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International Journal of Clinical Reports and Studies

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Case Report

Public Health Concerns of Drowning Survivors & Deaths!

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Received Date: August 01, 2025 | Accepted Date: November 18, 2025 | Published Date: November 26, 2025

Citation: Suresh Kishanrao, (2025), Public Health Concerns of Drowning Survivors & Deaths! *International Journal of Clinical Reports and Studies,* 4(6); **DOI:**10.31579/2835-8295/139

Abstract

Drowning is defined as respiratory impairment resulting from submersion or immersion in liquid, with outcomes classified as death, morbidity, or no morbidity. Accidental falls into water bodies are a major contributor to drowning deaths, with over 70% of cases in 2022 attributed to this cause. Other causes of drowning include unexpected flooding due to rains and suicidal or even homicidal drowning. Despite the high number of fatalities and many more morbidities following drowning among survivors, issues like immediate revival and management including referral transfers most often do not receive attention & resources like other public health issues. Globally, despite drowning death rate decrease by 38% since 2000, drowning remains a significant public health issue, with an estimated 300,000 deaths annually. The issue disproportionately affects low- and middle-income countries and young children. The global data indicates that over 92% of drowning deaths occur in Low- & Middle-Income countries nations, often affecting marginalized communities and vulnerable populations like children under five. In India, drowning is a significant cause of accidental death, with an estimated 38,000 fatalities annually, particularly of those between 1 and 14 years old. Resolutions endorsed by the United Nations General Assembly & the World Health Assembly provide a roadmap for global drowning prevention efforts showing concerns about deaths. However, global or national efforts, studies or media reports hardly cover or report the revival efforts, onsite management, transport, hospital management and immediate or long-term consequences, which need to get due attention. Health consequences range from the primary physical impact of hypoxia causing brain damage and cardiac arrest, non-fatal injuries and long-term health problems like neurological damage and psychological distress that need attention. This article is a comprehensive review of consequences; actions being promoted for prevention of drowning and neglected areas of health consequences of drowning listed above.

Materials and Methods: Drawing from anecdotes of drowning, both from personal encounters and media coverage, supported by literature review the author has tried drawing attention to most neglected areas of health consequences of drowning.

Keywords: drowning; death; hypoxia; onsite revival; prehospital management; transport; emergency & long-term health consequences management at hospitals

Introduction

The Texas flooding kills at least 104, including Camp Mystic counselors and campers as of 1030 AM IST on 8th July 2025 [1]. At least 104 people are dead across six counties from the devastating flood, rescue crews continue to search for survivors. The year 2025 rain is more than expected in some areas, and a flash flooding risk haunts the entire world! Despite a decrease of 38% since 2000 Globally, drowning remains a significant public health issue, with an estimated 300,000 dying annually [2, 9]. The issue disproportionately affects low- and middle-income countries and young children. The global data indicates that over 92% of drowning deaths occur in Low- & Middle-Income countries nations, often affecting marginalized communities and vulnerable populations like children under five. Drowning is the fourth leading cause of death for children aged 1–4 years and the third leading cause of death for children aged 5–14 years [2]. In India, drowning is a significant cause of accidental death, with an estimated 38,000 fatalities annually, accounting for a substantial portion of all accidental deaths in the country, with 9.1% in 2022. Children, particularly those between 1 and 14 years old, are especially vulnerable [3]. The National Crime Records Bureau (NCRB) reported 6,579 suicide deaths by drowning in 2018, representing 5% of all suicide deaths. While accidental & Flooding drownings dominate the proportion of suicidal drownings is also a serious concern. Rural India has a higher incidence of suicidal drowning due to proximity to unprotected or guarded water bodies & specific social circumstances.

The mechanism of drowning involves aspiration of water into the lungs which damages surfactants, disrupts the alveolar capillary membrane and leads to the development of alveolar oedema, resulting in a local acute respiratory distress syndrome (ARDS)-like syndrome [4]. A high proportion of drowning patients are hypoxic and have a PaO2/FiO2 ratio < 300 mm Hg. Treating this lung injury and reversing hypoxia are the cornerstone of the management of drowning. Non-fatal injuries and long-term health problems, including neurological damage and psychological distress go un-reported.

