of the traumatic factor and the place of its impact, with consideration of the case file. Considering the thanatological cases from our expert practice (Table 1), asphyxiological death of an animal can occur in cases of neck strangulation (e.g., with a rope), chest compression (e.g., with hands), obstruction of the respiratory tract (e.g., with dense objects), or aspiration (e.g., with liquids).

The thanatogenesis of mechanical asphyxia can be logically represented in two parts: firstly, the cessation of free air access causes the development of acute anoxia of the medulla oblongata, and secondly, damage to the neck stimulates vagal reflexes, causing sudden myocardial paralysis due to the development of bradycardia. However, in the premortem state, according to our clinical observations, the absence of respiratory excursions of the animal's chest precedes cardiac paralysis, which should

be considered from the standpoint of view of the semiotics of rapid death.

Therefore, when arguing for a forensic veterinary diagnosis of asphyxiated animal death, it is advisable to consider the genesis of death, where the initial (determining) and immediate causes of death coincide, while fatal complications in the form of cerebral anoxia and bradycardia are, in the causal aspect, competing links in thanatogenesis. Undoubtedly, in case of rapid death of animals, there is a need, firstly, to identify criteria that impartially substantiate the conclusion of a forensic veterinary expert, and secondly, to differentiate mechanical asphyxiation from other comparable conditions that result in sudden death.

It is during the implementation of the mechanism of animal death caused by asphyxiation that general signs are formed, which are proposed to be recorded at the relevant stages of forensic veterinary examination of the animal cadaver.

Thus, to substantiate the evidence of an animal's death from a specific type of asphyxia, it is logical to describe, first of all, the external general asphyxial signs (patterns of the first level of evidence). Thus, during the examination of the experimental cadaver of a dog whose death occurred as a result of *neck strangulation* by the locking system of a device for remote fixation of dogs, attention is drawn to the pronounced swelling of the muzzle, hyperaemia of the conjunctiva and sclera in the form of subconjunctival petechiae (Fig. 35), rounded small-point haemorrhages with a diameter of 0.3 cm in the area of the tongue root and damage from the teeth to the back of the tongue (Fig. 36), prolapse of the rectum due to relaxation of the sphincters (Fig. 37). W.-H. Huang *et al*. (2021) described death in such situations.

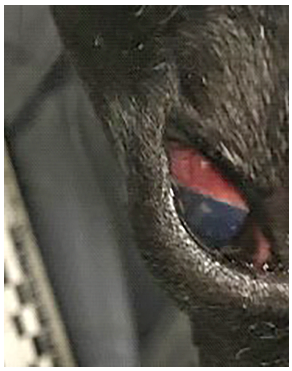

Figure 35. Conjunctival petechiae of the right eye of a dog cadaver in case of death from strangulation asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 36. "Pinching" of the tongue and haemorrhage of the oral mucosa of a dog cadaver in case of death from strangulation asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

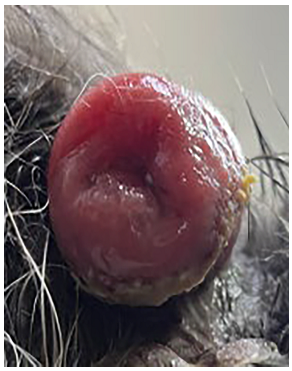

Figure 37. Prolapse of the rectum of a dog cadaver in case of death from strangulation asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

When determining the cause of death of a dog with external signs of violent death, the position of the cadaver's head with its unnaturally increased mobility against the background of an unexpressed postmortem contracture of the neck muscles is of particular note. External bleeding that contaminates the scalp is also caused by trauma to the tongue by canines (Fig. 38).

Radiological examination of the neck of the experimental dog cadaver in RL projection indicates anatomical instability of the cervical vertebrae at the level of the *articulatio atlantooccipitalis* (Fig. 39). Histotopograms of skeletal muscles obtained from the area of neck strangulation confirm signs of local soft tissue compression: thinning, flattening, and pressing of muscle fibres against each other, their dystrophy, compaction, compression, and desolation of blood vessels, waviness and rupture of myofibrils (Fig. 40.1).

