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Estimation of Time Since Death by using Algorithm in Early Postmortem Period

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The objective of this paper is to find a way for faster and more simple estimation of the time since death by using several parameters.

At the Institute of Forensic Medicine and Criminology an analysis of five parameters for estimation of time since death was performed: supravital reactions (electrical excitability of muscles, chemical excitability of muscles) and early signs of death (cooling of the body, post mortem lividity and rigor mortis) at 120 cases with known time of death. Obtained results have been used for preparation of a special table-algorithm, which contains the limit minimum and maximum values of the post mortem period for each tested parameter.

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Estimation of Time Since Death by using Algorithm in Early Postmortem Period

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The algorithm makes the work easier for the person doing the autopsy, enabling easy and fast estimation of the probable post mortem period.

Keywords : time of death, electric and chemical excitability, cooling of the body, postmortem lividity, rigor mortis.

I. Introduction

The estimate of the time since death, after the first 48 hours (the so called early postmortem period) is determined by routine appliance of conventional methods of corpse examination and detecting the development of postmortem changes. Due to the big variations in time of occurrence and duration of such corpse changes, influenced by many endogenous and exogenous factors, it allows only approximate determination of the time of death in a few hours interval after death.

Using several methods for estimation of time since death (the supravital signs and the early signs of death) has significantly increased the preciseness and certainty in estimation of the time of death.

Electric excitability and chemical excitability of muscles present highly important supravital reactions in achieving higher level of precision in estimating the time since death. Most appropriate and accessible muscles for testing by electric stimulation are the muscles around the eyes (m.orbicularis oculi) and the muscles around the mouth (m.orbicularis oris). While the flat muscles of the iris in the eye react to chemical stimulation in a longer post-mortem period. (4,6,7)

The postmortem cooling of the body (algor mortis) is one of the significant parameters in estimating the time since death. After death the body temperature regulation is stopped, the corpse becomes poikilothermic resulting in drop of body temperature in order to adjust to the environmental temperature.(1,4)

Postmortem lividity starts to manifest and develop immediately after cardiac arrest, i.e. stoppage of blood circulation; it can also start developing before death, during a long comatose period due to disrupted circulation. From the moment of death blood remains fluid and is liable to physical laws moving as influenced by gravity; thus the blood in the blood vessels flows passively towards the distal parts of the body (depending on its position). The time of appearing of postmortem lividity and manifestation extent depends on many reasons among which the most important are the cases of a long comatose agony and massive blood loss.(4,5)

Rigor mortis is a specific type of muscle contraction which mainly does not decline from physiological contraction, appears within 1-3 hours after the moment of death. All body muscles contract and stay rigid, without activity potential. This contraction is caused by loosing of the total ATP which is necessary for separation of cross bridges from the actin filaments in the process of relaxation. Muscle stays in rigor until muscle proteins disintegrate which usually occurs by autolysis with enzymes released from lysosomes, 15 to 24 hours after death, depending on external temperature.(4,5)

II. Purpose

Purpose of this paper is to find a way for faster and more simple determination of the time since death by using several parameters.

III. Material and Methods

120 cases of death with known time of death, autopsied at the Institute of Forensic Medicine and Criminology, Faculty of Medicine, Skopje, in a period of 2 years have been analyzed. All these cases are:

- of quick death / short agony period;

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- with postmortem period of 2 to 24–25 hours;
- analyzed at ambient temperature of 17 to 25°C.

a) Electrical Excitation

Testing is carried out with a device for electrical muscle stimulation which supplies a direct current, of 50 *mA*, frequency 50 *Hz*. (8)

Fig. 1 : Testing of m.orbicularis oculi

I degree – contraction of facial muscles from the same side
II degree – contraction of the lower and upper eyelid
III degree – contraction of the upper eyelid
IV degree – contraction of the medial part of the upper eyelid

Fig. 2 : Testing of m.orbicularis oris

I degree – contraction of the whole musculature around the mouth
II degree – contraction of the *musculus orbicularis oris*
III degree – excitation in a form of muscle quivering

b) Chemical Excitation

Testing is performed by injecting of the miotic *Carbahol* and mydriatic *Adrenalin HCl* either in the front eye chamber or sub-conjunctively.(8)

Fig. 3 : Chemical excitability by miotic

Fig. 4 : Chemical excitability by mydriatic

Reaction of the pupil after injecting the miotic (*Carbachol)* and mydriatic (*Adrenalin HCl)*

c) Algor Mortis

Measuring of the rectal and ambient temperatures of all the analyzed cases with digital thermometer which consists of a probe and monitor, the latter displaying the measured temperature.

