

Features of postmortem interval evaluation for crime investigation

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The work of police investigators includes investigation of violent deaths, which sometimes are of scarce evidence. The examination of corpse is essential in most of violent deaths cases; thus, there is a need to correctly evaluate signs on the corpse as soon as they could help investigators obtain important information about a murder. There could be various questions to be answered by forensic medical examiners; one of which is determination of time since death.

The study is aimed to present guidelines on choosing the method of evaluation of postmortem changes based on forensic medical data, in accordance with condition of the body, features of surroundings and other factors that have to be noted at the place of corpse finding. Guidelines are composed in accordance with current legal procedures on forensic medical examinations.

Keywords: *forensic examination of corpses, forensic thanatology, time since death, postmortem interval evaluation.*

Formulation of Research Problem

Forensic examination of corpses is mainly based on Order № 6 of Ministry of Health of Ukraine: *On the development and improvement of the forensic service of Ukraine*¹. During the external examination, the presence of injuries and some features of the corpse should be outlined. The time of death is usually evaluated in accordance with recommendations², using livor mortis dynamometry and rectal temperature measurement. However, the results of time interval evaluation using abovementioned methods could be affected by various external factors and some individual features of the corpse. Also, there are some limitations for time intervals for those methods. Therefore, there is a need to use specific methods for each case of corpse examination at the place

of corpse finding, depending on different features, such as surroundings, corpse, presence and development of putrid changes.

Analysis of Essential Researches and Publications

The analysis of different methods of postmortem interval (PMI) evaluation had been performed by M. S. Bokarius³, R. Shrestha, T. Kanchan, K. Krishan⁴; entomology-based methods of PMI determination were studied by M. Harvey, N. Gasz, S. Voss⁵, R. Sharma, R. K. Garg, J. R. Gaur⁶; histochemical methods of PMI assessment were studied by C. Guerrero-Urbina, M. del Sol, G. M. Fonseca⁷, R. Elgawish et al.⁸, H. F. A. Salam et al. studied thanatochemical methods of PMI evaluation⁹.

- 1 Про розвиток та вдосконалення судово-медичної служби України : наказ Міністерства охорони здоров'я України від 17.01.1995 р. № 6. URL: <https://zakon.rada.gov.ua/laws/show/z0248-95#Text> (date accessed: 29.09.2021).
- 2 Гуров О. М., Кондратенко В. Л., Бурчинський В. Г., Гладких Д. В. Сучасний алгоритм судово-медичної діагностики давності настання смерті у ранній постмортальний період : метод. рек. Київ : [б. в.], 2017. 36 с.
- 3 Бокариус Н. С. Сведения к практическим работам, необходимые при выполнении и сдаче их студентами медицинского факультета Харьковского университета на производимых ими практических занятиях по судебной медицине. Вып. 13. Сведения к составлению протокола судебно-медицинского вскрытия. Харьков, 1918. 16 с. ; Его же. Первоначальный наружный осмотр трупа при милицейском и розыском дознании. Харьков, 1925. 542 с.
- 4 Shrestha R., Kanchan T., Krishan K. Methods of Estimation of Time Since Death. *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing*. 2021. URL: <https://www.ncbi.nlm.nih.gov/books/NBK549867> (date accessed: 29.09.2021).
- 5 Harvey M., Gasz N., Voss S. Entomology-based methods for estimation of postmortem interval. *Research and Reports in Forensic Medical Science*. 2016. Vol. 6. Pp. 1–9. DOI: 10.2147/RRFMS.S68867 (date accessed: 29.09.2021).
- 6 Sharma R., Garg R. K., Gaur J. R. Various methods for the estimation of the post mortem interval from Calliphoridae: A review. *Egyptian Journal of Forensic Sciences*. 2015. Vol. 5. Is. 1. Pp. 1–12. DOI: 10.1016/j.ejfs.2013.04.002 (date accessed: 29.09.2021).
- 7 Guerrero-Urbina C., Sol M. del, Fonseca G. M. Histochemical and Immunohistochemical Methods for the Postmortem Interval Estimation in Human Tissues: A Review. *International Journal of Morphology*. 2020. Vol. 38. No. 2 Pp. 241–246. DOI: 10.4067/S0717-95022020000200241 (date accessed: 29.09.2021).
- 8 Elgawish R., Abdelrazek H. M., Desouky A., Mohamed R. M. Determination of postmortem interval through histopathological alterations and collagen evaluation in the prostate of Wistar albino rats. *Zagazig Journal of Forensic Medicine and Toxicology*. 2021. Vol. 19. Is. 2. Pp. 1–12. DOI: 10.21608/ZJFM.2021.63677.1071 (date accessed: 29.09.2021).
- 9 Salam H. F. A., Shaat E. A., Abdel Aziz M. H., MoneimSheta A. A., Mohammed Hussein H. A. S.

