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REVIEW ARTICLE

Drowning in pediatrics: literature review

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Keywords:
Drowning,
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Accident Prevention.

Abstract

Objectives: To review the literature on the most up-to-date knowledge in pathophysiology, management and prevention of drowning accidents in the pediatric age group to propose a protocol for the care of these patients in the emergency department. **Methods:** Systematic literature review in PubMed, Embase and Cochrane Library databases using drowning, pediatrics, emergency treatment and accident prevention descriptors, including articles published in the last 5 years that cover the objectives of the present study. **Results:** Worst drowning outcomes are associated with age < 5 years, submersion time > 5 minutes, higher Szpilman score, and admission with lower Glasgow Coma Scale, hypothermia < 30°C, acidosis, hyperglycemia, hypernatremia, hyperkalemia, elevation of lactate and liver enzymes and an abnormal chest X-ray. **Conclusions:** The analysis of prognostic factors through a review of the current literature provided the development of an algorithm for managing drowning patients in pediatric emergency and reinforced the importance of working preventive measures collectively.

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INTRODUCTION

Drowning is an emergency resulting from the process of respiratory impairment secondary to submersion or immersion in a liquid medium that begins when the airway remains under water - submersed, and/or when water occludes the face or airways - immersion, causing respiratory difficulty and significant morbidity and mortality in the pediatric age group[1]. In accidents due to submersion, the patient can be rescued from the water without signs of aspiration of the liquid, characterizing the rescue, or as a corpse when he presents evident signs of death[2]. A drowning accident is a continuous process, which can be interrupted by adequate rescue at any stage, with variable sequelae that can lead up to death[3].

Submersion accidents are the leading preventable cause of death in patients aged 1 to 4 years worldwide, and adolescents are the second highest risk group[4]. Older children who drown often have underlying medical conditions and are left unattended for longer periods[5]. Approximately 5 to 10% of non-fatal childhood drownings result in severe neurological sequelae, such as spastic quadriplegia and a vegetative state[6].

The particularities that are associated with outcomes in submersion accidents in pediatrics are a lower body mass index and weight, with a greater body surface area proportional to weight and relatively less subcutaneous adipose tissue, causing them to lose heat quickly, as well as greater effort to breathe and risk of air trapping with consequent barotrauma, especially in children under 8 years of age. Those patients who are prone to fainting or have a history of neurocardiogenic syncope may have heightened sensitivity to face cooling or hypothermia, with exacerbated bradycardic reactions to diving or even simple face immersion. In addition, children do not always have adequate-sized equipment for safe swimming and diving[7].

Drowning in childhood has been the subject of several studies in recent years, but the particularities of this group make it difficult to manage in extra- and intra-hospital settings. Submersion accidents are still neglected and constitute an important public health problem, with serious consequences when rescue is not carried out properly. Thus, the standardization of care for children and adolescents is essential to improve outcomes in this population.

OBJECTIVES

This review covered the most up-to-date knowledge in pathophysiology, management and prevention of drowning accidents in the pediatric age group to propose a protocol for the care of these patients in an emergency care service.

METHODS

A systematic review of the current literature was carried out, through the search for articles published in the last 5 years in the PubMed, Embase and Cochrane Library databases using the descriptors drowning, pediatrics, emergency treatment and accident prevention (Table 1). Initially, 272 articles were selected, 216 were excluded by reading the titles and abstracts and those repeated, later, 1 more study published only in Asian language was passed over from the analysis, of the remaining 55, 40 were removed after reading the full text, for not encompassing the objectives of this study (Figure 1).

PATHOPHYSIOLOGY

Panic causes water to come into contact with the airway, stimulating coughing and laryngospasm as forms of protection, leading to hypoxia that will promote relaxation of the respiratory muscles in seconds or minutes. As more water is aspirated into the lungs, the victim develops apnea, loss of consciousness, cerebral hypoxia and arrhythmias. There is, simultaneously, the release of cytokines with disruption of the integrity of the alveolar-capillary membrane and intense pulmonary edema[8].

Younger children who are unable to keep their heads above water without supervision and those patients with associated pre-existing medical conditions, such as a history of epilepsy, autism, cardiac arrhythmias (QT prolongation syndromes and Brugada syndrome), are at increased risk of accidents by submersion[9]. The diving reflex, characterized by bradycardia and vasoconstriction secondary to immersion in water, provides massive release of inflammatory mediators, thereby contributing to the systemic inflammatory response syndrome associated with heart failure and cardiac rhythm disturbances. Furthermore, the adrenergic discharge by exercise itself may be related to syncope, seizures or cardiorespiratory arrest (CRA) in children and adolescents with comorbidities during or after swimming[10].

