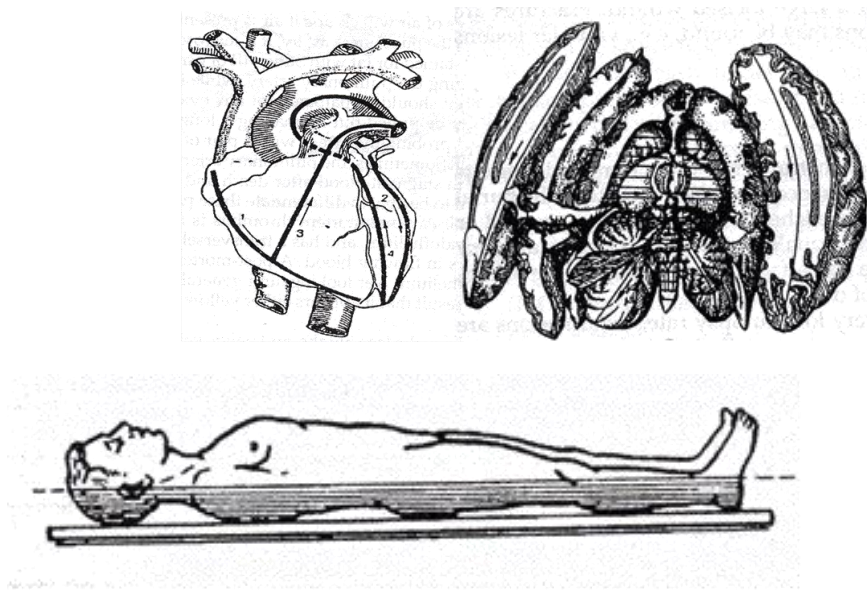


Module 1. The organization of forensic-medical examination and general problems of forensic medicine. Forensic-medical principles of examination violent and natural death

The sub module 2. Forensic-medical thanatology

Theme 3. Forensic-medical thanatology

Guidelines for students and interns



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Змістовний модуль 2. Судово-медична танатологія

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*Методичні вказівки
для студентів та лікарів інтернів*

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
Харківський національний медичний університет

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Рекомендовано вченою
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**Харків
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2014**

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Compilers: Vasil Olkhovsky
Mykola Gubin
Petr Kaplunovsky
Vjacheslav Sokol

Модуль 1. Організація судово-медичної експертизи та загальні питання судової медицини. Судово-медичні засади експертизи насильницької та ненасильницької смерті. Змістовний модуль 2. Судово-медична танатологія. Тема 3. Судово-медична танатологія: методичні вказівки для студентів та лікарів інтернів / упор. В.О. Ольховський, М.В. Губін, П.А. Каплуновський, В.К. Сокол. – Харків: ХНМУ, 2014.

Упорядники: Ольховський В.О.
Губін М.В.
Каплуновський П.А.
Сокол В.К.

Substantiation of the Topic. Forensic-medical thanatology is most an important section of forensic medicine. The medico-legal study of death falls within the unit of Forensic Thanatology (thanatos=death; logos=science). Thanatology deals with death in all its aspects.

Duration of practical classes: 3 academic hours

Purpose of the Practical Class: to reveal and describe signs of death, to make medico-legal conclusions.

Direct purpose of study:

1. The common peculiarities in the development of changes in the body;
2. Relative signs of death;
3. Forensic medical classification of changes in the body;
4. Postmortem lividity: morphogenesis, forensic medical diagnostics, significance for the expert's practice.
5. Rigor mortis: morphogenesis, forensic medical diagnostics, significance for the expert's practice.
6. Late changes in the body: preserving and decomposition changes. Putrefaction, adipocere (saponification), mummification.

Basic level of knowledge and skills (before the practical class):

1. Reasons of a pathomorphological autopsy;
2. Order of the documents drawn up in pathologic anatomy;
3. Principles of a pathologist's diagnosis;
4. Dialectic-materialistic and medical interpretation of essence of life and death;
5. Peculiarities of microorganisms physiology, rotting fermenting, decay;
6. Changes in a human body which are connected with dying.

Visual Aids and Material Tools

1. Different natural specimens and some reports of autopsy; the object of the investigation is the protocol part of the «Report of forensic autopsy" and additional cases materials.
2. Studying tables, photos, and video.

