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Modern Aspects of Forensic Examination of Drowning

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Abstract
Drowning is defined as death from mechanical asphyxia due to the closure of the respiratory tract by a liquid, most often water. As literature data show, drowning has been and remains a serious social problem, since a significant number of people, mostly young people, die from drowning. Forensic medical diagnosis of drowning, as well as other causes of death, is made on the basis of establishing a set of signs detected both during a sectional study and with the help of additional research methods and depending on the type of drowning. This literature review focuses on modern aspects of forensic medical examination of drowning.

Keywords: drowning, forensic medical examination, corpse, plankton.

Relevance. According to the WHO, more than 300,000 people die from drowning every year, making drowning a major public health problem in the world. This type of injury accounted for more than 9% of total global mortality, accompanied by various complications [13, 15]. Drowning is the third leading cause of death from unintentional injuries, accounting for 7% of all injury-related deaths [3]. In accordance with the methods used to systematize official drowning data, they exclude cases of intentional drowning deaths (suicide or homicide), as well as drowning deaths resulting from floods and watercraft accidents. Particular attention is paid to laboratory research methods [1, 5], especially the detection of diatom plankton in internal organs [1, 3, 8, 10].

The most important issue in the forensic medical examination of corpses of persons recovered from water is the establishment of factors contributing to drowning. At the same time, determining the circumstances of the drowning is difficult without knowledge of the specific location of the incident. Therefore, it is relevant to develop new objective methods that make it possible to clarify the location of drowning. Drowning is defined as death from mechanical asphyxia due to the closure of the respiratory tract by a liquid, most often water. As literature data show, drowning has been and

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remains a serious social problem, since a significant number of people, mostly young people, die from drowning. For drowning, complete immersion of the body is not necessary; immersion of only the head or part of it in water with the closing of the breathing holes is sufficient (in a state of alcoholic intoxication, during an epileptic seizure, etc.) [1]. According to generally accepted opinion, death from drowning (as a type of mechanical asphyxia) occurs from the cessation of air flow into the respiratory tract due to their closure with liquid. However, drowning has a number of features that significantly distinguish it from other types of mechanical asphyxia. When the body is immersed in water, a reflexive breath hold of varying duration occurs. Due to the increasing lack of oxygen in the body, involuntary respiratory movements appear. At the stage of inspiratory dyspnea, water begins to actively enter the respiratory tract, irritating the mucous membrane of the trachea and large bronchi, causing coughing movements [3, 7, 8]. The mucus released during this process mixes with water and air, forming a foamy mass of grayish-white color that fills the lumen of the respiratory tract. During the stage of inspiratory and expiratory dyspnea, a person usually tries to float to the surface of a reservoir (increasing oxygen starvation leads to loss of consciousness). In the stage of relative rest, when respiratory movements are temporarily suspended, the human body sinks to depth. At the stage of terminal respiratory movements, water under pressure enters the depths of the respiratory tract, fills the smallest bronchi and penetrates, along with the remaining air, into the alveoli. Due to high intrapulmonary pressure, alveolar emphysema develops, or so-called acute water emphysema - hyperhydroaeria. Water, breaking the walls of the alveoli, enters the tissue of the interalveolar septa. Through broken capillaries, water enters the blood vessels. Blood diluted with water penetrates the left half of the heart, and then into the systemic circulation. Following the terminal stage comes the final cessation of breathing [2]. The entire period of drowning lasts on average 5–6 minutes. The rate of development of asphyxia during drowning is greatly influenced by water temperature, hydrostatic pressure, emotional factors, etc.

In cold water, the onset of death from drowning is accelerated due to the rapid impact on reflex zones. Observations show that the process of dying during drowning does not proceed in the same way, therefore the results of autopsies of drowned bodies are far from the same. The spastic (asphyxial) type of drowning is characterized by signs of death from acute oxygen starvation, caused by the closing of the respiratory openings with water with the development of a persistent spasm of the larynx from irritation of its receptors with water. Due to the occurrence of pseudo-respiratory respiratory movements with a closed glottis, the phenomena of acute hyperairy of the lung tissue develop with damage to its structural elements. The reflex (syncope) type of drowning is caused by the simultaneous rapid cessation of respiratory and cardiac activity when a person suddenly finds himself in extreme conditions. Pathological changes in the heart and lungs and a specific allergic reaction to the aquatic environment may play a role in the occurrence of this type of drowning [4, 10].

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The mixed type of drowning is characterized by polymorphism of signs, which is caused by a combination of different types of dying. To establish a specific type of drowning, the authors proposed a diagnostic tetrad: fluid in the sinus of the main bone, acute pulmonary emphysema, air embolism of the left heart, “reflux” of red blood cells into the thoracic lymphatic duct, which objectively characterizes patho- and thanatogenesis in various types of drowning [1,3] .

