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Review Article

A review on importance of forensic photography in investigation of drowning deaths

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ABSTRACT

Forensic photography plays an important role in solving the cases related with drowning, a proper photography of crime scene or victim/deceased helps in proper investigation, ruling out doubts and also in court room presentation. A recent report of the World Health Organization (WHO) labels drowning as one of the world's leading causes of death [1] As police investigation continues, parallel public investigations also start which can spread rumours, misinformation and speculation. The onlookers on crime scene (including Local Media) may misinterpret the visible post mortem changes of the body of drowned victims as antemortem injuries. A clear photography using correct lighting, accurate angling, and different viewpoints of the characteristic external features like (Bluish Skin, Froth and foam, Washerwomen's Hand, Cutis anserina, Cyanosis, Keratin loss, Cadaveric spasm) of drowned body [2] and evidences around the crime scene will help in avoiding possible misinterpretation and public pressure on officials and also helps the medical officer in autopsy findings and in preparation of report. This article discusses the importance of Photography of drowning cases.

1. Introduction

Drowning is a form of asphyxia due to aspiration of fluid into air-passages, caused by submersion in water or other fluid. Complete submersion is not necessary, for submersion of mouth and nostrils alone sufficient period can cause death from drowning. About 1,50,000 people die from drowning each year around the world.

Types of drowning: a) Wet drowning: In this, water is inhaled into lungs and the victim has severe chest pain. This is also known as typical drowning, in which death occurs within minutes of submersion. b) Dry drowning: In this type, water does not enter the lung, but death results from immediate sustained laryngeal spasm due to inrush of water into the nasopharynx or larynx. c)Post immersion syndrome or near drowning: Near drowning refers to a submersion victim who is resuscitated and survives for 24 hours. The person may or may not be conscious. The person may develop hypoxemia, pulmonary oedema, sepsis, cardiac arrythmias and myocardial anoxia. d) Immersion syndrome: Death results from cardiac arrest due to vagal inhibition as a result of (a)cold water stimulating the nerve endings of the surface of the body, (b) water striking the epigastrium, (c) cold water entering ear drums, nasal passages, and the pharynx and larynx which cause stimulation of the nerve endings of the mucosa. Deprivation of oxygen caused by obstruction of alveolar spaces is factor in all types of drowning, especially as the time of immersion lengthens. [3] (d) Shallow water drowning (Submersion of the unconscious): Alcoholics, drugged, epileptic, children and unconscious persons may die due to drowning in shallow water in a pit or drain.

Drowning, often referred to as the "silent epidemic," continues to claim countless lives worldwide, posing a

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significant public health concern. As one of the leading causes of unintentional injury-related fatalities, drowning incidents occur in various settings, from natural bodies of water to swimming pools and bathtubs. Despite its prevalence, the multifaceted nature of drowning deaths demands a comprehensive exploration to grasp the underlying factors contributing to this global crisis.

2. Materials and Methods

The Digital SLR camera is the primary choice for crime scene investigations. For effective crime scene and evidence photography, digital cameras with image sensors of twelve megapixels or higher and manual exposure settings, in addition to automatic or programmed modes, are typically recommended.

When selecting digital cameras for this purpose, one of the most critical factors to consider is the quality of the image sensor. Image sensors with a resolution of twelve megapixels or greater are capable of producing photographs that can be enlarged to 16" x 20" for use as court exhibits. However, several other factors should also be taken into account when choosing digital photography equipment. These include close-up photography capabilities, the availability of accessories, and even the choice of printer for producing high-quality digital prints.

The majority of contemporary cameras come equipped with reliable automatic exposure systems as a standard feature. In fact, approximately 90% or more of the photos captured at typical crime scenes can be effectively taken using the camera's automatic modes. However, it is crucial to recognize situations, where relying solely on automatic functions might yield suboptimal images. This awareness allows you to make necessary adjustments or adapt your photography techniques for better results.