Article Purpose

To present guidelines on choosing the method of evaluation of postmortem changes based on forensic medical data, in accordance with condition of the body, features of surroundings and other factors that have to be noted at the place of corpse finding, in compliance with current legislation on forensic examination of the corpse.

Main Content Presentation

According to Order № 6 of Ministry of Health of Ukraine, forensic examination of the corpse should be recorded in the protocol, including circumstances of a case, summarized information related to examination, information from medical and other documents.

The usage of livor mortis dynamometry for PMI evaluation could be not sufficiently precise after 12 hours after the death. Angi M. Christensen et al. noted that livor mortis typically manifests itself around thirty minutes to four hours after death, and is most pronounced approximately twelve hours after death¹⁰. Stephanie R. Dillon in her course titled: *Chemistry for Liberal Studies – Forensic Academy* denotes that “livor mortis does not have very precise measurement of the time of death after 12 hours; so, it is also less helpful on bodies found days or weeks after the death”. In one of the last studies

in this field, Yosuke Usumoto et al., using spectrophotometric blood-color values, determined accuracy of postmortem interval: ± 8.84 hours, without considering the age of the deceased¹¹. To conclude, the study of livor mortis is showing that the degree of postmortem interval preciseness calculated based on livor mortis could not satisfy the needs of crime investigators in some cases.

When it comes to PMI measurement using temperature drop, algor mortis, the study made by Henssge et al. showed the need to collect additional information about body weight, thickness and quantity of clothing layers on the corpse, bedding of the corpse – the place the corpse laid on, dry or wet air, still or flowing air; thus, the effect of these factors on the corpse’s temperature drop could be taken into account while calculating the time since death¹². Surely, in order to retrieve such information, there is a need for additional instruments to measure all those parameters precisely enough to obtain the correct postmortem interval, which requires providing forensic examiners with all necessary equipment to make such evaluations.

Methods of postmortem interval evaluation, which are based on histological, biochemical and immunohistochemical changes in the corpse, show the possibility of their application in late postmortem interval, when most of currently used methods

Estimation of postmortem interval using thanatochemistry and postmortem changes. *Alexandria Journal of Medicine*. 2012. Vol. 48. Is. 4. Pp. 335–344. DOI: 10.1016/j.ajme.2012.05.004 (date accessed: 29.09.2021).

10 Christensen A. M., Passalacqua N. V., Bartelink E. J. *Forensic Anthropology: Current Methods and Practice*. Amazon.com Services LLC, 2014.

11 Usumoto Y., Kudo K., Tsuji A., Ihama Y., Ikeda N. Predictive equation to estimate post-mortem interval using spectrophotometric blood-colour values. *Medicine, Science and the Law*. 2019. Vol. 59. Is. 1. Pp. 36–41. DOI: 10.1177/0025802418819611 (date accessed: 29.09.2021).

12 Henssge C., Madea B. Estimation of the time since death in the early post-mortem period. *Forensic Science International*. 2004. Vol. 144. Is. 2–3. Pp. 167–175. DOI: 10.1016/j.forsciint.2004.04.051 (date accessed: 29.09.2021).

couldn't be used¹³. Scientists marked the possibility to determine PMI up to 6 days after the death, evaluating the morphological changes in some internal organs.

Usage of computer programs for evaluating histological slides is perspective, and artificial intelligence programs which are already effectively used, for example, in oncology, could be implemented in work of forensic histologists as well.

Usage of computer programs allowing a forensic examiner to combine several methods to get more accurate results was described in modern publications on PMI topic. For example, Cristina Cordeiro et al. have developed a computer program which calculates time since death by estimating biochemistry of the vitreous humor, temperature and body weight¹⁴. José I. Muñoz-Barús et al. developed program which measures the concentrations of potassium, hypoxanthine and urea in the vitreous humor¹⁵.

Conclusions

The work of forensic examiners while evaluating corpse time of death must involve various factors which should be noted for each case. In order to obtain precise results, several methods should be used. The usage of computer programs or mobile applications for this purpose could facilitate and faster its implementation for forensic examiners.

