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The Pathological Effect of Bacterial Translocation to the Henssge Nomogram

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Abstract

This article presents the results of measurements of the influence of pathological bacterial translocation on the intestinal wall of the area, measured per recta, and its influence on the course of a Henssge Nomogram. The gram-positive /negative bacteria which influence temperature measurements and the subsequent regressive non-stationary temperature data of biological objects when establishing the moment of death are described in a lucid, synoptic form. Based upon forensic praxis, professional studies and the acquired measured data, the article also presents the negative aspects of using the Henssge Nomogram.

Keywords: algor mortis, aerobic bacteria, corrective factors, bacterial translocation, diffusion, residue homogenity

1. Introduction

The inspection (post-mortem) of a cadaver is important not only from a medical point-of-view, but also as a legal act/performance, since the further approaches and procedures of the police and forensic specialists in the case of violent criminal acts, in which a doctor determines the cause of death, type of death and time of death of a person – which are the basic pillars for the investigative, prosecuting and adjudicating bodies in this field all depend upon this inspection. The doctor (further only pathologist) conducting the post-mortem must approach the body in question with due respect, has to take into consideration the religion of the dead person, and must take into consideration not only their own health but also the protection of the general public at large by using the appropriate instrumentaria and aides while inspecting the cadaver. The pathologist determines death in accordance with current scientific observations, verifies the identity of the deceased, collects information about the circumstances leading to their death, and investigates both the place where the cadaver was found and the cadaver itself. Their work must comply with generally given conditions established by laws and legislation. An important role for establishing the time of death is played by post-death changes, which appear on human bodies after their death. These post-death changes occur subsequent to the biological death of a human organism. They can be broken down into physical, chemical and enzymatic post-death changes [1-3]. Post-death physical changes include cooling of the body, post-death pallor and post-death patching. Cooling of the body (algor mortis) causes the effect that the temperature of the dead body reduces to the ambient temperature in which the body is located. Chemical post-death changes are defined as

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the diffusion of liquids and gases [4]. In the course of this diffusion of liquids and gases, the permeability of the walls of blood vessels increases leading to blood liquids soaking through into the surrounding tissues. In the intestines this leads to the bonding of hydrogen sulphide to the haemoglobin in the blood vessels in the walls of the intestines (verde haemoglobin).

2. Measurement of rectal temperatures – The Henssge Nomogram

The post-death cooling of the cadaver is the main parameter used in order to establish the time of death. This however can only be used within the course of a short time-frame after the death of the victim. Post-dis influenced by a wide range of factors that all need to be taken into consideration. The most widely used method for establishing the time of death is the so-called Henssge Nomogram, whose principle is based upon the measurement of the rectal temperature, the temperature of the environs and the characteristics of the surface textile materials of the person being observed. Establishing time-of-death according to the Henssge Nomogram clarifies how, we today establish the time of death of a human organism. The above-mentioned method is highly specific, and has both positive as well as negative aspects [4-5].

For Forensic Criminal praxis, the following negative aspects will be of interest:
- In the course of introducing the thermometer into the rectum, means the locomotion of biological material, and thereby may lead to damage caused to the body itself and the destruction of criminal clues.
- Per-rectal temperature measurement is a significant intervention on the human body after its death, and on the processes in the rectal area, where gases accumulate and the remnants of the digestive process in the intestinum tenue and intestinum crassum build-up, with great influence upon the corrective factors.
- The rectal probe must meet working as well as hygienic requirements and parameters.
- The professional introduction of the rectal probe into the biological materials.
- The necessity of performing ´s mathematical equation in order to calculate the period from the death of the person with the elimination of internal corrective factors of the human body.
- The need to install the special GSOFT 3050 software.
- The rectal probe has a length of cca 15 cm and the need to ensure that the detective head of the rectal probe does not injure the mucous membrane of the rectum.
- In cases where destruction of the investigated area occurs/has occurred, it is impossible to apply Henssage's method.
- The impossibility of using the above-mentioned method in cases where destruction of the biological material has occurred.
- The existing measurement system is made up of 10 internal and external components.
- In the course of activation of the measurement device, it is essential to minimalize temperature differences between the per-rectally introduced probe and the measured environs.