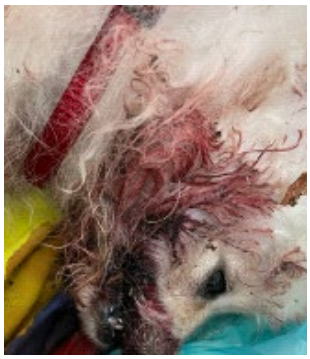

Figure 38. Contamination of the dog's head with blood due to strangulation asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

Figure 39. Rupture of the atlanto-occipital joint of a dog cadaver
Notes: photographic screen of X-ray in RL projection (*X-ray Device PCMAX-40HP*)
Source: *developed by the author of this study*

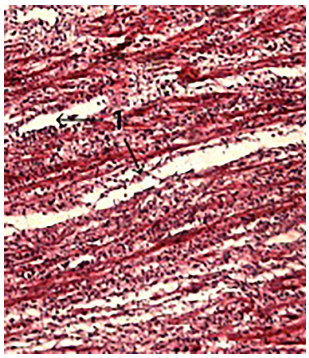

Figure 40. Histotopogram of the muscle tissue of the strangulated area of the neck of a dog cadaver due to local compression
Notes: *1 – deformation and tearing of muscle fibres. Haematoxylin and eosin, 10×40, (microscope "Granum R50")*
Source: *developed by the author of this study*

As for the peripheral organs of haemoimmunopoiesis, diametrically opposite morphological changes were observed in them. Thus, histological examination of the mandibular lymph nodes located topographically above the locus of strangulation revealed haemorrhages in the tissue above their capsule with simultaneous severe hyperaemia of the venules around and directly in the capsule of these nodes. The vessels of the lymph node are dilated and filled with blood cells, the focuses of microdiapenic haemorrhages are distributed evenly over the entire area of the histological specimen (Fig. 41.1), and the lumen of the vessel is filled with conglomerates of erythrocytes (Fig. 41.2).

The histomorphological examination of the spleen revealed the absence of pronounced microscopic changes. The outside is covered with a capsule made of dense fibrous fabric, which can be easily removed. Trabeculae, containing blood vessels, smooth muscle fibres and nerves, extend from the capsule. The white pulp covers a large area. It is organised into cylindrical clutches of lymphocytes that surround the central arteries that form the periarterial lymphoid sheaths. The red pulp consists of sinusoidal vessels and pulp bundles located between them. However, the segmental section shows visual anaemia (Sabinsky sign) and a slight scraping, which is confirmed by the findings

of histomorphological studies (Fig. 42). The erythrocytes are located in small clusters over the histotopogram area, unevenly (Fig. 43.1). During the forensic veterinary examination of the cadavers of animals whose deaths were caused by mechanical asphyxiation, general signs of asphyxiation of varying degrees of severity were identified.

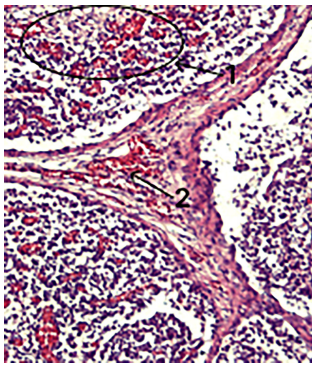

Figure 41. Histotopogram of a lymph node of a dog cadaver in case of death caused by strangulation asphyxia

Notes: *1 – diapedetic haemorrhages; 2 – erythrocyte conglomerates in the vessel lumen. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*

Source: *developed by the author of this study*

Figure 42. Segmental section of the spleen of a dog cadaver in case of death caused by strangulation asphyxia

Notes: *macro photo*

Source: *developed by the author of this study*

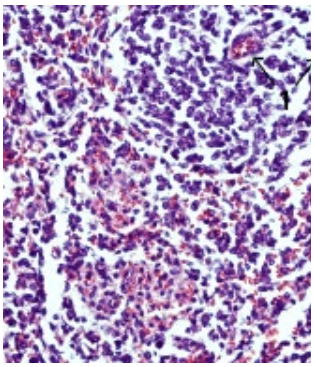

Figure 43. Histotopogram of the spleen of a dog cadaver in case of death caused by strangulation asphyxia