Особливості оцінювання посмертного інтервалу для розслідування злочинів Едгар Григорян, Анжела Стаццак, Німа Резаї

Поміж інших, до обов'язків слідчих поліції належить розслідування насильницьких смертей, коли бракує інформації про особливості настання смерті. Огляд трупа необхідний у більшості випадків настання насильницької смерті, саме тому існує потреба у правильному оцінюванні різноманітних ознак на трупі, оскільки це може допомогти слідчим — надати важливу інформацію про вбивство, якщо таке сталося. До судово-медичних експертів можуть виникнути різні запитання, одним з яких є визначення давності настання смерті.

- 13 Григорян Е. К., Мирошниченко М. С. Особливості післясмертних морфологічних змін матки. *Morphologia*. 2020. Т. 14. № 4. С. 90—94 ; Elgawish R., Abdelrazek H. M., Desouky A., Mohamed R. M. *Ibid.* DOI: 10.21608/ZJFM.2021.63677.1071 (date accessed: 29.09.2021) ; Salam H. F. A., Shaat E. A., Abdel Aziz M. H., Moneim Sheta A. A., Mohammed Hussein H. A. S. *Ibid.* DOI: 10.1016/j.ajme.2012.05.004 (date accessed: 29.09.2021) ; Olkhovsky V., Grygorian E., Myroshnychenko M., Kozlov S., Suloiev K., Polianskyi A., Kaplunovsky P., Fedulenkova Yu., Borzenkova I. Morphological features of the uterus in women at different time intervals of the postmortem period as diagnostic criteria for establishing the postmortem interval. *Wiadomości Lekarskie*. 2021. Vol. 74. Is. 4. Pp. 821—827 ; Коновал Н. С. Закономірності постмортальних структурно-біохімічних змін м'язової тканини діафрагми: значення для судово-медичної діагностики давності настання смерті. *Актуальні проблеми сучасної медицини: Вісник Української медичної стоматологічної академії*. 2019. Т. 19. № 1 (65). С. 71—77. DOI: 10.31718/2077-1096.19.1.71 (date accessed: 29.09.2021).
- 14 Cordeiro C., Ordóñez-Mayán L., Lendoiro E., Febrero-Bande M., Vieira D. N., Muñoz-Barús J. I. A reliable method for estimating the postmortem interval from the biochemistry of the vitreous humor, temperature and body weight. *Forensic Science International*. 2019. Vol. 295. Pp. 157—168. DOI: 10.1016/j.forsciint.2018.12.007 (date accessed: 29.09.2021).
- 15 Muñoz-Barús J. I., Rodríguez-Calvo M. S., Suarez-Peñaranda J. M., Vieira D. N., Cadarso-Suárez C., Febrero-Bande M. PMICALC: an R code-based software for estimating post-mortem interval (PMI) compatible with Windows, Mac and Linux operating systems. *Ibid.* 2009. Vol. 194. Pp. 49—52. DOI: 10.1016/j.forsciint.2009.10.006 (date accessed: 29.09.2021).

Метою цього дослідження є надання рекомендацій щодо використання методів оцінювання посмертних змін за даними судово-медичної експертизи відповідно до стану тіла, особливостей навколишнього середовища місця події й решти чинників, які необхідно зафіксувати на місці знаходження трупа. Методичні рекомендації, уміщені у цьому матеріалі, складено відповідно до вимог чинного законодавства, яке визначає правила й порядок проведення судово-медичних експертиз.

Ключові слова: судово-медична експертиза трупів; судово-медична танатологія; давність настання смерті; оцінювання посмертного інтервалу.

**Особенности оценивания давности наступления смерти для расследования преступлений
Эдгар Григорян, Анжела Стащак,
Нима Резаи**

Помимо прочего в обязанности следователей полиции входит расследование насильственных смертей, когда недостаточно информации об особенностях наступления смерти. Осмотр трупа необходим в большинстве случаев наступления насильственной смерти, именно поэтому существует необходимость в правильном оценивании различных признаков на трупе, поскольку это может помочь следователям предоставить важную информацию об убийстве, если таковое имело место. К судебно-медицинским экспертам могут возникнуть разные вопросы, одним из которых является определение давности наступления смерти.

Целью настоящего исследования является предоставление рекомендаций по использованию методов оценивания посмертных изменений по данным судебно-медицинской экспертизы в соответствии с состоянием тела, особенностями окружающей среды места происшествия и другими факторами, которые необходимо зафиксировать на месте нахождения трупа. Методические рекомендации, содержащиеся в этом материале, составлены в соответствии с действующим законодательством, определяющим правила и порядок проведения судебно-медицинских экспертиз.

Ключевые слова: судебно-медицинская экспертиза трупов; судебно-медицинская танатология; давность наступления смерти; оценивание посмертного интервала.

тология; давность наступления смерти; оценивание посмертного интервала.

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Contributors

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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