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Drowning Means Penetration of Liquid into the Respiratory Tract and Lungs

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ABSTRACT

Drowning refers to the entrance of fluid into the airways and lungs. It happens when the throat's flap dips below the liquid's surface. Rather than air, fluid fills the air passages, causing a reflex closure in the larynx that halts the flow of liquid into the airways. The individual rapidly ingests significant amounts of liquid, which fills the stomach, leading to stomach swelling, and pushes the diaphragm, lungs, and heart towards the neck.

Keywords: Drowning, Respiratory Tract, Lungs, Water, Health.

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Introduction

Drowning is the occurrence of respiratory difficulty resulting from being submerged or immersed in liquid [1]. This condition can be lethal, cause complications without being fatal, or occur without complications at all. This interpretation is frequently adopted in medical, professional, and research contexts to ensure accurate and consistent data collection and analysis.

Drowning incidents are prevalent due to numerous activities across all age groups in various communities [2]. This phenomenon ranks as a significant contributor to unintentional fatalities, with estimates suggesting an average occurrence of 1 in 30,000 people annually, or about 500,000 deaths globally each year. For each drowning that results in death, there are typically four additional instances of non-fatal drowning, previously referred to as near drowning. Most drowning cases have the potential to be prevented. This is especially true for situations involving hypoxic blackouts due to intentional hyperventilation before diving or extended breath-holding while submerged.

The World Health Organization's definition of drowning indicates respiratory impairment caused by being submerged in liquid.

Generally, the lungs become inundated, although in 10% of cases, the lungs remain dry due to severe laryngospasm. The alterations in blood volume and makeup are influenced by the quantity and type of fluid inhaled. Typically, the amount of water inhaled is not extensive, leading to minimal changes in serum electrolytes. Freshwater causes hypervolemia and hemodilution, while saltwater (5% saline) results in hypovolemia and hemoconcentration. Nevertheless, the distinctions are not always straightforward, and the pathological changes observed after fatal drowning, as well as the clinical and investigative results after non-fatal drowning, are comparable for both freshwater and saline environments.

Water

Traditionally, the disparities between drowning in saltwater and freshwater have been highlighted [3]. This emphasis

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is mainly drawn from studies conducted on animals. In dog experiments, following the inhalation of substantial quantities of saltwater, it was possible to recover larger volumes through suction or mechanical drainage than initially introduced. The hypertonic saltwater was seen to pull fluid into the lung's interstitial area, believed to lead to hypovolemia, hypernatremia, hemoconcentration, and pulmonary edema.

In contrast, when dogs inhaled freshwater, only small amounts of fluid could be retrieved from the lungs. The hypotonic water was absorbed into the bloodstream. The pulmonary edema observed was thought to arise from the removal of surfactant, with expectations of hypervolemia; dilutional hyponatremia and hemolysis were anticipated.

Recent studies involving animals and collections of human cases have indicated that the tonicity of the aspirated fluid is not relevant in clinical terms. There are no noticeable clinical variations in lung injury patterns between drownings in saltwater and freshwater; both lead to a reduction in the amount and efficacy of pulmonary surfactant, resulting in pulmonary edema both directly and through the creation of osmotic gradients, along with hypoxia due to lung collapse, atelectasis, and shunting, ultimately leading to acute respiratory distress syndrome (ARDS).

Aspiration

When saltwater or freshwater is aspirated, it causes alterations in the alveolar surfactant and disrupts the alveolar capillary barrier, leading to atelectasis, mismatches in ventilation and perfusion, and hypoxia [4]. Saltwater has a hypertonic nature, leading to bronchoconstriction, inflammation, and pulmonary edema. Aspiring 2. 5 mL/kg of seawater leads to a notable 75% increase in the shunting of deoxygenated blood from the right side to the left. Freshwater, being hypotonic, is typically absorbed by the pulmonary blood vessels, entering the systemic bloodstream and harming the alveolar capillary membranes. This absorption could also create foam, which decreases ventilation efficiency. The importance of ingesting water into the stomach during the drowning event is still uncertain. Significant electrolyte imbalances due to aspiration and ingestion of both hypotonic and hypertonic liquids are rare, needing more than 22 mL/kg of fluid, although instances of both hypernatremia and hyponatremia have been reported.