Aspiration of salt water, more associated with alveolar edema, or fresh water, mainly related to surfactant dysfunction, causes similar degrees of lung damage. The determining pathophysiological alteration is hypoxia, resulting from intrapulmonary shunt with alteration in the ventilation-perfusion

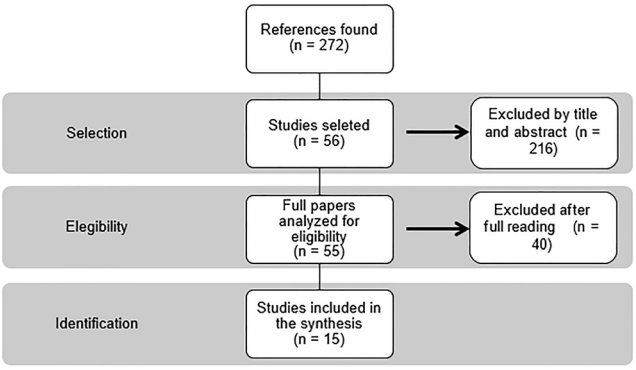


Figure 1. Flowchart of the articles included in the systematic review. SOURCE: The Authors (2021).

Table 1. Main results and characteristics of the studies included.

Year	Authors	Journal	Study type	Participants	Period	Results
2016	Son, Hwang, Choi	Korean Journal of Pediatrics	Retrospective study	29 children who drowned	2005-2014	Poor prognosis was associated with lower levels of consciousness (p = 0.003), higher Szpilman score (p = 0.007), greater need for OTI and MV (p = 0.001), and longer duration of oxygen therapy (p = 0.015), as well as BIC levels (p = 0.038), higher Na, AST and ALT (p = 0.034, p = 0.006 and p = 0.005, respectively). The Szpilman score correlated positively with level of consciousness (p = 0.002) and serum liver enzymes (p = 0.004).
2017	Al-Qurashi *et al*.	Pediatric Emergency Care	Retrospective study	51 victims of non-fatal drowning	2005-2015	Of the total cases, 94% recovered fully and 6% were diagnosed with brain death or were discharged from the ICU with severe neurological damage. Submersion time > 5 minutes, GCS ≤ 4, pH < 7.1, temperature ≤ 35 °C and blood glucose ≥ 180 mg/dL correlate with statistical significance to poor outcomes.
2017	Chotai *et al.*	Journal of Surgical Research	Retrospective study	363 victims of drowning or near-drowning	2011-2014	Factors associated with mortality included out-of-hospital transfer (p = 0.016), hypothermia on arrival (p < 0.0001), GCS 3 on entry (p < 0.0001), pool drowning (p = 0.013) or cooling brain on admission (p = 0.011).
2017	Shenoi *et al.*	Academic Emergency Medicine	Retrospective cross-sectional study	80 patients	2008-2015	5 factors generated a safe discharge score at 8 h: normal level of consciousness, normal RR, no dyspnea, no need for ventilatory support, and no systolic hypotension. The analysis resulted in an AUC of 0.81 (95% CI = 0.71-0.91; p < 0.001). A score ≥ 4 suggested a safe discharge within 8 h (sensitivity = 88.2% [95% CI = 72.5%-96.7%]; specificity = 62.9% [95% CI = 44.9%-78.5%]; PPV = 69.8% [95% CI = 53.9%-82.8%]; NPV = 84.6% [95% CI = 65.1%-95.6%]).
2018	Ballestin *et al.*	Pediatric Emergency Care	Retrospective observational study (1992-2004) and prospective (2005-2015)	131 patients admitted to a pediatric ICU after drowning	1992-2015	The clearest factor associated with a poor outcome was the type of initial resuscitation: all patients who required no CPR or only basic CPR had good outcomes; 96.3% of those who required advanced CPR with Epinephrine administration had poor results. Patients who required advanced resuscitation with VAD administration had lower temperature, as well as GCS, pH and BIC on admission and higher blood glucose. In this group, there was also a higher incidence of seizures, ARDS, hemodynamic compromise and AKI.
2018	Brennan, Hong, Wang	American Journal of Emergency Medicine	Retrospective study	185 patients	1995-2014	Patients with abnormal pulse oximetry readings on arrival were more likely to develop respiratory complications (p = 0.001).
2018	Cantu *et al*.	American Journal of Emergency Medicine	Retrospective cohort	90 patients	2010-2014	The patients were more likely to be discharged home with statistical significance if they did not desaturate, did not receive supplemental oxygen, did not undergo GSA, had a normal CXR, or if their history included a witnessed submersion event or no subsequent intervention required (all p < 0.01).
2018	Cohen *et al*.	Pediatric Emergency Care	Retrospective cohort	70 victims of drowning	2005-2015	12 patients suffered serious complications, including 5 diagnosed with brain death. CPR was performed in 80% of the fatal group (n = 5) and 23% of the non-fatal group (p = 0.006). CRP was significantly higher in the fatal group, as were low GCS scores, poor pupillary response, hypothermia, and bradycardia (p < 0.001).