Health consequences range from the primary physical impact of hypoxia causing brain damage and cardiac arrest [5]. Some studies have reported that few survivors have normal or mildly impaired neurological functions, others experience long-term cognitive difficulties &global memory impairment [12]

Resolutions endorsed by the United Nations General Assembly & the World Health Assembly provide a roadmap for global drowning prevention efforts showing concerns about deaths. Not many global or national efforts, studies or media reports cover their revival efforts, transport, management & immediate or long-term consequences, which need to get due attention [10]. This article is a comprehensive review of consequences; actions being promoted for prevention of drowning and neglected areas of health consequences of drowning, immediate revival, transport and management by individuals on site, pre-hospitalization care and hospital level management and local and Nation authorities.

Case Reports:

1. Unintentional Drowning & their Outcomes:

a) The first ever case of drowning death this author came across was in early 1970, when a 2-year-old son of his colleague doctor got drowned in underground water storage tank built for house construction jus in the backyard of the house. It was a traumatic but educative episode. b) An autorickshaw driver aged 36 years, standing near the riverbank, asked a tourist to click his photo. Unfortunately, he slipped and fell into water, slipped and was swept away by the strong currents of Cauvery River near Sarva Dharma Ashrama, in Srirangpatna Taluk, Mandy district on 7 July 2025 evening. The tourist raised an alarm, and the rescuers were trying to locate Mahesh yet to find the body [7].

b) A healthy 18-year-old man suffered a cardiorespiratory arrest due to submersion while swimming in a freshwater lake in February 2025. A call to 108, quick arrival of the ambulance and First-responder cardiopulmonary resuscitation & defibrillation using an automated external defibrillator resulted in a return of spontaneous circulation. The patient was later evacuated to a public tertiary care center attached to a medical college hospital. The ambulance staff experienced difficulties in oxygenating and ventilating the patient because of early-onset acute respiratory distress syndrome (ARDS). The hospital put the person on mechanical ventilation, using a lung-protective strategy with low tidal volumes (6 ml/kg predicted body weight), aiming to keep plateau pressures below 30 cm H2O. Positive end-expiratory pressure (PEEP) was needed in improving oxygenation. The fraction of inspired oxygen (FiO2) was titrated to maintain adequate oxygen in prone position, as he had severe ARDS. Since the response was not encouraging after a few hours he was put on extracorporeal membrane oxygenation (ECMO). His condition improved over the next 48 hours and was discharged on the third day.

c) One case involved a 51-year-old farmer with a near-drowning experience followed by bronchopneumonia and later, neurological symptoms suggestive of raised intracranial pressure, including headaches and neck stiffness in December 2024.

d) Another case reported a 41-year-old man with locked-in syndrome & ocular bobbing after pontine infarction following a drowning was reported recently in a government hospital.

e) **Drowning in Floods:** Kerr County, hundreds of people died in the holiday flooding, has no siren system despite years of debate, in part because some local officials felt it was too expensive to install. The part of Texas Hill Country known as “flash flood alley” has seen rising waters many times before, but the swift and punishing destruction over the 4th to 8th of July 2025 has focused attention on whether local officials are doing enough to protect their residents as climate change causes more frequent and severe weather disasters and the federal government is slashing spending on emergency preparedness [1].

Many summers on the banks of the Guadalupe River, were transformed by the deadly floods. But Camp Mystic's legacy remains. This camp and the more than a dozen others in the USA, UK and India offer the “pristine beauty of nature” and provide young people with a place where they can express themselves, promote that youths can “find out who they really are,”! Though the camps may have had flooding before, sometimes it’s never anything like that happened last. “The water comes to places it’s never been before. It will be a long time and will be hard, but I think we’re resilient,” Camps and Floods teach people the resilience.