Technological card of carrying out of practical classes

№	Level	Time (min)	Manuals	Place of carried
1	Control of initial level of knowledge on the topic	15	Oral answering	Class room
2	Analysis the scheme of the description postmortem signs	15	Tables with scheme	Class room
3	Studying theme of classes, description postmortem changes on corps	60	Corps	Autopsy room
4	Conclusion about character of postmortem signs	10	Oral answering	Class room
5	The decision of situational tasks	30	Situational tasks	Class room
6	Classes summarising	5	-	Class room

BLOCK OF INFORMATION

Process of dying can be rapid, or long. Stages of dying:

1. Preagonal state. There is a loss of consciousness, falling of arterial pressure, decrease of the level of metabolism.
2. Terminal pause. Functioning of the nervous centres starts to have chaotic character; the arterial pressure and breath are reduced.
3. Agony. It is characterized by a further fall of arterial pressure and reduction of breath, but at a certain moment everything is back to normal and it seems that the person has survived the crisis and is recovering, but then all the parameters become again sharply reduced. The so-called "Hippocratic face" is observed (Hippocrates described the attributes of the dying person: sallow complexion, loss of shine of the eyes, sticking of the eyes, lowering of the lower jaw).
4. Clinical death. Complete oppression of consciousness, reflexes, heart activity and breath.
5. Biological death. It is the last stage of irreversible changes in organism.

THE MEANING OF DEATH

Death is now accepted as meaning brain stem death or brain death. The brain stem is a small area of the brain that controls respiration. If this area is dead, the person will never be able to breathe spontaneously or regain consciousness.

Molecular death means individual death of cells and tissues, which takes place usually 1 to 2 hours after the stoppage of the vital functions. Molecular death occurs piecemeal. Nervous tissues die rapidly, the vital centres of the brain die in about 5 minutes, but the muscles live up to 1 to 2 hours.

Some authorities recognize a third concept of *apparent death*. This is also known as a suspended animation. It may occur under certain specific conditions, for example drowning or hypothermia. Under such a condition, the signs of life are not found as the functions are interrupted for some period or are reduced to minimum. However, life keeps on, and resuscitation is successful in such cases. The functions may be diminished exactly like the metabolic processes and functions of the cells and organs of hibernating animals. With freezing of the body or severe drug poisoning of the brain, the activity of the brain can completely stop, and in some cases it can start again. Suspended animation may be produced voluntarily.

Severe brain damage which does not involve the brain stem may result in a persistent vegetative state. These patients breathe spontaneously, open and close their eyes, swallow and make facial grimaces. However, they show no behavioural evidence of awareness. It is in these cases that the moral dilemma of "allowing someone to die" arises.

Social-Legal Classification of Circumstances of Death

Categories of circumstances of death can be violent and non-violent. The violent death occurs due to action of environmental factors. Manner of violence falls under one of several categories:

- suicidal,
- homicidal,
- accidental,
- undetermined or unexplained origin.

The non-violent death is caused only by the internal reasons that are diseases. As for the manners of death, the non-violent death comprises sudden death, death from diseases and physiological death.

Post-mortem Signs

The signs of death are subdivided into three groups:

I. Immediate (relative signs of death):

- Insensibility and loss of voluntary power.
- Cessation of respiration.
- Cessation of circulation.

II. Early (absolute signs of death):

- Drying and loss of elasticity of skin, changes in the eye.
- Livores mortis.
- Rigor mortis.
- Cooling of the body.
- Autolysis of inner organs.

III. Late (absolute signs of death):

a) Decomposition and decay:

- Putrefaction.
- Decay by insects and animals.

b) Preserving:

- Adipoceros formation or saponification.
- Mummification.
- Peat hardening.
- Miscellaneous (salt, oil, freezing, etc.).

EARLY POST-MORTEM SIGNS

Drying and loss of elasticity of Skin, changes in the Eyes

Skin becomes pale and ashy-white and loses elasticity within a few minutes of death. The lips tend to darken due to drying. Drying flutters in connection with evaporation of moisture from the surface of body. Evaporation of moisture is a physiological, constantly compensated process, occurring in a living organism. After death the physiological balance between loss and compensation of liquid is disturbed, an organism starts to lose moisture by convection and evaporation. In places that at

life are most humidified (lips, sclera), drying is manifested intensively, as sites of parchment density. The speed and intensity of drying depend on conditions of environment, i. e. temperature of air, moving of air and specific features such as degree of fatty tissue, clothes, etc. Drying of skin and mucous begins at once after approach of death, but it is visually shown in for a short time. Epidermis protects the skin from drying, therefore in places where it is damaged (a graze, ligature marks), drying occurs quicker and forms a parchment or parchment spots.