Accessories required along with Digital Camera (DSLR):

1. Tripod: A tripod helps ensure stable and level shots, which are essential for documenting the scene accurately. In drowning cases, it can be used to capture clear images of the victim's position in the water, the surrounding area, and any relevant evidence.
2. Macro lens: A macro lens allows for detailed close-up shots of specific evidence, such as injuries on the victim's body or objects related to the incident, like aquatic plants or debris.
3. Flashes (TTL) and lighting equipment: Proper lighting is crucial for achieving well-exposed and clear images in challenging conditions, such as low-light situations, or areas with poor visibility.
4. Scale markers: Placing scale markers, such as rulers (ABFO no.2) or measuring tapes, in the photographs helps provide a reference for size and distances in the images. This is important for accurately documenting evidence and recreating the scene.[4,5]
5. Memory cards and backup equipment: Ensure you have ample memory cards and backup camera equipment to capture a large number of images and ensure you don't miss any critical evidence.

2.1. Correct exposure

The incident light, which represents the amount of light illuminating the scene. The reflected light, signifying the light that bounces off the subject. The ISO value, denoting the sensitivity of your camera's image sensor. f-stop, indicating the aperture of your lens. Shutter speed, representing the duration for which the camera's shutter remains open.[6]

Incident light: Outdoors, the incident light intensity can fluctuate significantly, ranging from 100,000 lux in bright sunlight to as low as 0.0001 lux under weak starlight conditions. In scenarios like overcast days or stadium lighting for televised professional sports, the lighting levels typically fall within the range of 2,000 to 3,500 lux. Indoors, the light intensity can range from complete darkness with no lux to around 50 lux in a dimly lit suburban living room, and up to 600 lux in well-illuminated settings like an office or a television studio. In outdoor environments, the incident light's intensity can fluctuate continuously as clouds pass in front of the sun and as the sun progresses across the sky.

Reflected light: A scene composed almost entirely of freshly fallen snow might reflect 90% of the incident light. A scene composed almost entirely of anthracite coal dust might reflect 2% of the incident light. Crucial factors include the angle of incidence, which determines how the incident light strikes the subject, and the angle of reflectance, which dictates how this light is reflected back towards the camera.

Additionally, the subject's lighting conditions can vary, ranging from front lighting, side lighting, to back lighting. Cameras typically produce their highest picture quality at their base ISO, which is usually ISO 100. In the case of advanced DSLR cameras, good picture quality can often be achieved at ISO 800-1000, while fair picture quality is attainable at ISO 1600-3200. For situations demanding flexibility, picture quality that suffices can be obtained at ISO 6400 and beyond.[7]

(ISO-International Organization for Standardization)

Considering the substantial number of cameras that have been discontinued but are still in use, it's advisable to conduct tests with your camera across different ISO values to determine the highest ISO setting that still yields photos suitable for your intended purpose.

2.2. Lighting angles

Shutter speed: Shutter speed regulates the duration for which the camera's shutter remains open. In the case of

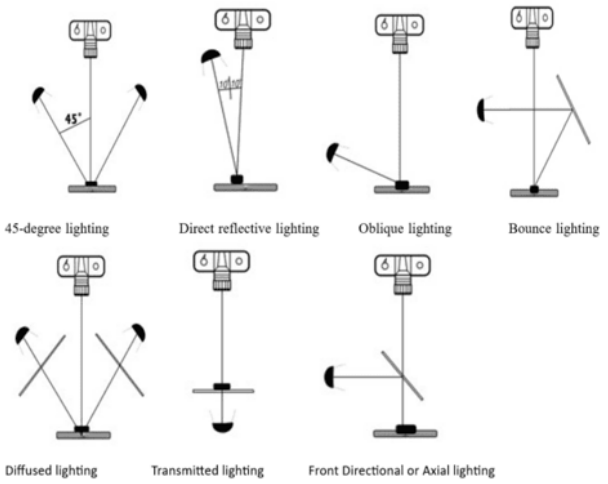

Figure 1: Different lighting angels in close up photography

an advanced camera, you have the flexibility to choose shutter speeds ranging from as long as thirty seconds to as short as 1/8,000th of a second. For instance, a thirty-second exposure can capture well-exposed images under the light of a full moon. To capture a crisp image of humming bird's wings in motion, a shutter speed of $1/8{,}000^{th}$ is good starting point.[8]