2.Intentional (Suicidal) Drowning & Outcomes:

a) A 19-year-old law student from Bengaluru who allegedly attempted suicide by jumping into the Cauvery River on Thursday (3 July 2025) evening miraculously survived miraculously trapped in a tree in the middle of the river near Hangar Halli in Srirangapatna Taluk, Mandya district, Karnataka, who was rescued on Friday morning. She was swept nearly 5 km downstream by strong floodwaters before getting caught in a tree. She spent the entire night perching there. On Friday morning, her cries for help alerted nearby farmers, who quickly informed the police. A rescue team of police and firefighters reached the spot and safely rescued her. She was extremely fortunate, as any further rise in the river’s water level could have swept her away but not many would be so lucky [6]. The exact numbers for suicidal drowning are difficult to pinpoint, but it is a recognized issue in both global & Indian contexts. Children under five account for a significant portion of accidental drowning deaths. Studies show that of 5-7% drowning deaths are due to suicide in India [9].

b) An unidentified body of around 35 years old male, recovered from Ganga River, was brought to a Govt. Medical College mortuary in March 2025. All the clothes were wet, and some mud was also there, and Rigor mortis was set in and was more pronounced on the back. All internal organs and mucosa were congested. Trachea was mud filled, and lungs were congested and oozing froth. Washerwoman’s hands indicated prolonged immersion in water. No other internal or external injuries were noticed. The cause was certified as respiratory failure.

3.Homicidal Drowning: A post-partum depressed mother took her 38 days old male baby asleep from the cradle around midnight, and wet outside the home bathroom, held the baby by legs and dipped the face in water in a wide mothed pot for few minutes and left the infant in the pot and returned and slept. Her mother (baby boy’s grandmother), alarmed not seeing her baby with the mother, started searching, then woke up the mother. In a few minutes 4-5 members of the family woke up and searched, to find the baby’s body floating in the pot finally. The mother confessed after a police enquiry about what she had done due to financial problems [8].

Discussions:

Drowning is defined as respiratory impairment resulting from submersion or immersion in liquid, with outcomes classified as death, morbidity, or no morbidity. Accidental falls into water bodies are a major contributor to drowning deaths, with over 70% of cases in 2022 attributed to this cause. Despite the high number of fatalities and many more morbidities following drowning among survivors, issues like immediate revival and management most often do not receive the same level of attention & resources as other public health issues [2].

Magnitude of the Problem: Even though globally, drowning deaths have decreased by 38% between 2000 and 2024, In 2024, there were an estimated

236,000 drowning deaths globally. The fact that 38,000 Indians died of drowning in 2024, makes it a significant public health concern, with children and young people particularly vulnerable. Over 92% of these deaths occurred in low- and middle-income countries. Drowning is a leading cause of death for children and young people aged 1-24, and the third leading cause of unintentional injury death worldwide. Under 5 years children, and males are disproportionately affected by drowning. Males drown more due to increased exposure to water & riskier behavior- swimming alone or after alcohol /drug abuse. However, in the United States, the drowning mortality rate increased from 2019 to 2022, and on an average, 11 drowning deaths per day occurred in last 5 years [11].

World Drowning Prevention Day: At World Drowning Prevention Day on 25th July 2024, a global initiative dedicated to raising awareness & accelerating action on global drowning prevention & to honor those who have lost their lives and to promote water safety awareness. The good news is drowning is a preventable tragedy. The World Drowning Prevention Day 2025 theme is "Your story can save a life". This theme encourages individuals & communities to share their personal experiences & stories related to water safety & drowning prevention, emphasizing the impact of individual actions and narratives in saving lives [10].

Magnitude of the Drowning Problem in India: Drowning is a leading cause of accidental death in India, with a high number of fatalities reported each year. National Crime Records Bureau (NCRB) Data reported 38,503 drowning deaths in 2022, representing 9.1% of all accidental deaths. Madhya Pradesh reported the highest number of drowning deaths in 2022 (5,427), followed by Maharashtra (4,728) and Uttar Pradesh (3,007). Children aged 1-14 are particularly Media reports, both Press and TV alike are common in rainy season across the country. Three students drown in a flooded basement library of a coaching center in Delhi, in June 2025, where complaints about waterlogging were ignored. In the first five months of 2025, a) Goa reported 68 drowning deaths, with 37 in South Goa and 31 in North Goa, b) Karnataka, seven people died by drowning in Mandya district within a 40-day period (January-February) c) Five young men from Hyderabad drowned in the Kondapochamma Sagar reservoir in Telangana These incidents commonly occur in swimming pools, the sea, and village ponds and wells [9].