Most drowning incidents happen in cold water, leading to a decrease in body temperature, with water considered to be thermoneutral at about 35 degrees Celsius. Cooling of the skin (cold shock) and tissue (hypothermia) are crucial aspects in drowning situations. The term 'dry drowning' historically referred to the 10% of drowning situations wherein the lungs appear macroscopically dry upon examination, attributed to laryngospasm caused by water irritation upon contact. This notion is still a matter of debate and is now regarded as inaccurate, as recent findings show microscopic liquid present in the lungs of all individuals who have drowned. The phrase 'secondary drowning,' which described patients developing acute respiratory distress syndrome (ARDS), is also considered misleading, as there is no second submersion involved, and ARDS is recognized as a complication linked with the drowning experience.

Clinical Picture

The drowning phenomenon presents a continuum, starting with respiratory difficulties as an individual's airway is submerged below the liquid's surface or when large amounts of water impede the airway by splashing over the face [1]. If an individual is rescued at any point during this process, the drowning is interrupted, which is designated as nonfatal drowning. Conversely, a fatal drowning occurs if the individual succumbs at any stage. Instances of submersion or immersion without signs of respiratory distress are categorized as water rescues rather than drownings.

When water enters the air passages, an initial coughing reflex is triggered. Consequently, persistent coughing can serve as an indicator that differentiates drowning from other water-related stress scenarios. It is uncertain whether a temporary laryngospasm may take place during the initial inhalation of water, but its clinical importance remains unclear. As a person remains submerged, whether or not they aspirate water, hypoxemia can result in unconsciousness, cessation of breathing, and lung injury. Extended apnea and low oxygen levels can lead to cardiac arrest. Typically, hypoxic cardiac arrest happens following a phase of rapid heart rate, then slowing heart rate, and eventually pulseless electrical activity; it is uncommon for this condition to present as ventricular fibrillation. The transition from submersion to cardiac arrest happens in a matter of seconds to minutes. The only reliable factor that predicts outcomes at the scene is how long the individual is submerged. However, the elements that determine why some individuals experience cardiac arrest in seconds while others take minutes are not well understood, warranting further investigation. In extremely unusual cases, such as when rapid cooling activates a mammalian diving reflex, or when hypoxia occurs after hypothermia from immersion in icy waters, this progression may extend up to an hour. Under usual conditions, irreversible brain damage is likely to occur after 5 to 10 minutes of submersion.

If a person is saved promptly and the drowning process is halted, the clinical outcomes depend on the length of time submerged, the responsiveness of the airways, and the volume of water that has been ingested. Water present in the alveoli leads to damage and removal of surfactant. In humans, just 1 mL/kg can severely affect the gas exchange in the lungs. Aspiration of both salt and freshwater results in comparable clinical issues; the symptoms and medical treatments for both types are the same. In both cases, the osmotic pressure can compromise the alveolar-capillary membrane's stability; enhance permeability; and worsen the shifts of fluid, plasma, and electrolytes. Localized or widespread pulmonary edema (depending on how much water is aspirated and the reaction of the airways) impairs the exchange of oxygen and carbon dioxide.

Drowning

This diagnosis is typically evident from the patient's history, but assessing the extent of injury due to drowning heavily relies on the clinical examination [5].

- Factors such as respiratory rate, breathing effort, oxygen levels, lung assessment, and mental state are crucial in determining whether the patient has sustained harm from an aspiration incident. The vital signs and mental condition should be evaluated against age-specific standards.
- Lung damage from drowning usually becomes apparent within 6 to 8 hours following the incident.