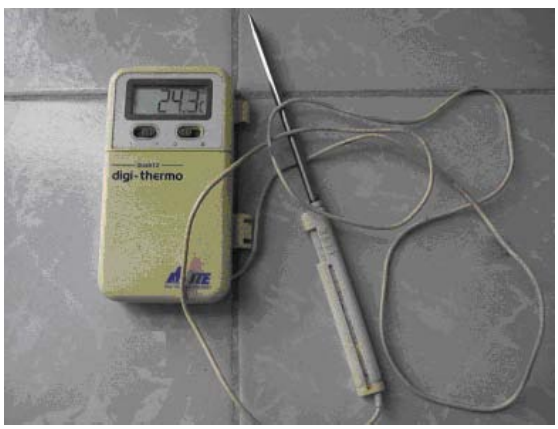


Fig. 4 : Digital Thermometer

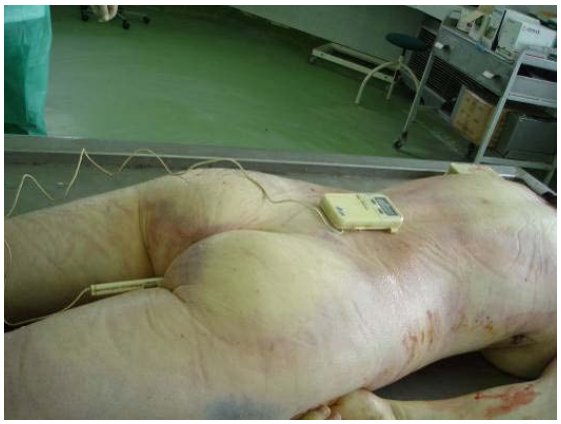


Fig. 5 : Measuring the rectal temperature

d) Henssge Nomogram

The Nomogram method is based on a formula which follows the sigmoid shape of the cooling curve.

This formula contains two exponential parts. The first represents the post mortem plateau and the second constant shows the exponential drop of t° after the plateau, according to Newton's law on cooling.(2,3)