Underreporting: The actual number of drowning deaths Globally and in India may be higher than reported, particularly in rural areas where accidents go unnoticed. A population-based study of 224 077 children aged 1–14 years, a decade ago reported drowning deaths of 7.2%, 12.5% and 5.8% of all deaths in 1–4, 5–9 and 10–14 years age groups, respectively. The adjusted incidence of deaths drowning was 14.3 per 100 000 children, with it being higher in urban (16.1) areas. Nearly half of the children drowned in a river (5.9) followed by in a pond (2.8). Drowning death incidence was the highest while playing (5.1) & bathing (4.0) with the former accounting for more deaths in 1–4 years age group. Sixty per cent of children were already dead when found. None of these deaths were reported to the civil registration system to obtain death certificate. In the United States, it is the leading cause of death among children aged 1-4 years. Even when not fatal, drowning can result in permanent & severe disability due to hypoxia [13].

Factors Contributing to Incidents of Drowning in India are:

i. Access to Water Bodies lacking safety measures and supervision, Many Indians live near rivers, ponds, and wells for daily activities exposing to drowning risk for children.
ii. Accidental falls into water bodies accounted for 28,257 deaths of a total of 38,000 in 2022.
iii. Other Cases account for 9,962 deaths, reflecting a range of unclassified drowning incidents and boat capsizes resulted in 284 deaths.
iv. Flooding: Monsoon rains cause flooding, worsened by poor drainage, making communities vulnerable to drowning.
v. Cultural Perceptions: Some communities view drowning as inevitable, hindering safety measures and awareness campaigns.
vi. Economic Constraints: Poverty limits access to safety equipment, swimming lessons, and emergency services, affecting low-income families in high-risk areas.

Inadequate Safety Regulations: There is a lack of stringent safety regulations governing the use of public water bodies. Enforcement of safety measures, such as lifeguards at beaches and swimming pools, is often lacking, contributing to higher drowning rates.

Drowning is described in 3 groups, 1) Unintentional /Recreational adventure Drowning ii) Intentional or Suicidal Drowning iii) Homicidal drowning [1]. Drowning is a type of asphyxia due to aspiration of fluid into air passages, caused by submersion in water or any other fluid. There are four types of drowning – i) Wet (primary) drowning ii) Dry drowning iii) Secondary drowning (post-immersion syndrome, near drowning) iv) Immersion syndrome (hydrocution, submersion inhibition) [4, 12]

Health Consequences of drowning among Survivors:

Drowning in India, a significant public health issue, can lead to severe health consequences, ranging from immediate physiological effects to long-term psychological trauma. A significant number of drowning incidents result in non-fatal hospitalizations, highlighting the substantial health burden associated with this preventable cause of drowning injury. The primary physical impact is hypoxia which can cause brain damage & cardiac arrest. Beyond the immediate risk of death, drowning can also result in non-fatal injuries and long-term health problems, like neurological damage and psychological distress.

Immediate Physical Consequences:

Hypoxia and Organ Damage: Drowning causes a lack of oxygen to the body, particularly the brain, leading to potential brain damage and another organ damage.

Respiratory Issues: Aspiration of water can cause lung injury, leading to acute respiratory distress syndrome and breathing difficulties.

Cardiac Arrest: In severe cases, drowning can lead to cardiac arrest, requiring immediate resuscitation.

Neurological Damage: Hypoxia can result in neurological damage, potentially impacting cognitive and motor functions.

Long-Term Health Consequences:

Psychological Trauma: Drowning experiences can lead to post-traumatic stress disorder (PTSD), anxiety, depression, and other mental health issues.

Neurological Impairment: Even non-fatal drowning can result in neurological damage, affecting cognitive abilities and motor skills.

Chronic Respiratory Problems: Lung injuries from aspiration lead to chronic respiratory issues.

Reduced Quality of Life: Long-term health consequences can significantly impact an individual's quality of life and ability to participate in daily activities.

World Drowning Prevention Day: It is an annual global event held on 25th. Established by a United Nations General Assembly (UNGA) resolution in April 2021, the event is coordinated by the World Health Organization (WHO).

The World Drowning Prevention Day 2025 theme is "Anyone can drown. No one should.". This theme emphasizes that drowning is a preventable

tragedy and aims to raise awareness about the importance of water safety and drowning prevention measures. The day is observed annually on July 25th WHO Slogan: "Seconds can save a life".