Notes: *1 – uneven accumulation of red blood cells. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*

Source: *developed by the author of this study*

In such cases, it is crucial to adequately interpret and distinguish between them, which is particularly true for the statement of internal general asphyxiological features (patterns of the first level of evidence). Specifically, the absence of dark red blood clots in large vessels, an "asphyxiated heart" due to blood stasis in its right half, venous hyperaemia of internal organs, multifocal spotted or punctate haemorrhages (Tardieu spots) under the epicardium (Fig. 44) and lung pleura (Fig. 45), emphysema with numerous ruptures of alveolar membranes and haemorrhages in them (Fig. 46.1) on a small number of intact structural elements of the parenchyma (Fig. 46.2).

In the array of animal deaths from mechanical asphyxiation, fatal neck strangulation ranks second. Notably, imitation of killing an animal by hanging has been encountered in our forensic practice. In contrast to humans, among whom hanging is one of the most common causes of violent death (Marrone *et al*. 2023), strangulation asphyxiation in animals is predominantly the result of cruelty. During the experimental suspension of animal cadavers two hours after death, local signs of strangulation were observed, specifically, subcutaneous haematomas, mucosal oedema, and skin compression, which is caused by the prolonged vertical position of the cadaver in the noose under the influence of gravity. Unlike the human neck, the neck of animals is densely covered with hair, which clearly determines the absence of a pronounced classical strangulation furrow, which

is not a permanent feature, but, accordingly, the main sign of death from strangulation. In this regard, the forensic veterinary expert's special attention should be focused on establishing the signs of intravital formation of fatal injuries. Thus, during the dissection of the neck skin of a dog whose death was reliably caused by strangulation asphyxia, there was a spilled blood imbibition of the muscles and subcutaneous tissue with a characteristic relief impression from the laryngeal cartilage and dermal oedema below the strangulation locus (Fig. 47).

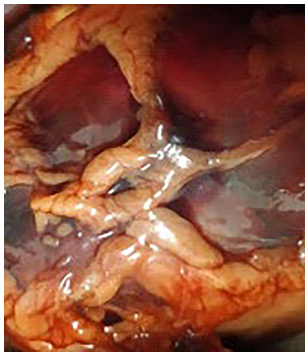

Figure 44. Spotted haemorrhage under the epicardium of a dog cadaver in case of death from asphyxiation
Notes: *macro photo*
Source: *developed by the author of this study*

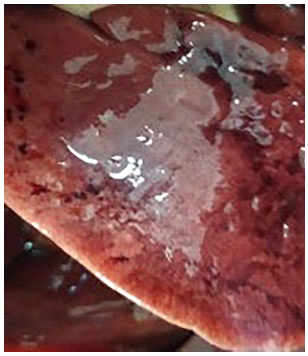

Figure 45. Point haemorrhages under the lung pleura of a dog cadaver in case of death from asphyxiation
Notes: *macro photo*
Source: *developed by the author of this study*

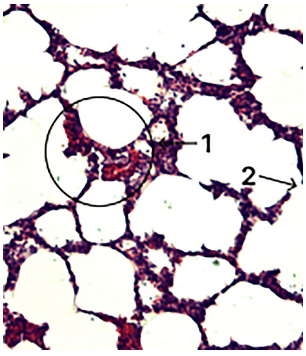

Figure 46. Histotopogram of the lungs of a dog cadaver in case of death from asphyxia with alveolar emphysema
Notes: *1 – haemorrhage and destruction of the alveolar membranes; 2 – intact alveolus. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*
Source: *developed by the author of this study*

Figure 47. Haematoma of the locus of strangulation of a dog cadaver
Notes: *macro photo*
Source: *developed by the author of this study*