Livores mortis

This is bluish-purple or purplish-red discoloration, which appears under the skin in the most superficial layers of the dermis (rete mucosum) of the dependent parts of the body after death, due to capillary-venous distension. It is also called post-mortem lividity, post-mortem staining, subcutaneous hypostasis, cadaveric lividity, suggillations, vibices and darkening of death.

The intensity of the colour depends upon the amount of reduced haemoglobin in the blood. It is caused by stoppage of circulation, stagnation of blood in blood vessels and its tendency to sink by force of gravity. The blood tends to accumulate in the subcutaneous tissues of dependent parts of the body. Filling of these vessels produces a bluish-purple colour to the adjacent skin. The upper portions of the body drained of blood are pale. The colour of hypostasis may vary from area to area in the same body

Stages of Livores mortis: Hypostasis; Stasis (diffusion), and Imbibition. Its extent helps in estimating the time of death.

I stage - Hypostasis. It is the earliest stage of Livores mortis in which there is only an outflow of blood through vessels downwards. Livores mortis begins shortly after death, but it may not be visible for about half to one hour after death in normal individuals, and from about 1 to 4 hours in anaemic persons. It is usually well developed within 4 hours and reaches a maximum between 6 and 12 hours. It begins as a patchy mottling of the skin. The areas then enlarge and unite to produce extensive discoloration. If the dynamometer (or the end of the thumb) is firmly pressed against the skin, the Livores mortis at that part will disappear and the skin will be pale when Livores mortis first develops.

II stage - Stasis. If the body is moved before the blood coagulated, these patches will disappear and new ones will form on dependent parts, but Livores mortis to a slight degree remains in the original area, due to staining of the tissues by haemolysis.

In about 10-12 hours the Livores mortis becomes "fixed" and repositioning the body, e.g. from the prone to the supine position, will result in a dual pattern of Livores mortis since the primary distribution will not fade completely. Fixation of Livores mortis is a relative, rather than an absolute phenomenon, nevertheless, well-developed Livores mortis fades very slowly and only incompletely. Duality of distribution of Livores mortis is of importance because it shows that the body had been moved after death. Duration of stasis is 10, 12-24, sometimes 36 hours.

III stage - Imbibition. It takes place when no less than 24-36 hours have elapsed since death. As the vessel walls become permeable due to decomposition, blood leaks through them and stains the tissues.

Rigor mortis

Rigor mortis: This is a state of stiffening of muscles, sometimes with a slight shortening of fibres. Individual cell death takes place in this stage. Rigor Mortis occurs due to chemical changes involving the proteins of muscles fibers. It marks the end of muscle's life. The contractile elements of muscles consist of two types of protein filaments — actin and myosin. When a muscle contracts, actin and myosin filaments utilize ATP. After death ATP supply is exhausted and the filaments are fused into a dehydrated stiff gel resulting in a condition termed Rigor Mortis.

Conditions Altering the Onset and Duration:

Muscular State: The onset is slow and the duration is long, in cases, where muscles are healthy and at rest before death. The onset is rapid if there is fatigue or exhaustion before death.

Age: In healthy adults, it develops slowly but is well-marked, while in children and old people it is feeble and rapid.

Nature of Death: In deaths from diseases causing great exhaustion and wasting (tuberculosis, cancer, cholera, typhoid, etc.), and in violent death (fire-arms or by electrocution, etc.) the onset of Rigor is early and duration is short. In strychnine and other spinal poisons, the onset is early and the duration is longer. In deaths from asphyxia, severe haemorrhage, nervous disease causing paralysis of muscles, the onset is delayed.

Atmospheric Conditions: At the increased ambient temperature and dry air Rigor develops more quickly, and at the lowered temperature and the damp environment - more slowly.

Time of Onset: Usually in tropical countries it begins 1 to 2 hours after death and takes further 1 to 2 hours to develop. In temperate countries, it begins in 3 to 6 hours and takes further 2 to 3 hours to develop.

Medico-Legal Importance:

- It is an absolute sign of death.
- Its extent helps in estimating the time and reason of death.
- It indicates the position of the body at the time of death.