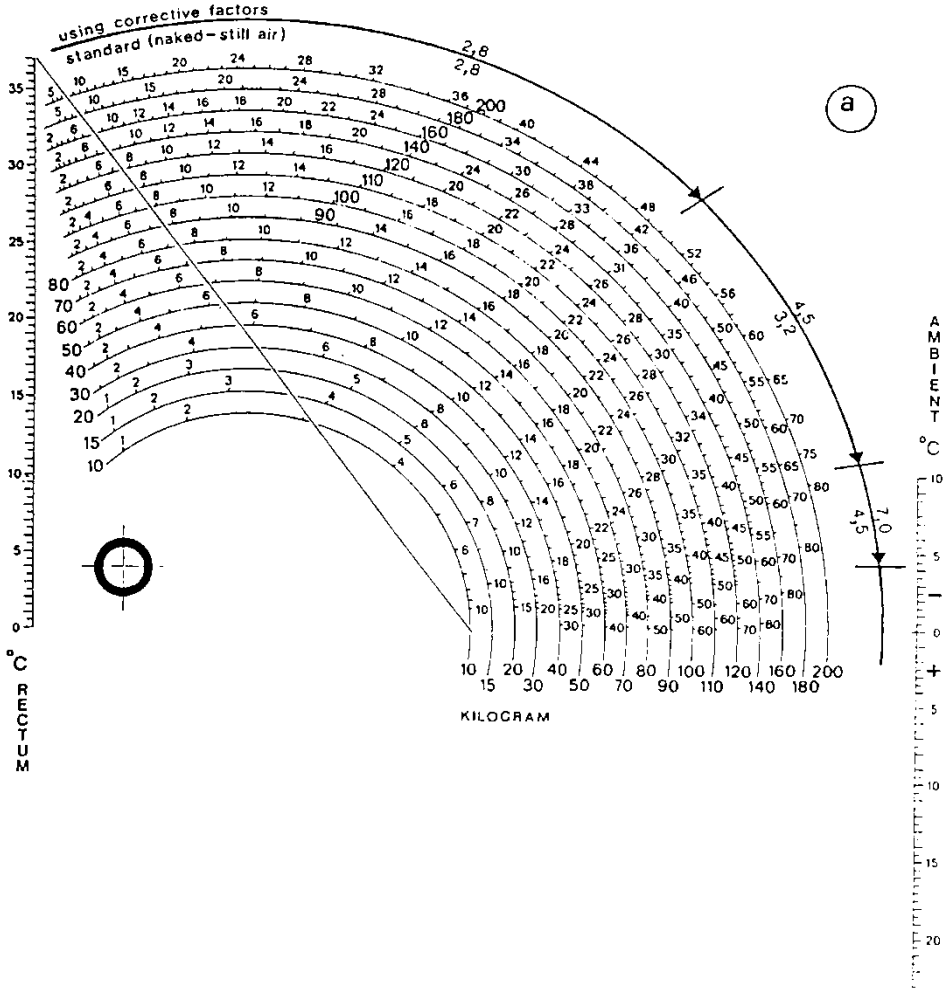


Fig. 6 : Nomogram for ambient temperature below 23°C (4)

e) Post mortem lividity

Examination – visual inspection in relation to the occurrence and intensity and by turning the body to the side, inspecting the shifting ability.

Fig. 7 : Poorly shown post mortem lividity

Fig. 8 : Fixed post mortem lividity

Fig. 9 : Examination of rigor mortis of the elbow

Fig. 10 : Examination of rigor mortis of the knee

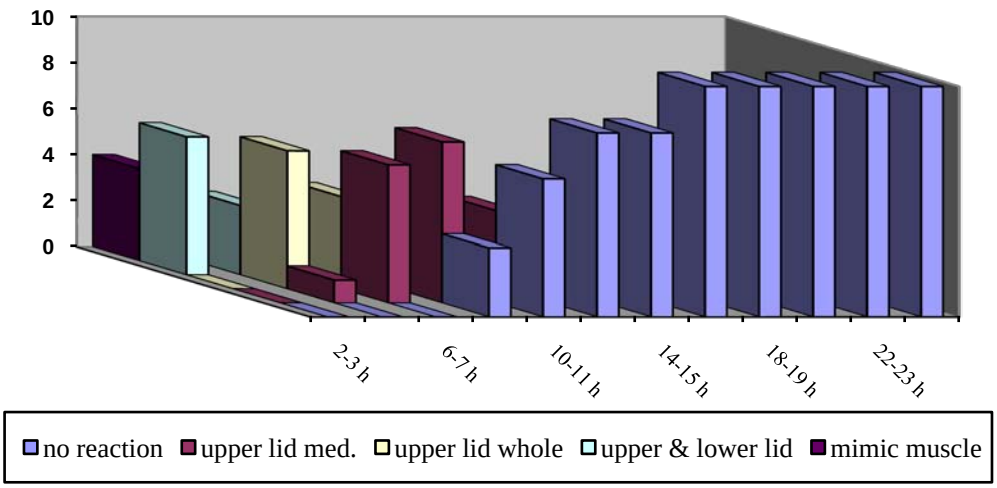
f) Rigor Mortis

Examination – analyzing by manual inspection of the stiffness of all joints.