Management of Drowning Survivors:

Prehospital Care: Any individual may be rescued at any time during the process of drowning, whether any intervention is necessary or not or whether rapid rescue & resuscitation is warranted. The victim must be removed from the water at the earliest opportunity. Rescue breathing should be performed while the individual is still in the water, but chest compressions are inadequate because of buoyancy issues. The patient should be removed from the water with attention to cervical spine precautions, and where possible the victim be lifted out in a prone position as an upright manner, causes hypotension due to a relative change in pressure surrounding the body from water to air. Victims of drowning have most likely suffered asphyxial cardiac arrest; therefore, rescue breathing as well as chest compressions are indicated and not the compression-only resuscitation for cardiac arrest. The type of water, water temperature, quantity of water aspirated, time in the water, and individual's underlying medical condition all play a role. As optimal prehospital care is a significant determinant of outcome in the management of immersion victims worldwide. Children can be transported by family members or any onlooker, by taxi or private vehicle. Bystanders must call 180 Ambulance Service in India immediately which is a toll-free emergency medical transportation service available nationwide. Accessible 24/7 provides prompt response and critical care to individuals in medical emergencies, ensuring timely transportation to hospitals for further treatment. Bystanders and rescue workers should never assume the individual is unsalvageable unless it is patently obvious that the individual has been dead for quite a while. If they suspect injury, they should move the individual the least amount possible and begin cardiopulmonary resuscitation. As in any rescue initiative, initial treatment should be geared toward ensuring adequacy of the airway, breathing, and circulation (ABCs). Give attention to cervical spine stabilization if the patient has facial or head injury, is unable to give an adequate history, or was involved in a diving accident [9,12].

In the patient with an altered mental status, the airway should be checked for foreign material & vomitus. Debris visible in the oropharynx should be removed with a finger-sweep maneuver. Ventilation must be achieved even if fluid is present in the lungs. Once the ambulance arrives with supplemental oxygen, a fraction of inspired oxygen (FiO2)100%, be administered as soon as available. The degree of hypoxemia may be monitored continuously with noninvasive pulse oximeter. If the patient remains dyspneic on 100% oxygen or has a low oxygen saturation, use continuous positive airway pressure (CPAP) if available. If it is not available, consider early intubation, with appropriate use of positive end-expiratory pressure (PEEP). Higher pressures may be required for ventilation because of the poor lung compliance due to pulmonary edema. Prehospital care providers should begin rewarming by removing Wet clothing and the victim is wrapped in warming blankets [12, 15].

Emergency Department Care - Transition to the ICU:

Patients who arrive in the emergency department in cardiopulmonary arrest after a warm-water submersion have a dismal prognosis. The benefit of resuscitative efforts should be continuously assessed. Initial management of near drowning should place emphasis on immediate resuscitation and treatment of respiratory failure. Frequent neurological assessments should occur using the Glasgow Coma Scale. Evaluate associated injuries early, as cervical spine injury complicate airway management. Initially provide all drowning victims with 100% oxygen yet be cognizant of the goal to avoid or treat hypoxemia while minimizing hyperoxemia. Early use of intubation and PEEP, or CPAP/bilevel positive airway pressure (BiPAP) in the awake, cooperative, and less hypoxic individual, is warranted if hypoxia or dyspnea persists despite 100% oxygen. In individuals awake but unable to maintain adequate oxygenation, or in whom airway protection is warranted oxygen by mask or via CPAP endotracheal intubation and mechanical ventilation may be started. Endotracheal Intubation is required to provide adequate oxygenation in i) a patient unable to maintain a PO2 > 60-70 mm Hg (>80 mm Hg in children) on 100% oxygen by facemask ii) Altered level of consciousness and inability to protect airway or handle secretions iii) High alveolar-arterial (A-a) gradient: PaO2 of 60-80 mm Hg or less on 15 L oxygen non-rebreathing mask iv) PaCO2 greater than 45 mm Hg indicating Respiratory failure [12,13].