Cooling of the Body

The Cooling of the body after death (algor mortis; chill of death) is a complex process, which does not occur at the same rate throughout the body. The body cools more rapidly on the surface and more slowly in the interior. For about half to one hour after death, the rectal temperature falls little or does not fall at all. The body heat is lost by conduction, convection and radiation. Only a small fraction of heat is lost by evaporation of fluid from the skin. In serious illness, circulation begins to fail

before death and hands and feet become cooler than the rest of the body; this coolness gradually extends towards the trunk. In sudden death, the Cooling starts after death. A laboratory thermometer 25 cm long, with a range of 0 to 50°C, which can be read in single degrees, is used. The rectum is the ideal place to record temperature except for cases of sodomy. The thermometer should be inserted 8 to 10 cm, and left there for two minutes. The temperature can also be recorded by making a small opening in the abdomen and inserting the thermometer under the liver. The time of this reading is recorded and temperature of environment is recorded at the same time. Reading should be made at intervals in order to obtain the rate of fall of temperature.

A rough idea of approximate time in hours of death can be obtained by using the formula:

$$\frac{\text{Normal body temperature - rectal temperature}}{\text{Rate of temperature fall per hour}}$$

It cannot be assumed that the body temperature is normal at death. In cases of fat or air embolism, certain infections, heat stroke and in cerebral haemorrhage, a marked rise in temperature occurs. Exercise or struggle before death may raise the rectal temperature up to 1.5°-2°C. Low temperature occurs in cases of collapse, congestive cardiac failure, etc. During sleep the rectal temperature is half to 1°C lower. Absolute sign of death is decrease of a body temperature below + 20°C.

In this condition of post-mortem calorificity the temperature of the body remains raised for the first two hours after death. This occurs when the regulation of heat production has been severely disturbed before death, as in sunstroke and in some nervous disorders, when there has been great increase in heat production in the muscles due to convulsions, as in tetanus and strychnine poisoning, etc., and when there has been excessive bacterial activity, as in septicaemia condition, cholera and other fevers.

Factors affecting the Rate of Cooling includes:

The difference in temperature between the body and medium: The temperature fall is rapid when the difference between body and air temperature is great. In tropical climates the heat loss is roughly 0.5°C to 0.7° C per hour, in temperate countries the heat loss is roughly 1.0°C per hour. The temperature estimates are of importance only in cold and temperate climates. In tropical zones the post-mortem fall in temperature may be minimal. Due to above-mentioned factors an accurate formula to determine rate of heat loss cannot be devised. The rectal temperature of an average-sized naked body reaches that of environment in about twenty hours.

- The build of the body: The rate of heat loss is proportional to the weight of the body to its surface area. Thus, children and old people cool more rapidly than adults.

- The physique of the body: Fat is a bad conductor of heat. Fat bodies cool slowly and lean bodies - rapidly.

- The environment of the body: A body kept in a well-ventilated room will cool more rapidly than that in a closed room. Moist air is a better conductor of heat than dry air, so that Cooling is more rapid in humid atmosphere than in dry atmosphere.

- Covering on or around the body: The rate of Cooling is slow when the body is clothed, as clothes are bad conductors of heat.

Medico-Legal Importance:

- It is a absolute sign of death.
- It helps in estimation of time of death.
- It helps in estimation of reason of death.

Autolysis

Autolysis is a process of self-digestion of tissues, caused by action of proteolytic enzymes, which occurs without participation of microorganisms. After death in separate organs and tissues during some time production of enzymes proceed. The vigorous activity of enzymes (pepsin, tripsin, etc.) not always stops right after death. Due to disintegration of cells, enzymes that in norm are isolated from tissues are released. Tissue acidosis promotes increase of activity of enzymes.

Initially autolysis it is shown in organs with the high contents of proteolytic enzymes (pancreas, adrenal glands, stomach, spleen, liver). There are destruction of organs and tissues.

Medico-Legal Importance:

Autolysis has negative value, simulating ante-mortem pathological processes. Besides allows determining rate of dying (at sudden death it is expressed more strongly).

LATE POST-MORTEM SIGNS

Putrefaction

Putrefaction is the final stage following death, produced mainly by the action of bacterial enzymes, mostly anaerobic organisms derived from the bowel. Other enzymes are derived from fungi, such as *Penicillium* and *Aspergillus*, and sometimes from insects.