IV. Results

a) Electrical Excitability

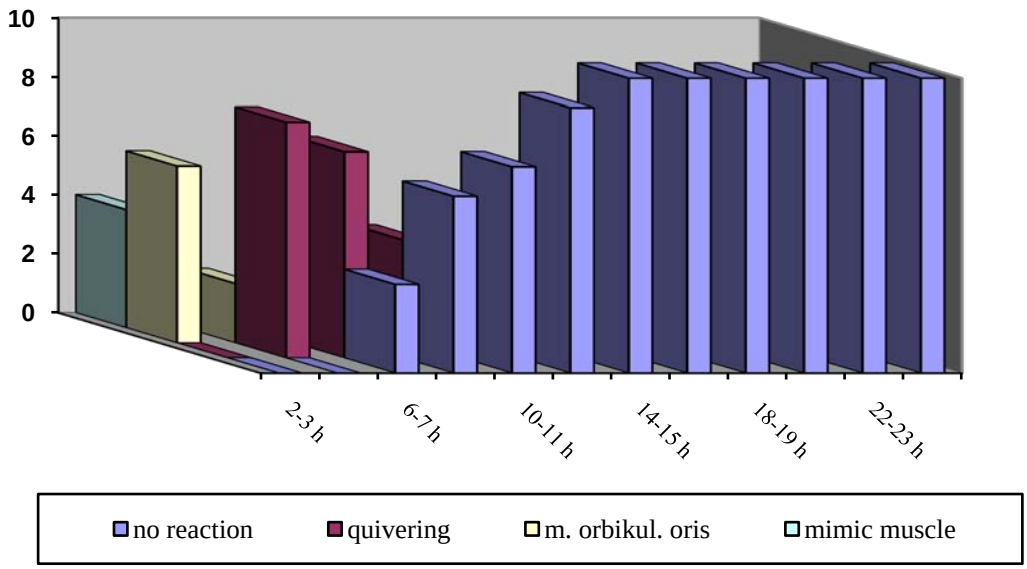
Chart 1 : Reaction upon electrical excitation of the ocular musculature per hours PM



Electrical excitation of the *m. orbicularis oculi:*

- reaction of any degree - post mortem period shorter than 8 hours.
- uncertain reaction – post mortem period 8-15 hours
- no reaction at all - post mortem period of 16 and more hours.

Chart 2 : Reaction upon electrical excitation of the mouth musculature per hours PM

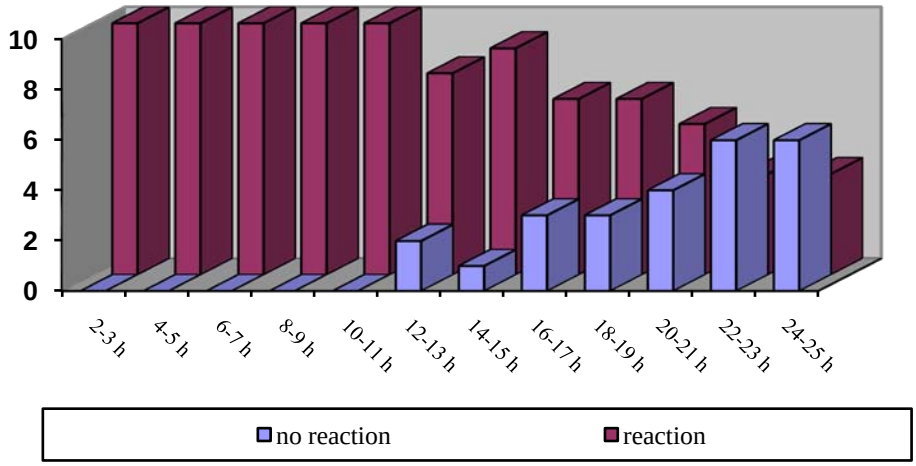


Electrical excitation of the *m.orbicularis oris*:

- reaction of any degree - post mortem period up to 6 hours
- uncertain reaction - post mortem period 6 to 13 hours
- no reaction at all - post mortem period of 14 and more hours.