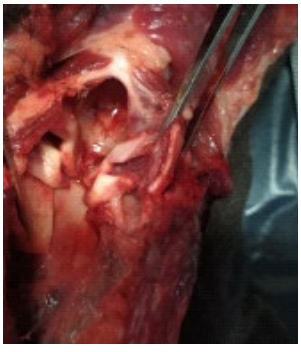

Figure 48. Blood leakage into the larynx of a dog cadaver due to strangulation asphyxia (sagittal section)
Notes: *macro photo*
Source: *developed by the author of this study*

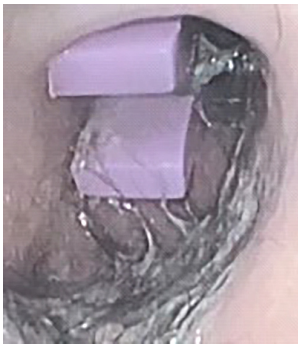

Figure 49. Foreign body in the laryngeal cavity of a dog cadaver
Notes: *photo screen of endoscopic examination (Olympus CLV-160)*
Source: *developed by the author of this study*

A sectional examination of the larynx of an experimental dog cadaver revealed signs of blood leakage into the cavity itself (Fig. 48), caused by damage to the surrounding blood vessels. In the absence of reliable macroscopic signs of intravital strangulation, we emphasise that the morphological picture of an animal cadaver must be supported by the results of histomorphological studies that reasonably document pathological patterns at the micro level, and a forensic veterinary expert can only reach a reasoned conclusion by considering structural changes at different levels of organisation, only in totality.

Summarising the above, we emphasise that in the death of animals caused by strangulation asphyxia, apart from general asphyxial signs, subspecific signs (patterns of the second level of evidence) were identified, namely, "pinching" of the tongue between the teeth, blood leakage from the mouth and nose above and below the locus of injury, hyperaemia of the nearest lymph nodes, spleen anaemia, diapedetic haemorrhages in the mucous membrane of the tongue root, deformation of the skeletal muscle fibres of the animal's neck at the locus of injury, which should be considered in the practice of forensic veterinary examination. N.M. Mazzante *et al*. (2020) cited cases of lethal strangulation of the neck of animal cadavers with intimal tears, tears of the carotid arteries and jugular veins, damage to the ligaments and muscles of the neck, cartilage of the larynx and trachea, and the hyoid apparatus. In our expert practice, we have not detected the specified phenomena.

Structural and functional changes that occur in rare accidents of mechanical obstruction of air access caused by obstruction of the *respiratory* tract of animals by foreign objects are conditioned by the direct effect of the obstructing factor on the laryngeal interoceptors, followed by the development of a reflex response in the form of a combination of acute haemodynamic disorders and metabolic syndrome, which together lead to rapid death (Fig. 49). During the forensic veterinary internal examination of the cadavers of such animals, only general asphyxiological signs are found.

From the standpoint of forensic veterinary examination, it stays relevant to establish subspecies-specific signs of death caused by *aspiration asphyxiation*, since drowning, as a separate variant of animal killing, is most common in expert practice. In this context, the death of an animal as a result of fluid aspiration can occur in certain pathological conditions or processes; however, such a lethal outcome is classified as a non-violent death and occurs mainly during hospitalisation in veterinary medicine. However, in case of suspicion of violent death caused by drowning, the forensic veterinarian should pay special attention to the argumentation of a direct causal link, since, according to our observations, during a long stay of the animal cadaver in water, the fluid can fill the lung parenchyma through direct entry into the respiratory tract or by diffusion caused by emphysematous biotransformation.

Thus, during the external examination of the examinee cadaver of a kitten whose death occurred due to drowning and which was removed from the water immediately after death, a fine bubbly light-coloured foam around the nostrils and mouth was visually noticeable (Fig. 50).

The autopsy of the respiratory tract shows that similar fluid also fills the lumen of the trachea, but in the bifurcation area and below, in the bronchi, it has a pinkish tint (Krushevsky sign). The lungs appear to be enlarged in volume, with pronounced rounded edges, "marbled" in colour (Fig. 51): light red areas alternate with light grey oval spots. The latter are subpleural haemorrhages (Rasskazov-Lukomsky-Paltauf sign) and are formed as a result of destruction of pulmonary acini capillaries due to excessive stretching and rupture in the setting of acute alveolar emphysema. A pink, foamy liquid may flow freely from the surface of the lung incision.