Positive end-expiratory pressure (PEEP): Intubated victims of submersion injury may require PEEP with mechanical ventilation to maintain adequate oxygenation. It improves following ventilation patterns in the noncompliant lung – i) increases functional residual capacity ii) Minimizes atelectasis or alveolar collapse by maintaining pressure above which the lungs collapse iii) Decreases intrapulmonary shunting of blood and improves arterial oxygenation iv) Increases intrathoracic pressure, which transmits the applied PEEP to transmural capillary pressure resulting in minimizing interstitial lung water v) Increases the diameter of both small and large airways to improve distribution of ventilation [13]

Extracorporeal membrane oxygenation (ECMO): ECMO is considered if i) Respiratory lack of response to conventional mechanical ventilation or high-frequency ventilation ii) A reasonable probability of recovering neurologic function iii) Persistent hypothermia from cold-water drowning [12,13]

Significant disorders of vascular volume are not common after drowning, although intravascular volume depletion has been attributed secondary to pulmonary edema and intracompartmental fluid shifts, regardless of the type of fluid aspirated. In cases of hyponatremia & hypernatremia due to the ingestion of large amounts of fresh or salt water, rapid volume expansion is done using isotonic crystalloid (20 mL/kg) or colloid. Inotropic support may be required using dopamine and/or dobutamine. Most acidosis is restored after improved oxygenation and correction of volume depletion. Hypothermia may be present and exacerbate hypoxemia, acidosis, and bradycardia. Vasoactive infusions may be efficacious in treating myocardial dysfunction and abnormal peripheral vascular resistance; however, the need for extended cardiovascular support is rare. Normalization of cardiovascular function is ideal for neuroresuscitation. Overall, treatment goals are aimed at normalization of BP, maintaining organ perfusion, & facilitating gas exchange. Nasogastric tube placement can be used for removal of swallowed water & debris. Orogastric route is used if head or facial trauma is noticed. Bronchoscopy is resorted to removing foreign material, such as aspirated debris or vomitus plugs from the airway. The routine administration of surfactants is not supported, but it is reserved for severe hypoxemic respiratory failure [13]. The mainstay of neuromonitoring is achieved by frequent neurologic examinations. Deterioration of brainstem function does not bode well for favorable recovery. Continuous EEG monitoring may be helpful in the assessment of subclinical seizures. Utility of intracranial pressure monitoring in the case of severe ARDS to monitor the impact of permissive hypercarbia & the effect of PEEP is useful [15].

Therapeutic hypothermia: Hypothermia remains potentially beneficial, and its utility has been extrapolated from adults experiencing witnessed out-of-hospital cardiac arrest and asphyxiated newborns. Current recommendations propose maintaining core temperatures of 32-34ºC for 12-72 hours. his mode of therapy may impede the neurologic examination because of the potential need for neuromuscular blockage to blunt shivering. Patients with severe hypothermia may appear dead because of profound bradycardia and vasoconstriction. Resuscitation should continue while aggressive attempts are made to restore normal body temperature. Optimal temperature management in drowning related hypothermic patients with core temperatures less than 86°F due to sudden, is considered under 2 categories i) rapid immersion in cold water led slowing of metabolism and preferential

shunting of blood to the heart, brain, and lungs, which exerts a neuroprotective effect during submersion ii) Most immersion victims, become hypothermic gradually and are at risk for ventricular fibrillation and neurologic injury. The mechanism for this reflex has been postulated to be reflex inhibition of the respiratory center (apnea), bradycardia, and vasoconstriction of nonessential capillary beds triggered by the sensory stimulus of cold water touching the face. The responses must preserve the circulation of the heart and brain and conserve oxygen, thereby prolonging survival. The sudden temperature drop may depress cellular metabolism significantly, limiting the harmful effects of hypoxia and metabolic acidosis. Core rewarming with warmed oxygen, continuous bladder lavage with fluid at 40°C, and intravenous (IV) infusion of isotonic fluids at 40°C is initiated during resuscitation in Indian facilities. Warm peritoneal lavage is used for patients with severe hypothermia. A cascade unit on the ventilator is used to warm inspired air. Thoracotomy, with open heart massage and warm mediastinal lavage, is used in refractory situations. The hypothermic heart is typically unresponsive to pharmacotherapy and countershock. Extracorporeal blood rewarming has been rarely used in patients with severe hypothermia who did not respond to lavage/thoracotomy or who were in arrest. The old practice was to continue resuscitation of a submersion victim until the patient has been warmed to a minimum of 30°C. However, newer literature suggests that therapeutic hypothermia may confer neuroprotection.

