32. Rosenberg DR, Andrade CX, Chaparro AP, Inostroza CM, Ramirez V, Violant D, et al. Short-Term Effects of 2% Atorvastatin Dentifrice as an Adjunct to Periodontal Therapy: A Randomized Double-Masked Clinical Trial. J Periodontol. 2015;86(5):623-30.
doi: https://doi.org/10.1902/jop.2015.140503

33. Rosenberg DR, Kernitsky JR, Andrade CX, Ramirez V, Violant D, Nart J. Atorvastatin-Medicated Dentifrice Significantly Inhibits CD4+ T Cell Proliferation: In vitro Pilot Study. Int J Morphol. 2017;35(2):394-402. doi: https://doi.org/10.4067/S0717-95022017000200002

34. Sakoda K, Yamamoto M, Negishi Y, Liao JK, Node K, Izumi Y. Simvastatin drcreases IL-6 and IL-8 production in epithelial cells. J Dent Res. 2006;85(6):520-3. doi: https://doi.org/10.1177/154405910608500608

35. Sangwan A, Tewari S, Singh H, Sharma RK, Narula SC. Effect of hyperlipidemia on response to nonsurgical periodontal therapy: Statin users versus nonusers. Eur J Dent. 2016;10(1):69-76.
doi: https://doi.org/10.4103/1305-7456.175685

36. Saver BG, Hujoel PP, Cunha-Cruz J, Maupomé G. Are statins associated with decreased tooth loss in chronic periodontitis? J Clin Periodontol. 2007;34(3):214-9. doi: https://doi.org/10.1111/j.1600-051X.2006.01046.x

37. Seidman LM, Aichelmann-Reidy MB, Bashirelahi N. What every dentist should know about statins. Gen Dent. 2017;65(5):66-69.

38. Shah SR, Werlang CA, Kasper FK, Mikos AG. Novel applications of statins for bone regeneration. Natl Sci Rev. 2015;2(1):85-99.
doi: https://doi.org/10.1093/nsr/nwu028

39. Sinjab K, Zimmo N, Lin G-H, Chung M-P, Shaikh L, Wang H-L. The Effect of Locally Delivered Statins on Treating Periodontal Intrabony Defects: A Systematic Review and Meta-Analysis. J Periodontol. 2017;88(4):357-67.
doi: https://doi.org/10.1902/jop.2016.160384

40. Subramanian S, Emami H, Vucic E, Singh P, Vijayakumar J, Fifer KM, et al. High-dose atorvastatin reduces periodontal inflammation: A novel pleiotropic effect of statins. J Am Coll Cardiol. 2013;62(25):2382-91. doi: https://doi.org/10.1016/j.jacc.2013.08.1627

Стаття надійшла до редакції
07.12.2020

UDC 616-001-07:340.6(048.8)
https://doi.org/10.26641/2307-0404.2022.2.260063

N.M. Erhard [*]***,***
A.M. Biliakov,
O.E. Volobuiev

ESTABLISHMENT OF LIFETIME AND PRESCRIPTION OF INJURY IN FORENSIC MEDICAL PRACTICE (literature review)

Bogomolets National Medical University
Mechnikova str., 5, Kyiv, 01133, Ukraine
Національний медичний університет імені О.О. Богомольця
вул. Мечникова, 5, Київ, 01133, Україна
[*]*e-mail: ergard2017@ukr.net*

Цитування: Медичні перспективи. 2022. Т. 27, № 2. С. 34-38
Cited: Medicni perspektivi. 2022;27(2):34-38

Key words: *forensic assessment, lifespan of injury, duration of death, death*
Ключові слова: *судово-медична оцінка, зажиттєвість ушкодження, тривалість вмирання, смерть*
Ключевые слова: *судебно-медицинская оценка, прижизненность повреждения, продолжительность умирания, смерть*