Figure 50. Light foamy liquid in the mouth of a kitten cadaver in case of death by drowning
Notes: *macro photo*
Source: *developed by the author of this study*

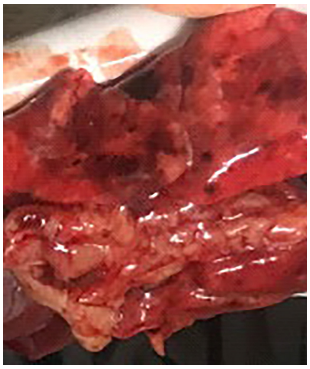

Figure 51. Pronounced haemorrhages under the lung pleura of a kitten cadaver in case of death by drowning
Notes: *macro photo*
Source: *developed by the author of this study*

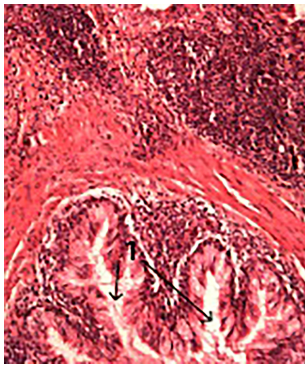

Figure 52. Histotopogram of pulmonary acinus of a kitten cadaver in case of death by drowning
Notes: *1 – the lumen of the bronchioles is filled with light red fluid. Haematoxylin and eosin, 10×40, (Granum R50 microscope)*
Source: *developed by the author of this study*

Histomorphologically, the lumen of the bronchioles was found to be filled with fluid with red blood cells (Fig. 52.1), and the alveolar vesicles were in a state of congestive hyperaemia, which was confirmed by G. Piegari *et al*. (2019), who obtained analogous macroscopic and microscopic findings.

Thus, the signs found in the experimental cadaver prove the death of the animal by thanatogenesis of aspiration asphyxia caused by drowning. In terms of the death of animals caused by asphyxiation as a result of *compression of the chest cavity*, in the practice of forensic veterinary examination, such cases are rare. This was confirmed by Kr. Prihirunkit (2022) in an alternative study of dog cadavers that died due to chest compression by hands. Undoubtedly, excessive compression of the animal's chest limits the number of respiratory excursions and, subsequently, due to pressure, disrupts lung vascularisation. Pressure on the chest contributes to an increase in partial pressure in the pleural cavities, is accompanied by overstretching and rupture of the microcirculatory vessels and causes the development of acute hypoxia in the setting of hypercapnia.

The forensic veterinary diagnosis of compression asphyxia can be made only in the absence of "active" organ nosology, prolonged crush syndrome, gross trauma to the chest, or penetrating injuries to the chest, as such injuries cause pulmonary atelectasis, which has independent thanatogenetic significance. Thus, during the external examination of the experimental cadaver of a neonatal puppy that died due to an accident caused by another dog squeezing the abdomen and thorax in the anteroposterior direction, the presence of subconjunctival haemorrhages and an "ecchymotic mask" of the skin of the oronasal part of the head and distal thoracic limbs was detected (Fig. 53).

Cardiosternal contact, verified by radiological examination of the chest of the cadaveric puppy in the RL projection, indicates no signs of pneumothorax (Fig. 54). The autopsy data confirm the expert hypothesis of compression of the chest cavity organs, as the cadaver

revealed massive dark red infarcts in the cranial lobes of the lungs, relief of the inner surfaces of the lungs from the heart, their atelectasis against the background of venous hyperaemia, and a liquid state of blood in the heart chambers and large blood vessels (Fig. 55).