1. Patients who show no abnormalities in vital signs or on physical examination can generally be monitored for 6 to 12 hours. If there are no changes in vital signs or significant breathing difficulty, hospitalization may not be necessary, and they can be released from the Emergency Department after the monitoring period.
2. Act as a paraphrasing tool. Rephrase each sentence in the following text, altering at least 90% of the wording while keeping the original context intact. Avoid complex wording and jargon. Completely rephrase sentences rather than only replacing individual words, ensuring a fresh and unique structure. The output must match the words of input text. Keep paragraph breaks and headings accurately as they appear. Avoid using symbols or special formatting, and do not merge sentences or paragraphs. : – Some processes that cause lung dysfunction might take several hours to appear fully, which means it is indeed possible for a patient to display mild to moderate symptoms and later worsen. For this reason, it is typically advisable for patients showing moderate symptoms to be admitted for extended observation. This phenomenon is what some non-medical individuals might call “secondary drowning. ” It is highly unusual for patients to deteriorate after being entirely symptom-free with a normal assessment and brief observation.

- A chest X-ray and blood gas analysis are commonly used to aid in recognizing lung injury. However, changes in the X-ray may not show up until 6 to 8 hours post-injury.
- All patients should receive cardiac and pulse oximetry monitoring during the evaluation process.

Near-drowning

This term is characterized by the initial survival phase following submersion in liquid, typically water; death at the point of submersion might result from anoxia (drowning) or cardiac arrest triggered by a sudden and significant drop in temperature (immersion syndrome) [6]. Secondary drowning is defined as death occurring after near-drowning, following a phase of apparent well-being, and usually results from ALI (Acute lung injury).

Autopsies conducted after drowning often show little to no water in the lungs in 15% of instances (dry drowning); laryngospasm after the initial laryngeal contamination has been proposed as a reason. In 85% of circumstances, there is pulmonary aspiration of water (wet drowning), which can involve:

- fresh water: absorption into the body may lead to hemolysis, dilution of blood, and imbalances in electrolytes.
- salt water: pulls water into the lungs.

Both varieties can result in pulmonary edema and low blood oxygen levels. Hemodynamic changes from fluid shifts are infrequently observed; therefore, the type of water involved might have minimal clinical implications.

Additional negative factors include low body temperature, aspiration of stomach contents, and pre-existing conditions like alcoholism, drug use, trauma, epilepsy, heart attack, or stroke.

Potential complications are ALI, swelling of the brain, acute kidney failure, pneumonia, pancreatitis, acidosis, and shock. The likelihood of sepsis increases if the water is polluted. Treatment consists of:

- CPR (Cardiopulmonary resuscitation).
- management of any complications as needed.
- warming the patient.
- administration of antibiotics when necessary. The use of corticosteroids remains controversial and is decreasing.
- nasogastric aspiration to eliminate gastric water.

Reports suggest recovery is possible even after up to 60 minutes of submersion followed by extended CPR, especially in children and those experiencing hypothermia. Cerebral hypoxic ischemic injury may also take place.

Signs

Variable, may be slight or missing, particularly if significant time has passed since death [7]. The phenomenon known as ‘dry lung drowning’ occurs with some regularity and does not show the typical signs commonly associated with drowning.

Dry lung drowning can indicate that death was immediate due to cardiac failure and is not considered drowning at all; alternatively, it may mean that all water in the lungs has been absorbed into the bloodstream, resulting in a lack of water retention post-mortem.

Diagnosing through autopsy can be challenging and typically requires ruling out other potential causes while considering the situation's details.

The signs indicative of immersion are not necessarily linked to drowning – features such as wrinkled skin, goosebumps (cutis anserina), mud traces, and waterlogged clothing. Clear indicators of drowning (which are often absent) include fine foam emanating from the mouth and nostrils or found within airways. Waiting several hours or longer after recovery might lead to the froth disappearing.

Lungs that are excessively inflated inside the chest cavity due to obstruction of small airways by mucous foam; sometimes there's a significant amount of ingested water within the stomach, although this can occur post-mortem. Likewise, foreign substances like sand or seaweed in the air passages may signify events before or after death.