Abstract. Assessing survival and prescription of injury establishment in forensic medical practice (literature review). Erhard N.M., Biliakov A.M., Volobuiev O.E. *Determining the prescription of organ and tissue damage in forensic practice is of pivotal role in establishing an objective picture of the facts and circumstances. Nowadays, when the latest research methods and modern laboratory and instrumental equipment appear, there is a need to improve forensic diagnostics to establish the prescription of injuries. Although experts and scientists are trying to invent new methods and techniques for diagnosing the age of injury, this area of research will not lose relevance, given the complexity of solving problems. The purpose of this work is to analyze literature data on the use of various diagnostic methods in forensic practice to establish the prescription of injuries and assessing survival. In our study we analyzed scientific papers and data of international scientific literature on the problem of various diagnostic methods in forensic practice to establish the prescription of injuries and assessing survival. Methods used: scientific research, analytical and generalizing. The authors cite publications that set out the methods and criteria to address this issue. In particular, promising areas of application of histological, immunohistochemical methods, postmortem computed tomography are shown. The issues of establishing the prescription of cranio-cerebral injuries are considered. The role of manifestations of the body's systemic response to trauma, in particular, the neuroendocrine system, is also shown. Examples of the use of non-ischemic heart disease to diagnose the duration of dying are given. The role of tropopnin I, creatine kinase, brain natriuretic peptide (NT-pro BNP) in the diagnosis of the duration of the traumatic process is shown. Based on a review of the literature, the authors conclude that new methods and criteria for assessing survival and prescription of injuries in forensic practice in order to unify the results of the study and avoid diagnostic errors are promising.*

Реферат. Установлення зажиттєвості та давності травмування в судово-медичній практиці (огляд літератури). Ергард Н.М., Біляков А.М., Волобуєв О.Є. *Визначення давності ушкоджень органів та тканин у судово-медичній практиці має ключове значення для встановлення об'єктивної картини обставин подій. У наш час, коли з'являються новітні методи дослідження та сучасне лабораторно-інструментальне обладнання, виникає необхідність у покращенні судово-медичної діагностики встановлення давності заподіяння ушкоджень. Хоча експерти та науковці й намагаються винайти нові методи та методики діагностики давності травмування, цей напрямок наукових досліджень не втратить актуальності, зважаючи на складність вирішення питань. Метою роботи є аналіз літератури, присвяченої застосуванню різних методів діагностики в судово-медичній практиці для встановлення давності та зажиттєвості ушкоджень. У якості досліджуваного матеріалу було використано дані закордонних джерел, які досліджують проблематику діагностики давності та зажиттєвості ушкоджень. Науковий пошук, аналіз та узагальнення були вибрані як методи дослідження. Автори наводять публікації, у яких викладено методики та критерії, що дозволяють вирішити ці питання. Зокрема, показано перспективні напрямки застосування імуногістохімічного методу, посмертної комп'ютерної томографії. Розглядаються питання встановлення давності черепно-мозкових травм. Також показана роль проявів системної реакції організму на травму, зокрема нейроендокринної системи. Наведені приклади використання неішемічних уражень серця для діагностики тривалості вмирання. Показана роль тропопніну І, креатинкінази, мозкового натрійуретичного пептиду (NT-pro BNP) у діагностиці тривалості перебігу травматичного процесу. На підставі огляду літератури автори роблять висновок про перспективність та необхідність розробки нових методів та критеріїв для визначення зажиттєвості та давності ушкоджень у судово-медичній практиці з метою уніфікації результатів дослідження та уникнення діагностичних помилок.*

Scientific development of issues related to determining the duration of fatal injuries during forensic examination is an urgent task for forensic experts.

The study of the prescription of death coming and lifelong reactions to injury were conducted by many scientists in various fields of medicine [20, 27]. This issue was paid attention to in the works of Ukrainian forensic scientists, including B.V. Mykhailychenko, A.M. Biliakov, I.G. Savka, O.I. Herasymenko, B.T. Bachynskyi, O.M. Hurov, B.O. Olkhovskyi and others.

The purpose of this work is to analyze the literature on the use of various diagnostic methods in forensic practice in assessing survival and prescription of injuries. Methods used: scientific research, analytical and generalizing.