Continued **Table 1.**

2019	Bauman *et al*.	Pediatric Emergency Care	Systematic review	29 patients from 10 different studies	Not applicable	Significant increase in mortality for asystole rhythm and hyperkalemia ($p < 0.05$).
2019	Cohen *et al*.	European Journal of Pediatrics	Retrospective study	80 patients seen in the pediatric ER after drowning	2007-2018	Crackles on lung auscultation, desaturation, and respiratory distress were significantly higher in the admitted group (n = 26) compared to the discharged group (n = 45) ($p < 0.05$). Respiratory distress and pulmonary crackles were independent predictors for admission.
2019	Ho *et al.*	Pediatric Radiology	Retrospective study	142 victims of drowning	2010-2013	The odds of an abnormal baseline CXR was 4 times higher in children with respiratory distress or abnormal baseline presentation (OR = 4.83; 95% CI = 2.1-10.85; $p < 0.001$). Improvement in radiographic findings occurred in 85% of children at 24 h. Children with an abnormal baseline CXR showed less clinical improvement at 24 h ($p < 0.001$). A normal CXR with mild pulmonary edema or atelectasis predicted clinical improvement within 24 h (sensitivity 95% and specificity 57%).
2019	Umapathi *et al.*	Clinical Pediatrics	Retrospective study	> 29.000 Pediatric hospitalizations because of drowning	2003-2016	Age < 5 years, Caucasian ethnicity, pool/bathtub accident, arrhythmia (OR = 1.3, p = 0.001), AKI (OR = 3.4, $p < 0.001$), cerebral edema (OR = 2.8, $p < 0.001$), CPR (OR = 12.1, $p < 0.001$) and MV (OR = 28.4, $p < 0.001$) were predictors of mortality.
2020	Loux *et al.*	American Journal of Emergency Medicine	Retrospective cohort	153 cases of drowning and 4,931 admissions to a trauma center	2010-2017	The risk of death (13.1% *vs*. 1.5%, $p < 0.01$), and severe outcome (24.8% *vs*. 7.8%, $p < 0.01$) were significantly higher for drowning vs. other causes. The odds of a severe outcome were higher for children aged ≤ 2 years (OR = 3.88 and 95% CI 1.58-9.53).
2020	Sik *et al.*	American Journal of Emergency Medicine	Retrospective study	89 patients referred to the pediatric emergency center because of drowning	2009-2019	Szpilman score ≥ 4, lactate level > 2 mmol/L and pathologic CXR findings were identified as predictors of hospital admission. 22 (24.7%) patients were treated with NIV and classified as grade 3 or 4 according to the Szpilman score. As the Szpilman score increased from grade 3 onwards, there was a positive correlation with lactate levels ($p < 0.001$) and total length of hospital stay ($p = 0.001$).
2020	Raess, Darms, Meyer-Heim	Children	Retrospective study	80 victims of drowning admitted to the emergency ward/ICU/ Infirmary	2000-2015	61% (n = 49) required CPR. submersion time, Admission GCS, baseline body temperature, pH, glucose, and lactate level significantly correlated with prognosis.

OTI = orotracheal intubation; MV = mechanical ventilation; NIV = non-invasive ventilation; BIC = bicarbonate; Na = sodium; AST = aspartate aminotransferase; ALT = alanine aminotransferase; GSA = arterial blood gases; CXR = chest X-ray; ICU = intensive care unit; PS = emergency room; GCS = Glasgow Coma Scale; FR = respiratory rate; AUC = area under the curve; CI = confidence interval; OR = odds ratio; PPV = positive predictive value; NPV = negative predictive value; CRP = cardiorespiratory arrest; CPR = cardiopulmonary resuscitation; DVA = vasoactive drug; ARDS = acute respiratory distress syndrome; AKI = acute kidney injury.

ratio associated with evolution with atelectasis and reduced lung compliance, causing metabolic and respiratory acidosis due to hypercarbia. Patients may progress with acute lung injury and acute respiratory distress syndrome and, in cases of broncho aspiration, aspiration pneumonia[11,12].

RISK FACTORS

The intrinsic risk factors well established in the literature are male gender, children aged 0 to 4 years (with the highest mortality rate in children under 5 years of age) and

adolescents (with the second highest mortality rate), history of neurological disorders and cardiomyopathies. In turn, extrinsic factors include the use of alcohol and other substances with risky behavior, lack of supervision, low education, rural residence, lack of adequate fences for swimming pools and swimming equipment, and visits from family or friends from outside the city. The factors associated with the event and with worse outcomes are submersion time (> 5 minutes), water temperature (not cold) and delay in starting cardiopulmonary resuscitation (CPR) or duration > 30 minutes[13,14].