b) Chemical Excitability

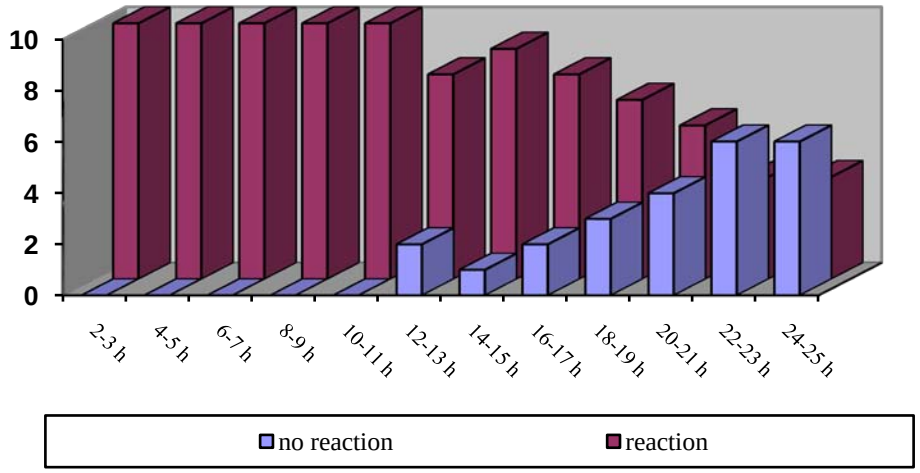
Chart 3 : Reaction upon chemical excitation with mydriatic per hours PM



Chemical excitation with mydriatic *Adrenalin HCl:*

- certain positive reaction - post mortem period up to 12 hours
- uncertain reaction - post mortem period of 12 to 25 hours

Chart 4 : Reaction upon chemical excitation with miotic per hours PM

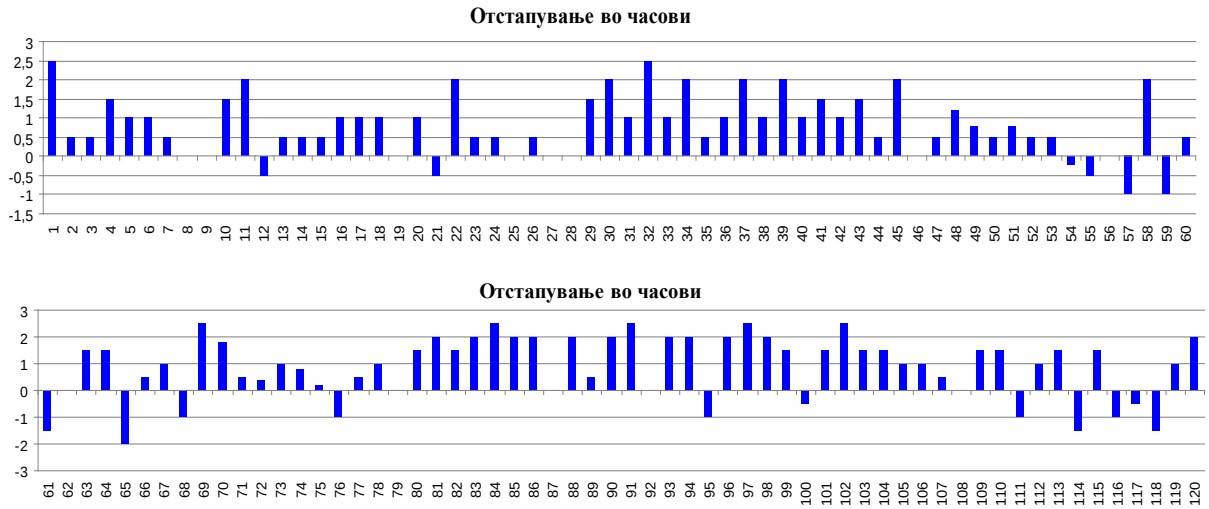


Chemical excitation with miotic *Carbachol:*

- certain positive reaction - post mortem period of 2 to 11 hours
- uncertain reaction - post mortem period of 12 to 25 hours