Recently, scientists have used post-mortem computed tomography (CT) to diagnose the prescription of death coming. The authors proved that the sensitivity of CT in the diagnosis of traumatic brain injury is 95.2%, although erroneous results are possible with damage to the heart and aorta [23, 33]. United Kingdom, the Netherlands, and Japan make extensive use of postmortem CT and MRI scans [9, 27]. In Switzerland currently comparative studies of postmortem CT and MRI with traditional autopsy are actively usesd [11, 18]. Even in foreign literature, the term virtopsy has become widely used – a method of postmortem examination of the body [18]. Used virtopsia to examine a person who has died due to mechanical asphyxia [10].

K.V. Surkov, M.V. Fedulova and others revealed the prospects of using immunohistochemistry methods of assessing survival and age of mechanical damage establishment in forensic practice [21, 19]. In particular, the possibility of: quantitative determination of cell adhesion molecules (CAMs) of

leukocytes and endothelial receptors to them in the tissues of skin wounds is shown; expression of so-called "early genes" that encode transcription factors in tissues in traumatic brain injury; P-selectin as a marker of early life reaction in damaged soft tissues; IHC-staining for fibrinogen of alveolar transudate in asphyxia; expression of proliferating cell nuclear antigen (PCNA), markers of keratinocyte apoptosis and connective tissue cells in the skin from the wound area; heat shock proteins in body tissues and fluids; CD3 (T-lymphocytes in general), CD4 (T-lymphocyte helpers) and CD20 (B-lymphocytes) in splenic injury; vascular endothelial growth factor (VEGF) at the site of injury; expression in reactive gliocytes of vimentin and glial fibrillar acidic protein (GFAP), markers of wounds lasting for a few minutes-hours (TGFβ1, TGFα, fibronectin, IL1β, IL6, TNFα, ICAM-1, VCAM-1, E- and L-selectin) wounds lasting for several days (tenostin, collagen III, V, VI, I, p53). A.V. Shai and others have determined the duration of axonal injuries in traumatic brain injury by the number of proteins released from neurons during their damage and found that they differ significantly on the first day [22]. D.V. Bavikin and others have determined the expression of immunohistochemical markers of proliferative activity of Ki-67 and antiapoptosis of Bcl-2 in gunshot wounds less than 1 hour of prescription [2]. D.V. Bogomolov and others have confirmed the importance of immunohistochemical study in assessing survival establishment and severity of gunshot wounds of soft tissues by IHC-reaction of expression of vimentin and fibrinogen [4]. Some authors have used polyclonal antibodies to common cytokeratins, fibrinogen, fibronectin and CD-117 to study deaths due to various types of mechanical asphyxia [5, 28, 29]. CD-117 has been proved to give significant focal expression in interalveolar septa in cases of strangulation mechanical asphyxia and can be used as an undifferentiated marker of acute alveolar hypoxia [5, 28, 29].

Also, to determine the prescription of death coming from injury, some scientists have studied the dynamics of the process of autofluorescence of coenzymes nicotinamidadenine nucleotide (NAND), flavinadenine dinucleotide (FAD) and redox ratio (RR) in rat skeletal muscle on the first day after birth [1]. Studies of these coenzymes in the ultraviolet and blue spectra are used as markers of redox processes to assess metabolic activity in many scientific studies not only in biology but also in clinical medicine [31, 32].

Given the diversity and prevalence of traumatic brain injury among the types of traumatic injuries, expert practice needs to determine prescription of it. Yu.E. Morozov and co-authors determined the duration of brain damage by changes in the nuclear organizer in astrocytes [14]. G.V. Nedugov and others determined the age of acute subdural hematomas by the quantitative distribution of ethanol in venous blood and urine [15]. G.V. Nedugov and K.N. Krupin also determined its prescription by mathematical modeling of the pathomorphology of brain contusions [12, 16].

I.A. Lewandowska on the basis of macroscopic examination established 6 time intervals that reflect the time of injury in the two-stage course of the traumatic process in the spleen [13].

However, most studies have focused on the manifestations of the body's local response to injury [3]. However, various aspects of the manifestation of the body's systemic response to injury are developed only in fragments. The importance of the neuroendocrine system in acute trauma accompanied by the development of stress and general adaptation syndrome was studied [3]. An increase in the content of catecholamines in the peripheral blood in injuries compared with non-violent death has been proven.