According to the Henssge Nomogram method, one needs to perform one measurement of the temperature of the body core at the scene of the crime/place of death while at the same time measuring the ambient temperature where the cadaver is. In order to be able to calculate the time-of-death, it is necessary to know the mass of the cadaver. Measurement of bodily temperature is, as already said, performed at the crime scene/death-site, which often means under unfavourable conditions. Post-death per-rectal temperature measurement is a significant intervention on the human body. Provided that this has to do with factors which could cause distortions to the results of the above-described methods, it is necessary a priori to mention that post-death, in the area of the rectum, processes occur in the intestinum tenue and intestinum crassum where gases and remnants of the digestive process accumulate, thus it would be necessary to eliminate the impact of the phenomena on the temperature (of the body and faecal and biological matters) with the aid of corrective factors. In the human body, post-death processes occur in the intestinum tenue and intestinum crassum where gases and remnants of the digestive process accumulate in the area of the rectum and the release of heat from the afore-mentioned area occurs, and this is also a reason why the given method is not appropriate. In addition, measurement of the rectal temperature is influenced by clostridial-type bacteria belonging to the Firmicutes phylum (typically divided into Clostridia - anaerobic; Bacilli - obligate or facultative aerobes; and Mollicutes), that can be found in the digestive tract of the investigated biological materials. One of the main types is Clostridium difficile, the most serious originator of diarrhoea linked to antibiotics (ADD) that may cause pseudo-membranous Colitis and grave intestinal infections as the consequence of the suppression of normal intestinal flora by antibiotics. C. difficile bacteria, commonly resident in the body, can then multiply [5].

This multiplication is harmful since the bacteria release toxins that may cause flatulence, or constipation or diarrhoea associated with stomach pains. Clostridium perfringens commonly occurs in infections as a benign component of normal flora. In such cases, their role in illnesses is small. Infections by C. perfringens have been proved for tissue necrosis, bacterial infections, Emphysematous Cholecystitis and for gaseous gangrene, also known as Clostridial Myonekrosis.

The that originates in the course of gaseous gangrene is known as α-toxin, and enters the plasmatic membranes of cells where it creates holes in them, thereby disrupting the normal functioning of these cells. An important factor when measuring rectal temperatures is also the problems and issues associated with Portal Hypertension (Ascites or peritoneal cavity fluid), which involves the accumulation of liquids in the peritoneal cavity of the digestive tract and other organs; and equally, Splenomegaly (or enlargement of the spleen), caused by increased hydrostatic pressure in the portal bloodstream. Complications caused by Ascites are compression of the abdominal organs, worsened breathing, and rarely, spontaneous bacterial peritonitis.

3. Gram-positive and gram-negative bacterial translocation

One of the diseases affecting the organs of the peritoneal cavity is Bacterial Translocation, whereby the penetration by living organisms and toxins across the layer of mucous membranes into the body occurs. Under normal conditions, this has to do with small quantities and the body´s immune system simply destroys the bacteria. However, Bacterial Translocation in the human body occurs in cases where a great quantity of bacteria accumulates in the intestines. In cases where the bacteria are not destroyed however, they have the ability to penetrate into the human bloodstream. The influential factor of this disease is the bacterial factor, represented by the nature of the translocating bacteria. The intestinal wall factor depends upon their morphological and functional states.

The defensive factor is represented by the antibacterial activity of the human organism. Among the most important bacterial phyla are: Aerococcus viridans, where this bacteria sometimes occurs as a human pathogen, as this especially in Bacterial Endocarditis. Micrococcus luteus is a gram-positive bacteria, a spherical, saprotrophic bacteria which belongs to the family of Micrococcaceae, which is an obligatory aerobic bacteria. M. luteus can be found in earth, dust, water or the air as well as like a component of the normal flora of mammal skin. Staphylococcus xylosus is a type of bacteria belonging to the Staphylococcus family. It is a gram-positive bacterium that creates a cluster of cells.

Similar to the majority of Staphylococci, it is coagulant-negative and exists commensally on human skin. Staphylococcus aureus occurs most frequently by transduction by the intermediary of tempered bacteriophages of the Siphoviridae family. S. aureus is ranked among the most active biochemical bacterial types. For all of the above-mentioned bacteria, it is characteristic that exothermic reactions occur, in the course of which energy – (in the form of) heat is released.

4. Results of the measurement of regressive functional parameters and residues

Studies based on a polynomial regressive model or the estimation of time-of-death through the intermediary of rectal temperature are the subject of world-wide discussions – mainly in regard to the precision and uncertainty of measurements of the acquired values in the course of bacterial translocation, as well as the influence of demographic profiles on the investigated biological material. Statistical significance in this field has been mathematically expressed by the value: $p < 0.01$ and the insignificant correlation value of $p > 0.05$. Based upon the measured values gained using the per-rectum measurement method in the course of bacterial translocation, the following graph was created of tests of the homogeneity of the residues, viz. Fig. 2., showing differing values as against the non-pathological functional course.