Figure 53. "Ecchymotic mask" of the head and thoracic limbs of a puppy cadaver in case of death from compression asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

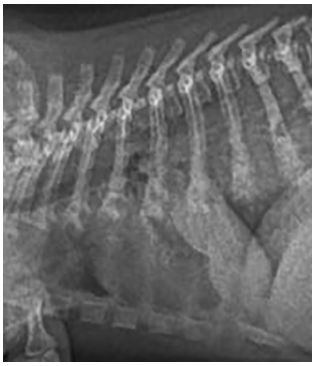

Figure 54. Pulmonary atelectasis of a puppy cadaver in case of death from compression asphyxia
Notes: *photographic screen of radiograph in RL projection (X-ray Device PCMAX-40HP)*
Source: *developed by the author of this study*

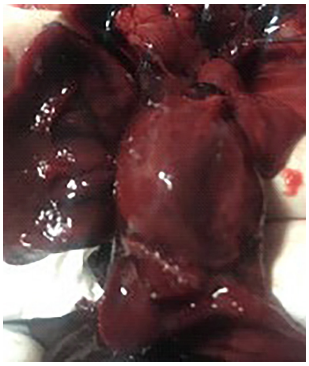

Figure 55. Appearance of the organ complex of the chest cavity of a puppy cadaver in case of death from compression asphyxia
Notes: *macro photo*
Source: *developed by the author of this study*

Thus, an objective basis for establishing causal relationships in critical conditions of animals with fatal consequences of mechanical and thermal trauma and asphyxiation is the establishment of morphological positions of fatal injury, reflected in the form of a forensic veterinary diagnosis, expressed in thanatogenetic and nosological forms, integrated with each other. From the standpoint of evidence-based veterinary medicine, we consider it necessary to selectively distinguish all morphological signs identified during the forensic veterinary examination of an animal cadaver by levels with the obligatory substantiation of the thanatognomic criteria inherent in a particular subspecies of violent animal death.

Thus, when a forensic veterinary expert is arguing for a conclusion on the cause of death, we believe that it is necessary to rely on the main links of thanatogenesis to resolve certain issues in the construction of the diagnosis, considering the semiotics of the injury. Considering the above, it is advisable to distinguish the initial cause of death of an animal according to the principle of complete completion of the links of the intra-nosological cause-effect relationship: the main cause of death is considered to be a nosological unit that, through the cause-effect relationship of pathomorphogenesis, ends with the direct cause of death.

Conclusions

For the first time in Ukraine, the authors of this study substantiated the cause-and-effect relationships in the genesis of violent death of animals caused by haemodynamic disorders and hypoxemia based on the findings of original research using the proposed approach with the identification of thanatognomonic patterns according to a two-level system of

evidence. It was substantiated that irreversible disorders of haemodynamics and hypoxia are involved in the thanatogenesis of animal death caused by mechanical injuries, thermal trauma, and mechanical asphyxiation. Based on such approach, it is necessary to assess the area of pathological changes in internal organs that are incompatible with life and to build an "expert hypothesis" about the determining cause of the animal's death.

To follow the principles of evidence-based veterinary medicine, we consider it necessary to selectively distinguish all morphological positions identified during the forensic veterinary examination of an animal cadaver into two levels with the obligatory substantiation of the thanatognomonic criteria inherent in a particular subtype of violent death of an animal.

The patterns of rapid death of animals of the first level of evidence common to the fatal consequences of mechanical trauma and mechanical asphyxiation were established as follows: absence of blood clots in large-calibre vessels, congestive venous hyperaemia of internal organs, multifocal spotted or punctate haemorrhages (Tardieu spots) under the epicardium and pleura of the lungs, alveolar emphysema of the lungs.

Proven patterns of mechanical asphyxia of the second level of evidence: "pinching" of the tongue between the teeth, blood leakage from the mouth and nose above and below the locus of injury, hyperaemia of the nearest lymph nodes, Sabinsky sign, diapedetic haemorrhages in the mucous membrane of the tongue root, deformation of the skeletal muscle fibres of the animal's neck at the locus of injury, Krushevsky sign, Rasskazov-Lukomsky-Paltauf spots. The cause of death of the animals due to generalised overheating as a result of brain swelling and hyperaemia of its membranes was substantiated. A reliable sign of death in the case of general hypothermia, the Wischnewsky spots, was found.