It should be noted that the pandemic of the new coronavirus infection COVID-19 has also made its adjustments. We need to differentiate the acute respiratory distress syndrome and "shock lung" in trauma [7, 8, 30].

Also, it should be noted that the main role in the body's adaptation to traumatic human injuries is played by the adrenal glands, because in response to stress or damage to the hypothalamic-pituitary-adrenal system the body tries to stabilize homeostasis. The general adaptation syndrome, which is manifested by restructuring in the neuroendocrine system, certainly has a morphological picture [6]. Many authors prefer to assess the morphofunctional response of the adrenal glands to determine thanatological factors in various cases of both violent and nonviolent death [3, 6]. A.M. Biliakov determined the duration of fatal injury by balance of esterified cholesterol in the adrenal tissue of corpses [3].

The development of methods for determining the prescription of death coming in the early postmortem period is closely related to the study of tissue resistance to hypoxia [3, 17].

Given the fact that the body's stress response to traumatic injuries causes non-ischemic heart disease, it is advisable to study changes in the biochemical parameters of Troponin I (Tn I) [24].

Some scientists have studied the increase in creatine kinase in the bloodstream associated with damage to muscle cells, which may be promising to establish the prescription of injury for various types [24].

Today, a significant range of research by post-Soviet scientists is aimed at establishing the dependence of the oxidative modification of serum proteins

of the corpse to develop criteria for determining the duration of the agonal period [25].

Another promising study is the research of brain natriuretic peptide (NT-pro BNP), which is associated with a significant effect on the endocrine, cardiovascular and urinary systems and may be an indicator of the stress response of the heart to hemodynamic changes in the body [25]. Increased secretion of BNP and proBNP by the ventricles of the heart is associated with increased stretching of certain areas of the myocardium, so they are widely used in cardiology in the diagnosis of heart failure [25]. That is, the study of the content of NT-pro BN) in the blood plasma of corpses of persons whose death occurred from mechanical trauma is appropriate and relevant to determine its duration.

CONCLUSIONS

Therefore, the relevance and practical significance of forensic diagnosis of the age of injury, the need to develop new diagnostic criteria to determine the systemic response to injury and necessitated a deep and comprehensive study of the above problem.

Contributors:

Erhard N.M. – resources, methodology, writing – original draft;

Biliakov A.M. – conceptualization, writing – review and editing;

Volobuiev O.E. – methodology, formal analysis.

Funding. This research received no external funding.

Conflict of interests. The authors declare no conflict of interest.

REFERENCES

1. Babkina AS, Sundukov DV, Golubev AM, Ryzhkov IA, Cokolaeva ZI, Zarzheckij JuV. [Determination of the fluorescence intensity of coenzymes NADH and FAD in rat skeletal muscle depending on the duration of death]. Sudebno-meditsinskaya ekspertiza. 2020;63(1):31-35. Russian. doi: https://doi.org/10.17116/sudmed20206301131

2. Bavykin DV, Bakhmetev VI. [Markers of cell proliferation ki-67 and antiapoptosis bcl-2 in gunshot injuries]. Nauchno-prakticheskiy zhurnal. 2016;19(3):144-50. Russian.

3. Biliakov AM. [Determination of diagnostic criteria for establishing the traumatic genesis of death and duration of fatal mechanical injury by the ratio of cholesterol / cholesterol esters in human adrenal tissue]. Visnyk Vinnyts. nats. med. un-tu im. MI. Pyrohova: 2013;17(1):8-10. Ukrainian.

4. Bogomolov DV, Fedulova MV, Shay AN, Pavlova AZ, Zbrueva YuV. [The role of immunohistochemical studies in establishing the lifetime and severity of gunshot injuries of soft tissues]. Sudebno-meditsinskaya ekspertiza. 2018;61(6):46-47. Russian. doi: https://doi.org/10.17116/sudmed20186106146

5. Bogomolov DV, Zbrueva JuV, Putincev VA, Denisova OP. [Forensic diagnostics of intravital strangulation groove by morphological methods]. Sudebno-meditsinskaya ekspertiza. 2016;59(2):40-44. Russian. doi: https://doi.org/10.17116/sudmed201659240-43

6. Erhard NM. [Forensic determination of the viability of hanging by quantitative assessment of steroidogenesis of glucocorticoids in the adrenal glands] [dissertation]. Kyiv: National Medical University O.O. Bohomolets; 2017. Ukrainian.