c) Algor Mortis

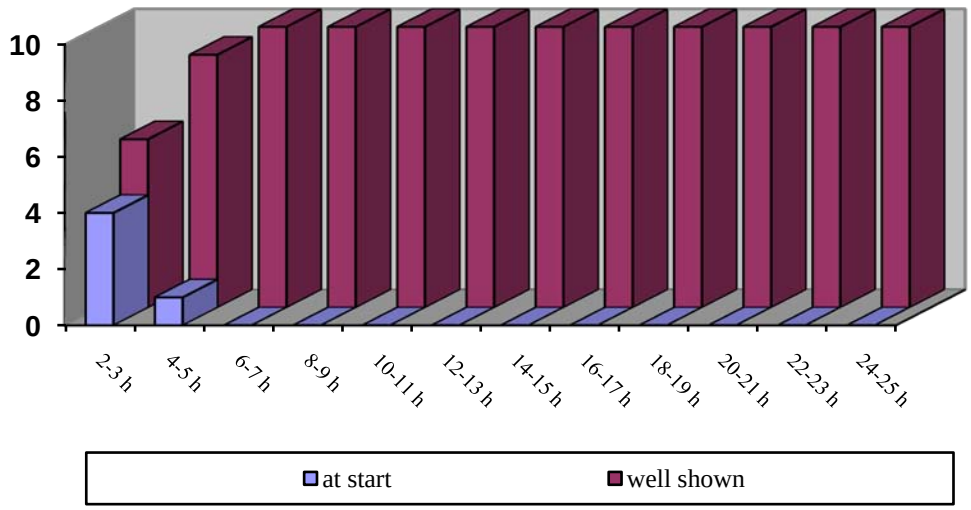
Chart 5 : Discrepancy of probable time of death obtained by the ***Henssge*** Nomogram from the actual time of death in hours



- discrepancy within limits from –2 to +2,5 hours.

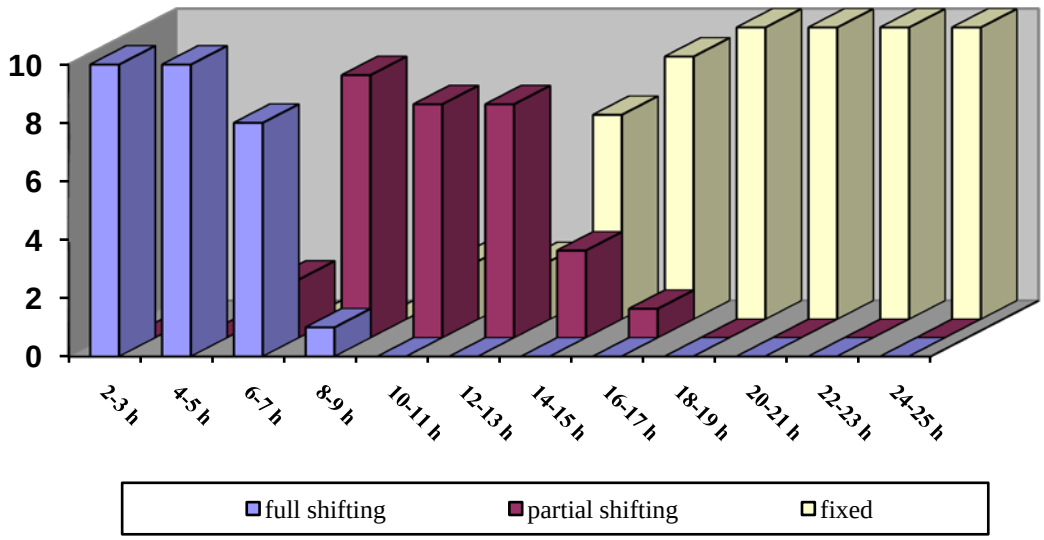
d) Post mortem lividity – livores mortis

Chart 6 : Intensity of the lividity per hours PM



- start of post mortem lividity - post mortem period of 2-5 hours
- well shown post mortem lividity – post mortem period up to 24-25 hours