Specific signs of traumatic injury (patterns of the second level of evidence) were identified: pleomorphism of the body injury, acute blood loss, general anaemia of the circulatory anaemic type. It was found that the most common adverse effects of traumatic illness in animals are caused by life-threatening injuries, namely: gross anatomical destruction (crushing or separation) of the body, significant damage to vital organs (e.g., heart tamponade with blood due to extra-mural infarction, brain and/or heart contusion); acute bleeding: external and internal; obstruction of major vessels by traumatic emboli (air, tissue, etc.); mechanical asphyxia: aspiration of the respiratory tract with blood and traumatic laryngeal edema; combined polytrauma; incompatible functional disorders caused by acute organ failure and/or pain shock. The new data obtained should be implemented in the practice of forensic veterinary examination of animal cadavers.

The prospect of further research will be the application of the thanatogenetic approach to the formulation of a forensic veterinary diagnosis in cases of fatal haemostasis and cardiac death of animals.

Acknowledgements

None.

Conflict of Interest

None.

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Танатогномонічне обґрунтування судово-ветеринарного діагнозу за смерті собак і котів внаслідок розладів гемодинаміки та гіпоксемії

Роман Казанцев

Аспірант
Державний біотехнологічний університет
62341, вул. Академічна, 1, с. Мала Данилівка, Україна
https://orcid.org/0000-0002-4479-1516

Іван Яценко

Доктор ветеринарних наук, професор
Державний біотехнологічний університет
62341, вул. Академічна, 1, с. Мала Данилівка, Україна
https://orcid.org/0000-0001-8903-2129

Анотація. Нині в Україні відсутні юридично закріплені регламентовані процедури проведення судово-ветеринарної експертизи трупів тварин, що ускладнює об'єктивну кваліфікацію правоохоронними органами форм адміністративних та кримінальних правопорушень у рамках досудового розслідування А тому, особливої актуальності набувають науково обгрунтовані результати дослідження у сфері поводження з тваринами. У роботі поставлено за мету – обґрунтувати причинно-наслідкові зв'язки у генезі насильницької смерті тварин внаслідок механічних ушкоджень, термічної травми та механічної асфіксії з виокремленням танатогномонічних патернів за дворівневою системою доказовості. Використовували методи комплексного судово-ветеринарного дослідження трупів тварин із наступною логіко-гносеологічною обробкою результатів. Аргументовано, що головними ланками танатогенезу у разі смерті тварин від зазначених видів є незворотні порушення гемодинаміки та гострої гіпоксемії. На підставі такого підходу, запропонована оцінка площі несумісних із життям патологічних ушкоджень внутрішніх органів із подальшою «експертною гіпотезою» щодо визначальної причини смерті тварини. Виокремлені морфологічні позиції судово-ветеринарного діагнозу у вигляді танатогномонічних позицій, притаманних певному підвиду насильницької смерті тварини, за двома рівнями доказовості та доведена їх критеріальна інформативність. Встановлені патерни швидкої смерті тварин першого рівня доказовості, спільні для фатальних наслідків механічної та термічної травми і механічної асфіксії: «асфіктичне серце», застійна венозна гіперемія внутрішніх органів, ознака Тард'є, альвеолярна емфізема легенів. Селективно рандомізовані патерни другого рівня доказовості,

показана їх видоспецифічність. Деталізовані обставини, за яких у тварин виникають фатальні механічні і термічні ушкодження та асфіксія, обґрунтовані механізми настання смерті. Акцентована увага судово-ветеринарних експертів на особливостях аргументації у висновку необхідного прямого причинно-наслідкового зв'язку генезу насильницької смерті. Отримані результати з дотриманням стандарту доказовості «дослідження об'єкта судово-ветеринарної експертизи на різних морфологічних рівнях» рекомендуються до впровадження у практику судово-ветеринарної експертизи трупів тварин

Ключові слова: тілесні ушкодження; термічна травма; механічна асфіксія; танатогенез тварин; аргументація висновку експерта