Lens aperture: The lens aperture, often referred to simply as the "aperture," is an adjustable opening in a camera lens that controls the amount of light that enters the camera and reaches the image sensor or film. It is a key component in photography and is measured in f-stops. The aperture setting determines the size of the opening, and it also affects other aspects of the photograph, such as depth of field and exposure. A smaller f-stop number (e.g., f/2.8) represents a larger aperture opening, allowing more light to enter and resulting in a shallower depth of field. A larger f-stop number (e.g., f/16) signifies a smaller aperture opening, which lets in less light and results in a deeper depth of field. Photographers use different aperture settings to control exposure, create artistic effects, and manage the sharpness of their images.[9]

3. Results and Discussion

Most of the external signs are not specific of death due to drowning and are rather signs of submersion of body under water for some period. Any dead body, Whatever the cause of death, will develop signs of immersion if left for a sufficient time water. When freshly removed from water, the body and clothes will be wet. There will be sand and particles on the body, hair and clothes. This finding is not specific of antemortem drowning or death due to drowning. The external findings along with internal findings, histological, toxicological and presence/absence of diatoms tissue and bone marrows will give a suitable report on the type of drowning. Information from possible site of drowning: Position of a submerged dead body, drowning site, surroundings of the site, accessibility, disturbance at site, unusual materials present in the scene, foot wear of the victim etc are important.

Figure 2: Body ofwoman in drowning position

A person submerged in water in the typical "drowning position," with their front facing downward. When this individual reaches shallow water, their limbs and forehead often come into contact with the riverbed, causing them to be scraped or bumped.

Cyanosis: It is a bluish or purplish discoloration of the skin or mucous membranes, often seen around the lips, fingers, and toes, due to a lack of oxygen in the blood (Figure 3). In drowning cases, cyanosis is a common and significant finding. It is an important clinical sign that indicates a critical oxygenation problem, and it is often an ominous sign in drowning cases.

Eyes are found half open or closed and pupils are dilated. Subjunctival haemorrhages may be present in lower eyelids, tongue may be swollen and protruded.

Postmortem staining: Light pink in colour, present over face, neck, front, of upper part of the chest, upper and lower limbs, as the body usually floats with face down, buttocks up, legs and arms hanging down infront of the body. With onset of putrefaction, skin, of head and neck become dark (Figure 7).

Froth: Presence of fine, copious white 'shaving lather' like froth at the mouth and nostrils is the most characteristic

Figure 3: Cyanosis & facial congestion in drowning death

Figure 4: Maceration of skin & presence of mud near nostrils

Figure 5: Appearance of froth from nostrilsin drowned body exposed to sun.

Figure 6: Froth mixed with blood oozing from mouth

antemortem external finding. Production of this tenacious, fine, lathery foam is a vital phenomenon.[10] The mass of foam, consisting of the fine bubbles, does not collapse when touched with the pointed object. It may be not present when wiped off, but it will reappear by itself within few minutes and when small amount of pressure applied on chest. The froth is produced by irritation of mucous membrane of air passages which causes the tracheal and bronchial glands to release visible amount tenacious mucus. Agitation of the seromucous secretion, surfactant, aspired water and retained air and drowning medium converts into froth. (Figure 6)

Cutis anserina : (goose skin/goose flesh/goose bumps/horripilation) is state of puckered and granular appearance of skin of the extremities immersed in cold water due to contraction of erector pilorum muscles (arrector pili muscle). Figure 7. It can occur on submersion of the body in cold water immediately after death while muscles are still warm and irritable, and also produced by rigor mortis of erector muscles.[11]

When a body is submerged in water while it decomposes, skin slippage takes place in around 24 hours. With water soaking through the top layers of skin, the cells holding the layers together separate far faster, letting in more bacteria into the rest of the body to aid in decomposition.