7. Zabozlaev FG, Kravchenko JeV, Galljamova AR, Letunovskii NN. [Pathological anatomy of the lungs in the new coronavirus infection (COVID-19). Preliminary analysis of autopsy studies]. Klinicheskaya praktika. 2020;11(2):21-37. Russian. doi: https://doi.org/10.17816/clinpract34849

8. Zairatiants OV, Samsonova MV, Cherniaev AL, Mishnev OD, Mikhaleva LM, Krupnov NM, Kalinin DV. [Pathological anatomy of COVID-19: 2000 autopsy experience]. Sudebno-meditsinskaya ekspertiza. 2020;6(4):10-23. Russian. doi: https://doi.org/10.19048/fm340

9. Klevno VA, Chumakova Yu V. [Viropsia - a new research method in the practice of Russian forensic medicine]. Sudebno-meditsinskaya ekspertiza. 2019;5(2):27-31. doi: https://doi.org/10.19048/2411-8729-2019-5-2-27-31

10. Klevno VA, Chumakova JuF, Kurdiukov FN, Dubrova SJe, Efremenkov NV, Zemur MA. [Possibilities of postmortem computed tomography (virtual autopsy) in case of death from mechanical asphyxia]. Sudebno-meditsinskaya ekspertiza. 2018;4(4):22-26. Russian. doi: https://doi.org/10.19048/2411-8729-2018-4-4-22-26

11. Kovalev AV, Kinle AF, Kokov LS, Sinicyn VA, Fetisov VA, Filimonov BA. [Real possibilities of radiation diagnostics in the practice of a forensic medical expert]. Consilium medicum. 2016;18(13):9-25. Russian. doi: https://doi.org/10.26442/2075-1753_2016.13.9-25

12. Krupin KN. [Mathematical modeling of traumatic brain injury]. Sudebno-meditsinskaya ekspertiza. 2018;4(1):13-16. Russian.

13. Levandrovskaia IA. [Macroscopic examination of the spleen in a two-stage course of the traumatic process in determining the duration of the injury]. Meditsinskaia ekspertiza i pravo. 2014;2:59-61. Russian.

14. Morozov YuE, Koludarova EM, Gornostaev DV, Kuzin AN, Dorosheva ZhV. [Determination of the duration of brain damage from changes in the nucleolar organizer in astrocytes]. Sudebno-meditsinskaya ekspertiza. 2018;4:16-18. Russian. doi: https://doi.org/10.17116/sudmed201861416

15. Nedugov GV, Nedugov VG. [Determination of the age of acute subdural hematomas by the quantitative distribution of ethanol in their contents, venous blood and cystic urine]. Vestnik sudebnoi meditsiny. 2019;8(4):23-29. Russian.

16. Nedugov GV. [Mathematical modeling of qualitative pathomorphology of brain contusions in terms of determining the duration of traumatic brain injury]. Vestnik sudebnoy meditsiny. 2019;8(3):10-15. Russian.

17. Putintsev VA, Bogomolov DV, Bogomolova IN, Denisova OP. [Determination of the duration and rate of dying by morphological characteristics]. Metodicheskie rekomendatsii. FGBU RTsSME; 2017. Russian.

18. Strelkov AA. [A method for examining the body in order to establish the cause of death and / or identify a person by X-ray computed tomography]. Sudebnaya meditsina. 2018;2:15-18. Russian.
doi: https://doi.org/10.19048/2411–8729–2018–4–2–15–18

19. Surkov KV, Surkova EI. [Determination of the age of mechanical damage by the immunohistochemical method]. Sudebno-meditsinskaya ekspertiza. 2015;1(2):50-51. Russian.