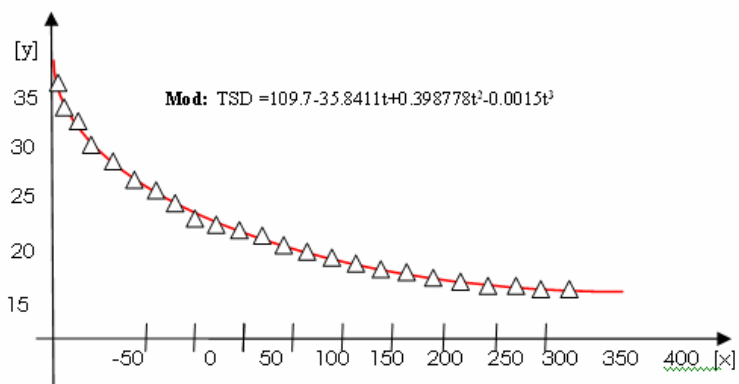**Mod:** $TSD = 109.7 - 35.8411t + 0.398778t^2 - 0.0015t^3$

Fig. 1. Normal p-graph of the interspaced data (Normality of residues – mean value of residues is 0.00000)

The homoscedasticity of the residues is assessed by means of the graph of dependence of the residues on the predicated values. Measurements of the rectal temperatures were conducted on persons where bacterial wipes of the rectal mucous membranes with the positive identification of samples of anaerobic micro-flora.

(a)

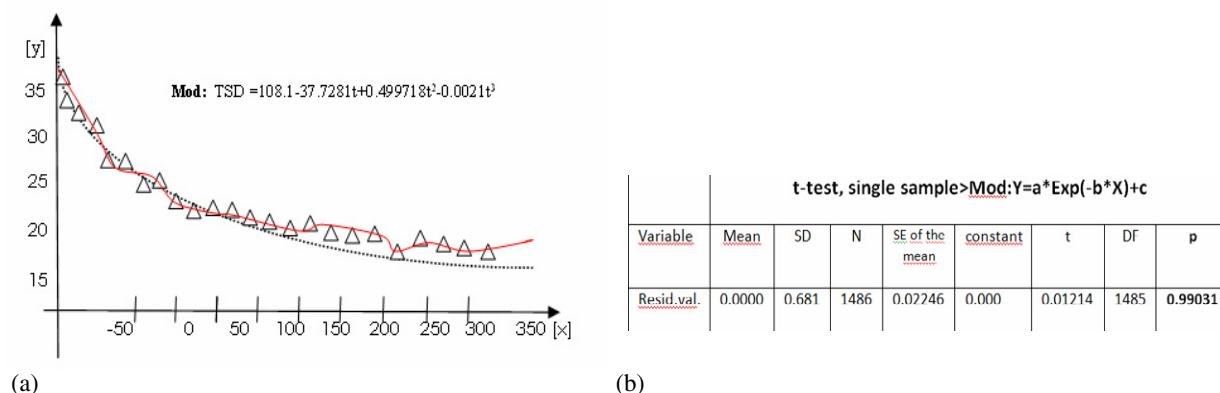| | t-test, single sample>Mod:Y=a*Exp(-b*X)+c | | | | | | | |
Variable	Mean	SD	N	SE of the mean	constant	t	DF	p
Resid.val.	0.0000	0.681	1486	0.02246	0.000	0.01214	1485	**0.99031**

(b)

Fig. 2 Ensuing p-graph of the interspaced data with the occurrence of bacterial translocation in the intestinal walls and (b) Normality of residues – mean value of residues is 0.99031

5. Conclusion

From the article herein above, it is possible to draw the conclusion that the practical application of Henssge's Nomogram is only realistic in the case that smaller changes to the construction of the model itself in connection with the segment of data. The elimination of undesirable factors in the area of per-rectal temperature measurement and the subsequent use of ´s Nomogram in Forensic Criminalistics is the subject of research and the suggestion of modern methods for non-invasive /non-contact data acquisition from the area of the peritoneal cavity of a biological object, which is set out in catalogue of subjects in the industrial ownership of ÚPV (Industrial Property Office - Patent Ownership) under č.sp. PV 2012-124.

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