Washerwoman's hand: hand is wrinkled, sodden, bleached appearance of palms, palmer aspect of fingers and soles of feet including plantar surface of toes due to submersion of the body. Maceration of skin occurs due to imbibition of water into its outer layers. It is first seen in the fingertips by 3-4 hours and whole hand by 24 hours.[13,14]

Skin alterations due to prolonged immersion, characterized by pronounced skin wrinkling and eventual shedding of the skin, commonly referred to as "washerwoman changes."[16] (Figures 10 and 11)

Figure 7: Postmortem Staining& cutis anserina on chest

Figure 8: Skin slippage on back of the drowned body

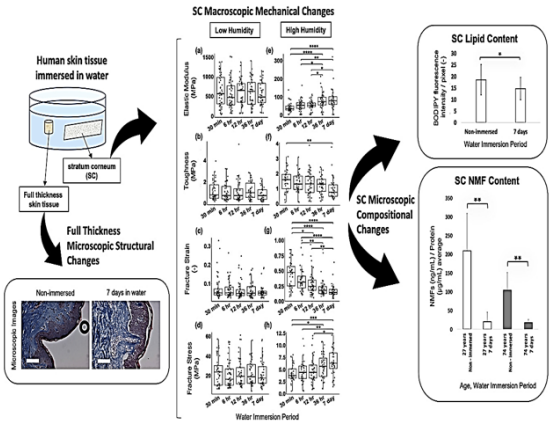

Figure 9: Mechanical, compositional, and microstructural changes caused by human skin maceration. https://doi.org/10.1016/j.eml.2020.101017.(https://www.sciencedirect.com/science/article/pii/S2352431620302340) [12]

Figure 10: Washerwoman changes in hands. [15]

Figure 11: Washerwoman changes in feet.

Grass, gravel, mud, sand, weeds or aquatic vegetations held firmly in clenched hands due to cadaveric spasm is a vital proof of antemortem drowning (Figure 12) The material clenched in the hands indicates the place of submersion. Rigor mortis appears early, especially when a violent struggle for life has taken place before death.

Figure 12: Mud and weeds held firmly in clenched hand [17]

Antemortem injuries might be sustained during fall into water, along the tank or by striking against a hard object while diving in shallow water. Examination of the skin

for blunt injuries should be delayed until the body is dry. Abrasions are easily seen after drying, which becomes brownish in colour.

Prolonged immersion causes maceration on the palms of the hands and soles of the feet and, later nail and skin detachment in a 'glove and stocking' manner (Figure 13) in cold water, this takes several weeks, but at warmer temperatures only a few days.

Figure 13: Skin detachment in a 'Glove and Stocking' manner.[18]

Adipocere is formed by the hydrolysis of triglycerides into glycerine and free fatty acids when adipose tissue decomposes. It is grey-white in colour and initially waxy, later developing a crumbly to solid consistency as fatty acids crystallize. This leads to solidification of affected body parts. Adipocere forms under a variety of conditions, as well as in embalmed and embalmed bodies.[19]

Figure 14: Adipocere formation in remains recovered from a moist environment.[20]

(Image courtesy of Krista Timm MD, Denver Office of the Medical Examiner)[21]

4. Conclusion

In summary, forensic photography proves to be an indispensable asset in the thorough investigation and resolution of drowning cases. The meticulous and systematic documentation of both the crime scene and the victim's state plays a pivotal role in dispelling uncertainties, quelling rumours, and curbing the propagation of misinformation and conjecture often associated with such incidents.

While police investigations progress, the simultaneous public scrutiny and media attention can lead to potential misinterpretations, especially when it comes to distinguishing post-mortem changes from antemortem injuries. Therefore, the methodical and precise application of photography, including proper lighting, angles and perspectives, becomes imperative in capturing the unique external features of a drowned body and the surrounding evidence.

Forensic photography, when executed with precision, not only aids authorities in upholding public trust and mitigating undue external pressures but also significantly assists medical examiners in conducting accurate autopsies and producing comprehensive reports. It stands as an objective and incontrovertible record of the scene and the victim's condition, thereby ensuring the pursuit of justice, both in the investigative process and in the courtroom. Hence, the importance of photography in drowning cases cannot be overemphasized; it stands as a pivotal element in the quest for truth, justice, and well-informed decision-making within the realm of the criminal justice system.

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None.

6. Conflict of Interest

None.

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