20. Tumanov JeV, Kildiushov EM, Ermakova JuV, Kuznecova GS. [Diagnostics of the prescription of death in the late postmortem period in forensic practice (literature review)]. Sudebno-meditsinskaya ekspertiza. 2018;4(1):34-38. Russian.
doi: https://doi.org/10.19048/2411-8729-2018-4-1-34-38

21. Fedulova MV, Kupriianov DD. [Reliability of immunohistochemical assessment of lifetime and duration of injury: analysis and research prospects]. Sudebno-meditsinskaya ekspertiza. 2020;63(2):52-57. Russian.
doi: https://doi.org/10.17116/sudmed20206302152

22. Shay AN, Fedulova MV, Zavalishina LE, Kvacheva YuE, Shigeev SV, Kovalev AV. [Immunohistochemical detection of biomolecular markers of axonal damage in traumatic brain injury]. Sudebno-meditsinskaya ekspertiza. 2018;61(3):8-10. Russian.
doi: https://doi.org/10.17116/sudmed20186138-10

23. Shhedrenok VV, Moguchaia OV, Potemkina EG, Kotov MA, Sebelev KI. [Diagnostics of craniocerebral and extracranial injuries in polytrauma from the standpoint of evidence-based medicine]. Politravma. 2015;3:47-57. Russian.

24. Jedelev NS, Vorobev VG, Jedelev IS. [Application of biochemical research methods in solving problems of forensic medical practice]. Sudebno-meditsinskaya ekspertiza. 2019;62(4):63-67. Russian.
doi: https://doi.org/10.17116/sudmed20196204163

25. Jedelev IS, Obuhova LM, Andrijanova NA, Jedelev NS. [Prospects for using the parameters of oxidative modification of blood serum proteins to determine the duration of the agonal period]. Sudebnaya meditsina. 2019;5(3):28-32. Russian.
doi: http://dx.doi.org/10.19048/2411-8729-2019-5-3-28-32

26. Klein WM, Bosboom DGH, Koopmanschap DH, Nievelstein RAJ, Nikkels PGJ, van Rijn RR. Normal pediatric postmortem CT appearances. J. Pediatric Radiology. 2015;45(4):517-26.
doi: https://doi.org/10.1007/s00247-014-3258-8

27. Noriaki I. Postmortem interval estimation – for better understanding of postmortem changes. Current issues of forensic medicine and expert practice - 2020: materials of the international. Cong. Moscow; (April 15-17, 2020).
doi: http://dx.doi.org/10.19048/2411-8729-2020

28. Castiglioni C, Baumann P, Fracasso T. Acute pulmonary emphysema in death by hanging: a morphometric digital study. J. Legal Med. 2016;130(5):1281-5.
doi: https://doi.org/10.1007/s00414–016–1418–0

29. Feng X, Zhang D, Gong Q, Zhang Z, Quan L. Expression of Glucose-Regulated Protein 78 and miR-199a in Rat Brain After Fatal Ligature Strangulation. J. Forensic Med Pathol. 2017;38(1):78-82.
doi: https://doi.org/10.1097/PAF.0000000000000298

30. Liu Q, Wang RS, Qu GQ, et al. Gross examination report of a COVID-19 death autopsy. Fa Yi Xue Za Zhi. 2020;36(1):21-23.
doi: https://doi.org/10.12116/j.issn.1004-5619.2020.01.005

31. Raghushaker CR, Chandra S, Chakrabarty S, Kabekkodu SP, Satyamoorthy K, Mahato KK. Detection of mitochondrial dysfunction in vitro by laser-induced autol uorescence. J. Biophotonics. 2019;(28).
doi: https://doi.org/10.1002/jbio.201900056

32. Schaefer PM, Kalinina S, Rueck A, von Arnim CAF, von Einem B. NADH Autol uorescence-A Marker on its Way to Boost Bioenergetic Research. Cytometry A. 2019;95(1):34–46. doi: https://doi.org/10.1002/cyto.a.23597

33. Sifaouia I, Nedelcu C, Beltran G, Dupont V, Lebigot J, Gaudin A, et al. Evaluation of unenhanced postmortem computed tomography to detect chest injuries in violent death. J. Diagnostic and Interventional Imaging. 2017;98(5):393-400.
doi: https://doi.org/10.1016/j.diii.2016.08.019

Стаття надійшла до редакції
23.02.2021