The highest priority is restoration of spontaneous circulation, after this continuous monitoring of core/and or tympanic temperatures is mandatory in the ED and intensive care unit and to the extent possible in the prehospital setting. Drowning victims with restoration of adequate spontaneous circulation who remain comatose should not be actively warmed to temperature values above 32º-34°C. If the core temperature exceeds 34°C, hypothermia should be achieved as soon as possible and sustained for 12 to 24 hours.

Other Treatment Considerations: Initiation of appropriate management of hypoglycemia and other electrolyte imbalances, seizures, bronchospasm and cold-induced bronchorrhea, dysrhythmias, and hypotension may be necessary in the drowning patient. Hypoglycemia and hyperglycemia are not only associated with increased mortality and morbidity but are also detrimental in patients with brain injury as the injured brain is exquisitely sensitive to aberrations in serum glucose. Normoglycemia should be the target goal.

Referral &Transfer: Drowning patients must be treated in a facility capable of providing appropriate, age-related intensive care if they exhibit i) Significant hypoxia that requires intubation ii) Worsening dyspnea with the potential for intubation iii) Evidence of hypoxic cerebral injury iv) Evidence of renal insufficiency or of hemolysis v) Severe hypothermia requiring cardiopulmonary bypass.

Patients who require care for significant cervical spine or head trauma should be managed in a facility capable of sophisticated neurologic monitoring and neurosurgical intervention and those with severe neurologic impairment must be transferred to inpatient rehabilitation institutions.

Prevention: In most instances, drowning and near drowning can be prevented with simple safety measures and common sense. Most children younger than 5 years enter a swimming pool directly adjacent to their home or one with inadequate fencing or unlatched gates or doors. Most children who drown in pools are found silently floating with no screaming or splashing. Children, especially toddlers, must be always supervised when they are around water, including a water storage underground tank for house construction, bathtub, toilet, or bucket full of water. Toilet lids should be left closed, when not in use. Baby bath seats do not provide additional safety for unsupervised children. Household buckets should be immediately emptied after use and left empty when not in use. Drowning prevention activities include i) Not leaving young children unattended at water sites ii) Adequate pool fencing - The enclosure must be a wall or fence that surrounds a pool on all 4 sides, at least 4 ft tall with no more than 4 in between openings in the fence and isolating the pool from the remainder of the property. The use of adequate fencing around swimming pools has decreased the number of immersion injuries significantly in the recent decade. However, in rural India fencing open wells, tanks are a source of risks of drowning where adult supervision is essential. If lapses of supervision are inevitable, other safety precautions must be in place. In Urban India Municipal swimming pools or pools in hotels must provide iii) Efficient or good pool maintenance iv) adequate well-trained lifeguard-to-swimmer ratios v) avoiding Lifeguard distraction and competing duties, vi) Any doors and windows with access to the pool area should remain closed and locked. Toys and other objects attractive to children should not be left in the pool area vii) Parents who own pools or who take their children to pools must be trained to learn CPR. At least one parent or caretaker should always remain focused on children, avoiding other activities that might disturb this concentration, such as using the phone and conversing with others. viii) Children must wear personal flotation devices in pool areas, though these do not eliminate constant supervision ix) Individuals with underlying medical illnesses like seizure disorders, diabetes mellitus, significant coronary artery disease, severe arthritis, and disorders of neuromuscular function, should swim under the observation of another adult who can rescue them should they get into trouble.

WHO Recommendations for the Prevention of Drowning Accidents:

Installation of Barriers: Erecting physical barriers around water bodies such as pools, wells, and ponds can significantly limit access, particularly for young children. Fencing and secure covers act as primary preventive measures to control entry to potentially hazardous areas.

Safe Areas Away from Water: Creating designated safe zones for children and adults away from water bodies helps minimize the risk of accidental drowning. These areas should be equipped with engaging activities to divert attention away from water.

Training in Rescue Techniques: Educating bystanders in safe rescue & resuscitation techniques, such as Cardiopulmonary Resuscitation (CPR) & mouth-to-mouth breathing, can save lives. Community programs must focus on training individuals to respond effectively in emergencies.

Integration into Education Curriculums: Incorporating water safety education into school curriculums ensures that children learn preventive measures from a young age.

Enforcement of Boating Regulations: Implementing and enforcing strict boating and shipping regulations is essential. This includes mandatory life jacket use, regular maintenance of vessels, and adherence to safety protocols to prevent accidents on water.