The colour appears in 12 to 18 hours in summer and in 1 to 2 days in winter. Green coloration is more easily seen on a fair skin than on a dark one. The green coloration then spreads over the entire abdomen, external genitals, and then patches appear successively on the chest, neck, face, arms and legs. The patches become dark-green and later purple and dark-blue. They are at first scattered, but later on unite and the whole skin of the body appears discoloured.

The superficial veins, especially over the roots of the limb, chest and neck are stained greenish-brown or purplish-red due to the haemolysis of red cells which stains the wall of the vessel and infiltrates into the tissue, giving a marbled appearance. This starts soon, but is prominent in 36 to 48 hours. The clotted blood becomes fluid, and as such, the position of the post-mortem staining is altered and the fluid blood collects in the serous cavities.

The chemical processes in this stage are those of reduction, the complicated proteins and carbohydrates being split into simpler compounds. The gases are non-

inflammable in the early stages, but as decomposition progresses, enough of hydrogen sulphide is formed, which can be ignited to burn with a blue flame. Gases collect in the intestines in 12 to 18 hours in summer, and the abdomen becomes tense and distended. On opening the abdomen the gas escapes with a loud explosive noise. At about the same time, the eyeballs become soft and yielding, the cornea becomes white and flattened. Later, the eyes collapse. Discoloured natural fluids and liquefied tissues are made frothy by gas. Due to presence of gas in the abdomen, the diaphragm is forced upwards compressing the lungs and heart and blood-stained froth exudes from the mouth and nostrils (post-mortem purge), which can be mistaken for bleeding following ante-mortem injury. The compression of heart forces out its contents. Pressure of gases may force food from the stomach into the fauces, and this may fall into the larynx.

From 18 to 36-48 hours after death, gases collect in tissues, cavities and hollow viscera under considerable pressure and the features become bloated and distorted. The subcutaneous tissues become emphysematous, due to which even a thin body appears obese. The breasts, scrotum and penis are greatly distended. The eyes bulge from their sockets, the tongue is forced out between the swollen and discoloured lips. The sphincters relax and urine and faeces may escape. The gas formation in the blood vessels may force blood stained fluid, air or liquid fat form small blisters between the epidermis and dermis. These gradually enlarge, unite and rupture, exposing large areas of dermis.

Colliquative putrefaction begins from 5 to 10 days or more after death. The abdomen bursts and the stomach and intestines protrude. In children, thorax also bursts. The tissues become soft, loose and are converted into a thick, semi-fluid, black mass and are separated from the bones and fall off. The cartilages and ligaments are softened in the final stage.

Adipoceros formation (Saponification)

In this, the fatty tissues of the body change into a substance known as adipocere. The change is due to gradual hydrolysis and hydrogenation of preexisting fats, such as olein, into higher fatty acids, which being acidic, inhibit putrefactive bacteria. Adipocere is delayed by cold and formed rapidly by heat.

Fresh adipocere is soft, moist, whitish and translucent, but old samples are dry, hard, cracked, yellowish, and brittle. It is inflammable and burns with a faint-yellow flame. It floats in water and dissolves in alcohol and ether.

Time required for Adipocere formation: In temperate countries, the shortest time for its formation is about three weeks in summer, when it occurs to a certain extent. Complete conversion in an adult limb requires at least three to six months.

Medico-Legal Importance

- When the process involves the face, the features are well-preserved, which help to establish the identity.
- The cause of death can be determined, because injuries are recognized.
- The time since death can be estimated.

- It indicates the place - water or moist ground, from which the body has been recovered.

Mummification

It is a modification of putrefaction. Dehydration or drying and shrinking of the cadaver occur from evaporation of water, but the natural appearance and features of the body are preserved.

It begins in the exposed parts of the body like face, hands and feet and then extends to the entire body including the internal organs. The skin may be shrunken and contracted, dry, brittle, leathery and rusty-brown in colour and adheres closely to the bones. As the skin contracts, some of the fat cells in the subcutaneous tissues are broken and the liquid oil is forced into the dermis which becomes translucent. The face will be greatly distorted due to shrinkage of soft tissues.

Mummification may be partial in some cases with only limbs or head or trunk being affected. The internal organs are shrunken, hard, dark-brown and black and mix together or may disappear. The entire body loses weight, becomes thin, stiff and brittle. If a mummified body is not protected, it will be gradually lost into dust, but if protected, it may be preserved for years. A mummified body is practically odourless. The time required for complete mummification of a body varies from three months to a year or two.