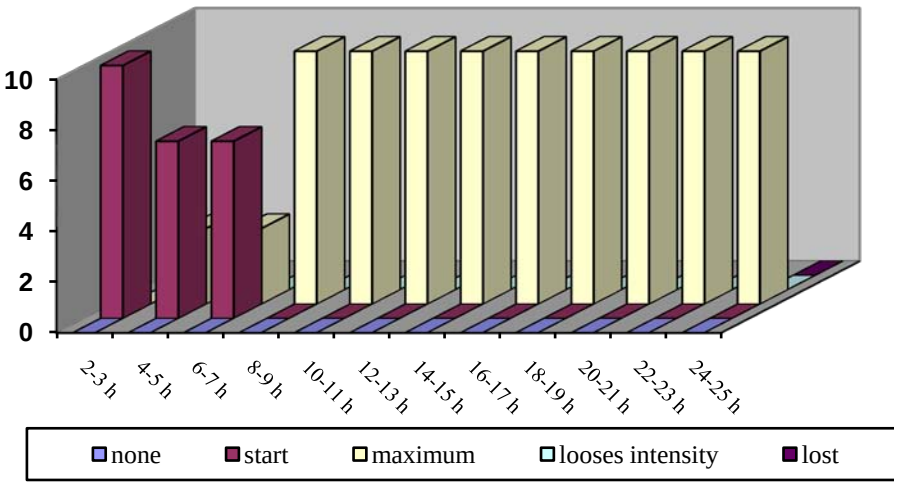
Chart 7 : Shifting ability of PM lividity per hours PM



- full shifting - up to 10 hours; partial shifting - from 6 to 17 hours;
- fixing - from at least 10 hours after death onwards
- at all cases with post mortem period of 18 hours and more, PM lividity is fixed.

e) Rigor Mortis

Chart 8 : Intensity of rigor mortis per hours PM



- start of rigor mortis - post mortem period of 2 to 7 hours
- maximal rigor for post mortem period of 8 hours and onwards.

f) Estimation of time since death by using Algorithm

An example of estimation of time since death with Algorithm

Case Protocol. No.	13952		Date	29.03.2008	Time 13,30 h
Age	44	Sex F	Body Weight/ *kg*	80	Height/ *cm* 164	Constitution overweight
Causa mortis	Canalis sclopetarium cerebri				

Livores mortis:
☐ poorly shown – post mortem period up to 5 hours
☐ well shown, shifting complete – post mortem period up to 10 hours
☐ well shown, shifting partial – post mortem period 6–17 hours
☒ well shown, fixed – post mortem period over 10–18 hours

Rigor mortis:
☐ start: post mortem period 2–7 hours
☒ maximum intensity: post mortem period over 4–8 hours

Electrical excitability of m.orbicularis oculi:
☐ positive reaction I degree – post mortem period 2–3 hours
☐ positive reaction II degree – post mortem period 2–5 hours
☐ positive reaction III degree – post mortem period 4–7 hours
☐ positive reaction IV degree – post mortem period do 15 hours
☒ negative reaction – post mortem period over 8–16 hours

Electrical excitability of m. orbicularis oris:
☐ positive reaction I degree – post mortem period 2–3 hours
☐ positive reaction II degree – post mortem period 2–5 hours
☐ positive reaction III degree – post mortem period do 6–14 hours
☒ negative reaction – post mortem period over 6–14 hours

Chemical excitability
☐ positive reaction with *Adrenalin HCl* – post mortem period up to 12–25 hours
☐ positive reaction with *Carbahol* – post mortem period up to 12–25 hours

Rectal T/°C	28,5°C	Ambient T/°C	23,5°C
Clothes	jacket, blouse, jeans	Base	floor

Nomogram – Henssge – post mortem period 20 ± 2,8 hours

The results obtained by analysis of the early signs of death and supravital reactions are marked and they point out to a post mortem period longer than 16-18 hours.

With the *Henssge* Nomogram the probable post mortem period is 20±2,8 hours. Possible time of death is the previous day at 17,30±2,8 hours.

Additional data have been obtained by investigation and enquiry of the witnesses, that the murdered person has been at work by 17,00 hours (video surveillance camera).

V. Conclusion

The algorithm we prepared also contains the limit values, minimum and maximum values for the post mortem period for each of the tested parameters, allowing an easy and quick estimation of the possible post mortem period.

Supravital reactions and the early signs of death are important parameters in estimating the time since death in the early post mortem period, especially during the first 24 hours after death, but only in case they have been analyzed together as a whole and provided that the influence of endogenous and exogenous factors has been taken into consideration.

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