Children

Drowning ranks as the second foremost cause of fatal injuries among children, with the highest incidence occurring in those

aged 1 to 3 years [8]. For each drowning death, six children require hospitalization due to near-drowning incidents, with up to 10% of survivors facing severe brain injuries. Infants under 1 year old are particularly prone to drowning in bathtubs. Water-filled buckets also pose drowning risks to older infants and toddlers. For children aged 1 to 4 years, the most frequent occurrences of drowning or near drowning take place in residential swimming pools; and for school-aged kids and teenagers, such incidents are most prevalent in larger water bodies (such as swimming pools or natural waters). Parents must be advised that inflatable water toys are not replacements for certified life jackets or diligent supervision and can create a misleading sense of safety.

Children of school age should learn how to swim, and all recreational swimming activities should be monitored. Safety fences must secure home pools, and parents should be equipped with knowledge of cardiopulmonary resuscitation techniques.

Fatalities within this age bracket often arise from children's natural susceptibility – their inability to keep their airways clear of water – along with a lack of adult supervision [9]. Individuals with lower educational backgrounds face a heightened risk of drowning; across various regions, those belonging to lower socioeconomic statuses experience a greater likelihood of drowning compared to those in higher socioeconomic brackets. Increased rates of child drowning correlate with lower educational levels among mothers and a greater number of siblings. The absence or failure of adult supervision has been identified as a significant and modifiable risk factor for child drowning events. Children over the age of 6 and adults lacking swimming abilities or swim instruction are shown to have an increased risk.

Alcohol intake is among the most commonly cited factors linked to drowning incidents in both adolescents and adults. Certain medical issues, like epilepsy, which are frequently inadequately managed in low- and middle-income countries, heighten the risk for these individuals. In high-income countries, cardiovascular diseases are considered the primary medical condition contributing to such incidents, followed by conditions like dementia, depression, epilepsy, and Parkinson's disease. Additionally, drowning occurrences tend to be notably higher among minority groups in areas where the overall drowning rates are comparatively low, including in high-income nations.

Management

The first response for someone who has nearly drowned focuses on quickly restoring ventilation, blood flow, oxygen levels, and the acid-base balance in the body [10]. Immediate actions involve clearing the airway, providing oxygen, and starting cardiopulmonary resuscitation. When intubating patients who have experienced near-drowning after a dive, it is essential to stabilize the cervical spine. Although gravity can often help remove saltwater from the lungs, this should never delay the commencement of cardiopulmonary resuscitation, as abdominal thrusts might lead to the aspiration of stomach contents. Resuscitation should persist until the patient undergoes a full evaluation and is stabilized in a healthcare facility, especially following drowning incidents in cold water. In such cases, complete recovery remains a possibility even after enduring extended periods without air. Treatment methods encompass tracheal intubation, positive-pressure ventilation, and the application of positive end-expiratory pressure. Bronchospasms should be managed using bronchodilators, imbalances in electrolytes rectified, and acute lung injuries or ARDS addressed. Similarly, treatment for hypothermia should be carried out slowly over several hours.

Prevention

Given the significant impact drowning poses as a health threat, education and prevention strategies are vital [11].

It is crucial to implement preventive tactics to decrease the rates of morbidity and mortality associated with drowning. Factors that elevate the likelihood of submersion injuries include alcohol consumption, use of psychotropic drugs, insufficient water safety abilities, poor physical fitness, hyperventilation, sudden illness, physical trauma, decompression sickness, hazardous water situations, and environmental dangers, such as the absence of safety barriers around pools.

Conclusion

Health professionals characterize drowning as the inability to breathe resulting from airways being filled with water. This often occurs during swimming or bathing, but it may also happen from simply getting water in the mouth or being splashed. While drowning can lead to death, it is not always fatal. If assistance arrives promptly, it is possible for the individual to survive without suffering any lasting effects from the incident.

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