Two factors are necessary for the production of mummification: absence of moisture in the air, and a continuous action of dry or warmed air. A body may be mummified artificially for the purpose of its preservation by a process known as embalming. The process consists of injecting embalming fluid containing formaldehyde, or solutions of lead sulphide, and potassium carbonate, into the femoral artery, the aorta and/or the carotids.

Medico-Legal Importance: It is the same as that of Adipocere, and also it indicates the place - hot, dry area, from which the body has been recovered.

QUESTIONS FOR STUDENT'S INDEPENDENT WORK

1. Death and its Causes.
2. Early post-mortem changes and their forensic-medical significance.
3. Late post-mortem changes and their forensic-medical significance.
4. Estimation of post-mortem Interval.

TESTS AND SITUATIONAL TASKS FOR SELF-ASSESSMENT

1. Mark the absolute sign of death
 - A. The unmoving position of body
 - B. Loss of any reflexes
 - C. Cooling of lower extremities
 - D. Livores mortis
 - E. Cessation of breathing
2. Stasis develops when ...hours have elapsed after death

- A. 2-3 hours
 - B. 4-5 hours
 - C. 8-10 hours
 - D. 12-14 hours
 - E. 18-20 hours
3. Under thumb pressure, postmortem lividity does not disappear but it becomes pale. Which stage or phase of postmortem lividity development takes place?
- A. the 1 phase of hypostasis
 - B. the 2 phase of hypostasis
 - C. stage of diffusion
 - D. stage of imbibitions
 - E. stage of blood coagulation
4. Citizen N. aged 75 was found out dead at home. Forensic-medical examination of the corpse revealed: cyanosis of the face and mucous membranes, and ill-defined livores mortis; red and mixed clots of blood in the heart and large vessels; oedema of pia mater and lungs. What do these signs indicate?
- A. Sudden death.
 - B. Asphyxial death
 - C. Apparent death.
 - D. Supercooling.
 - E. Agonal death.
5. Where should the temperature a dead body be measured for a estimation of death time on a place of detection corps?
- A. In axillar region
 - B. In a mouth
 - C. In a whisker
 - D. In a rectum
 - E. In iliac area

ANSWERS

1 — D; 2 — C; 3 — C; 4 — E; 5 — D

After the practical class every student should know:

1. General peculiarities of postmortem changes in the body;
2. Morphological features and forensic-medical importance of early and late changes in a body

should be able to:

1. Investigate changes in a body;
2. Determine the degree of expressiveness of post-mortem signs;

3. Determine the time of death;
4. Make forensic-medical diagnosis and drawing a Conclusion



THE RECOMMENDED AND USED LITERATURE

Basic:

1. Babanin A.A. Forensic medicine: Textbook / A.A. Babanin, O.V. Belovitsky, O.Yu. Skrebova. – Simferopol, 2007. – 464 p.
2. Franchuk V.V. Forensic Medicine: practical guide / V.V. Franchuk. – Ternopil: TSMU, 2011. – 2004 p.

Additional:

1. DiMaio V.J. Forensic Pathology, Second Edition (Hardcover) / V.J. DiMaio, D. DiMaio. - Boca Raton: CRC Press, 2001. – 592 p.
2. McLay W. D. S. Clinical Forensic Medicine 2E / W. D. S. McLay. – London: Greenwich Medical Media, 1996. - 336 p.
3. Jason P. Forensic Medicine: Clinical and Pathological Aspects / P. Jason, B. Anthony, S. William. - London: Greenwich Medical Media, 2001. – 832 p
4. Shepherd R. Simpson's Forensic Medicine / Shepherd R. - London: A Hodder Arnold, 2003. – 208 p.
5. Stark M.M. Clinical Forensic Medicine: A Physician's Guide (Forensic Science and Medicine): 2nd Edition / M.M. Stark – Totowa, NJ: Humana Press, 2005 - 455 p.

Навчальне видання

**Модуль 1. Організація судово-медичної експертизи та загальні питання судової медицини. Судово-медичні засади експертизи насильницької та ненасильницької смерті.
Змістовний модуль 2. Судово-медична танатологія.**

Тема 3. Судово-медична танатологія

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для студентів та лікарів інтернів*

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Відповідальний за випуск Губін М.В.

Комп'ютерний набір Губін М.В.