Flood Risk Management: Improving flood risk management through the development of flood-resistant infrastructure & early warning systems can significantly reduce the incidence of drowning during flood events. Local authorities should invest in such systems to enhance community resilience.

Economic Impacts of Drowning: Drowning in India has significant economic repercussions, due to loss of income from breadwinners, strain on emergency services, and long-term disability costs for survivors [16]. Economic Impacts of Drowning include:

i) Loss of Livelihood: Drowning deaths, especially of among fishermen and those employed in water-related activities, lead to a loss of income for families, impacting household economies.

ii) Strain on emergency services & Case management: Increased drowning incidents require more resources for rescue operations, medical treatment, & rehabilitation.

iii) Loss of Productivity: Survivors of drowning, especially those with long-term disabilities, may face reduced work capacity, leading to decreased productivity and economic output.

iv) Increased Burden on Families: Caring for drowning survivors with disabilities can place a significant financial and emotional burden on families.

v) Management of Survivors: Prompt & effective medical care, including resuscitation and treatment of lung damage, is crucial for minimizing long-term complications. Most survivors require physical, occupational, &speech therapy to regain lost functions & improve life quality.

vi) Psychological Support: Drowning survivors & their families experience trauma and require psychological support to cope with the experience and its aftermath.

vii) Long-term Care: For those with severe disabilities, long-term care and support services may be needed to ensure their well-being and participation in society.

The Value of a Statistical Life (VSL) obtained from the coefficient on the risk of fatality from the regression, using the following formula [16]:

VSL=W/B/X hours/year/Y

Where w is the hourly wage, X is the number of hours worked annually on a full basis (8x250 days= 2,000) and Y is the denominator of the risk variable. In Inda VSL was around INR 150,000, in 2004. Using a 5% annual inflation rate for 21 years (2004-2025), it would be equivalent to approximately ₹418,167.67 in 2025 [16].

A WHO investment case modelling investment in drowning prevention between now and 2050 shows scaling up just two interventions through investing in i) day-care programs for pre-school children and ii) teaching children basic swim skills. This will result in 774 000 fewer children drowning between now and 2050, and another 178 000 children would avoid severe, life-limiting injuries due to non-fatal drowning over the same period. Scaling these two interventions is projected to result in savings a return of 9-10 times the value of the cost of scaling up the interventions. Addressing drowning through prevention and effective survivor management is crucial for both public health and economic stability [17].

Effective policies and legislation are also important for drowning prevention. Setting and enforcing safe boating, shipping and ferry regulations are vital to improving safety on the water and preventing drowning. Building resilience to flooding and managing flood risks through better disaster preparedness planning, land use planning, and early warning systems can prevent drowning during flood disasters.

Conclusion

Drowning is a preventable tragedy that demands urgent attention in India. Addressing this silent disaster requires a comprehensive approach, ensuring that no life is lost to drowning. By understanding the socio-economic & environmental factors contributing to drowning incidents & implementing targeted interventions, countries can significantly reduce the number of fatalities. Collaborative efforts involving government bodies, NGOs, & local communities are essential to creating a safer environment for all, for vulnerable like children and non-swimmers. A global review on drowning prevention among children and young people found several effective strategies. In addition to placing barriers around bodies of water, the review also found wearing personal flotation devices and removing or covering water hazards to be effective in drowning prevention. The absence of prehospital cardiac arrest, along with transfer to a high-volume hospital and indoor drowning location, were factors significantly associated with a good clinical outcome. It is not necessary to wait until the patient is on dry land or in a vessel before commencing rescue breathing. Resuscitation of drowning patients should not focus on chest compressions alone. Ventilation and airway management are crucial because cardiac arrest often follows severe hypoxemia in drowning cases. The Heimlich maneuver is not recommended in drowning because efforts to expel water from the lungs delay resuscitation and might increase the risk for vomiting and aspiration. Empirical antibiotic administration is not recommended in initial drowning treatment. Prevention: Public awareness campaigns and the implementation of safety measures, such as lifeguards at water bodies, are crucial for reducing drowning incidents. Economic Impact: Drowning prevention efforts are crucial not only for saving lives but also for preventing health consequences and potential economic losses.

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