Research suggests that higher rates of drowning among men are associated with increased exposure to water and riskier behaviors such as swimming alone, drinking alcohol before swimming alone, etc. Increased access to water is another risk factor for drowning. Children who live near sources of open water, such as ditches, ponds, irrigation canals, or swimming pools, are at increased risk of drowning.

Usually, to establish a specific type of drowning, a diagnostic tetrad is proposed: fluid in the sinus of the main bone, acute pulmonary emphysema, air embolism of the left heart, “reflux” of red blood cells into the thoracic lymphatic duct, which objectively characterizes patho- and thanatogenesis in various types of drowning. When autopsying the corpses of persons who died from a true type of drowning, lungs are found to be sharply increased in volume. Their anterior sections cover the cardiac shirt. Stripe-like imprints of ribs may be visible on the surfaces of the lungs. The surface of the lungs often has a “marbled” appearance. Lungs don't always look the same. Hyperairy is a condition of the lungs when they are sharply swollen, but on a cut they are dry, or a small amount of fluid drains from the surface [6,10]. Hyperaeria depends on the penetration of air into the tissue under the pressure of liquid. At the same time, the alveoli rupture, and air penetrates into the intercellular tissue. Hyperhydria is a condition of the lungs when a large amount of watery liquid flows from the cut surfaces, the lungs are heavier than usual, but are airy everywhere. Rasskazov-Lukomsky-Palstauf spots are located subpleurally, which are vague hemorrhages in the form of spots or stripes under the pleura of the lungs. They have a pale pink color. The blood in the left half of the heart is diluted with water and has a cherry-red color [4, 10]. With the dry type of drowning, water is swallowed, especially in cases where this process is prolonged and the head appears above the surface. In such cases, a large amount of liquid is found in the stomach, in which the drowning occurred. Water may also be present in the initial part of the intestine. In the sinus of the main bone of the skull, fluid is found in which the drowning occurred. With a perforated eardrum, water irritates the receptors of the middle ear, and death can occur reflexively (like the so-called auriculocardiopulmonary reflex). It is imperative to open the cervical spine to avoid damage. Drowning also occurs after jumping into water upside down, when the cervical spine is damaged when hitting the surface of the water or the ground. Sometimes hemorrhages occur in the muscles of the neck and chest: along the sternocleidomastoid muscles, in the pectoral muscles. The detection of

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diatom plankton in the internal organs of a corpse is of great importance for the diagnosis of drowning [4, 7]. Diatoms are single-celled algae that have a durable mineral shell (shell). Usually, their detection in internal organs indicates drowning. If diatoms were detected only in the lungs, postmortem exposure of the body to water was excluded. For research, areas of the lungs, heart, spleen, kidneys, bone marrow, and fluid from the sinus of the main bone are taken. A water sample from the body of water where the corpse was found was required to be tested for diatom plankton.

Consequently, forensic medical diagnosis of drowning, as well as other causes of death, is made on the basis of establishing a set of signs detected both during a sectional study and with the help of additional research methods and depending on the type of drowning. For the true ("pale", "wet") type of drowning (in natural reservoirs or in reservoirs simulating natural ones), the presence of persistent whitish fine-bubble foam at the openings of the mouth and nose, acute swelling of the lungs, hemorrhages under the pulmonary pleura, detection of fluid in the drowning environment in sinus of the sphenoid bone, diatom plankton in the internal organs and bone marrow and some other signs. In the pathogenesis of the asphyxial ("blue", "dry") type of drowning, the leading link is an acute disorder of external respiration, and therefore, when examining a corpse, diffuse, saturated cadaveric spots of a bluish-violet color, cyanosis and puffiness of the face and neck, hemorrhages in the conjunctiva are noted , pronounced swelling of the lungs with a significant increase in their volume and airiness [7, 8]. The reflex type of drowning is characterized by signs of quickly occurring death, the most pronounced of which are diffuse, saturated cadaveric spots of a bluish-violet color, a liquid state of blood in the cavities of the heart and large vessels in the absence of signs of other types of drowning. In addition to signs that directly or indirectly indicate drowning, there are signs of a corpse being in water: pale skin, the so-called. "goose bumps", wrinkling of the skin of the scrotum and nipple area, maceration of the skin (the time and extent of which depend on many factors - water temperature, age of the victim, etc.). The final signs of maceration are the spontaneous separation of the epidermis of the hands along with the nails (the so-called "gloves of death"). What makes it difficult to identify the corpse. On the feet, the skin peels off only on the plantar surfaces. In the process of putrefactive changes in the corpse, hair separation occurs [9, 10]. Under the influence of water, hair loses contact with the skin. Wet items of clothing, skin and hair of the corpse, the presence of sand, silt, and algae on them also indicate that the corpse was in water.

Conclusions. Thus, providing locally supervised care for preschool-age children and people under the influence of alcohol may reduce the risk of drowning. The characteristic signs of various types of death from drowning have been identified. It is necessary to pay special attention to both a number of morphological changes in internal organs and the results of laboratory studies (the presence of diatom plankton) [10, 12].

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