MANAGEMENT

Prehospital

Seeking to optimize the initial assistance to the victim and reduce mortality, the systematic application of the drowning survival chain is recommended, corresponding to a series of sequential steps. They are: 1 - prevent drowning; 2 - recognize drowning; 3 - provide buoyancy; 4 - remove from water; 5 - provide care as needed. It should be noted that, in rescue operations, the rescuer's safety must be ensured first and, in deep water, the rescuer must approach the victim from the back, lift the victim's head to keep the nose and mouth out of the water, and swim to dry land[15].

Immediate resuscitation at the submersion site, even before the arrival of the emergency medical service (EMS), is the most effective way to improve survival and prognosis. The recommended resuscitation sequence is A - B - C (airway - breathing - circulation) and, to start it, it is advised to quickly clean the victim's nose and mouth, as they may be clogged with slime, debris or vomit. The child should be placed in the supine position for initial assessment and, if he is unconscious and not breathing spontaneously after opening the airways, 5 rescue ventilations should be performed, and, depending on the skill of the rescuer, ventilations may be even earlier and initiated in water; however, maneuvers such as chest and abdominal compressions are not indicated due to lack of evidence, increased risk of aspiration and delay in essential care[16].

After rescue breaths, a central pulse should be assessed and, if absent, with drowning < 1 hour and with no evidence of death, initiate CPR and continue until return of spontaneous circulation or arrival of the EMS, using chest compressions and rescue breaths in a ratio of 15:2 (children) or 30:2 (adolescents). In unconscious patients, CPR precedes rewarming, but in those who are conscious without cardiovascular or respiratory impairment, it is recommended to replace wet clothes with dry ones, use blankets or towels and, after the arrival of the EMS, the temperature should be measured and, in case of hypothermia, correct it aiming above 32-34ºC. Collar and neck stabilization are recommended only if head or neck injury is strongly suspected (as in cases of drowning from scuba diving or water sports), as generally only 0.5% of all victims have spinal injuries in the neck[17].

Hospital

Drowning victims who require any form of resuscitation (including just rescue breaths) should be transported to the emergency department for observation. Clinical observation and minimum monitoring of 6 to 24 hours are suggested. Monitoring should include pulse oximetry, electrocardiography, blood pressure and body temperature measurements[18,19]. In this context, validated systematizations can be used that help in the initial assessment and management of patients, based on the severity of the condition and considering the associated risk of mortality, such as the Szpilman score (Table 2).

Upon admission, adequate ventilation must be ensured: in spontaneous breathing, oxygen can be offered through a nasal catheter, face mask or non-invasive ventilation (NIV), but for those with a Glasgow coma scale (GCS) < 8, apnea or progressive respiratory distress, consideration should be given to invasive mechanical ventilation (MV), providing intermittent positive oxygen pressure or positive end-expiratory pressure. Initially, it is recommended to supply high concentrations of oxygen, aiming at saturation > 92%, with the use of protective ventilation (tidal volume between 4-6 mL/kg and plateau pressure < 30 cmH_2O), with a PaO_2 target of 55 to 80mmHg and the goal of reducing FiO_2 as quickly as possible to avoid hyperoxia lung injury. In cases of bronchospasm, B_2-agonists are used and, in the presence of pulmonary edema, a diuretic may be prescribed, with Surfactant and extracorporeal membrane oxygenation (ECMO) being indicated in severe cases[12,15,16].

After ensuring respiratory support, efforts should be made to restore effective circulation. If there is no pulse, chest compressions should be continued and, after reestablishing spontaneous circulation, pay attention to signs of hypoperfusion (capillary filling, evaluation of pulses, urinary output and changes in consciousness) and consider supplementing the volume with crystalloids or blood, as needed , as well as the need for vasoactive drugs, with Dobutamine being the drug of choice in the practice of a reference pediatric service, and clinical, laboratory and echocardiographic conditions should always be evaluated. If the patient develops signs of hypervolemia or the urinary output is reduced after restoring the volume, diuretics can be used at the usual dose[2,12].

Clinical impression should guide laboratory and imaging studies. The physician should order blood count, electrolytes, blood glucose, arterial blood gases, kidney function, liver enzymes and chest X-ray (CXR), since, as seen in the current literature review, worse outcomes were associated with low pH, bicarbonate alteration, hypernatremia, hyperkalemia, acute kidney injury, increased lactate, glucose and liver enzymes (Figure 2). Neck spine X-ray may be used in case of suspected neck injury, as well as other complementary exams depending on the clinical picture[20,21].

The routine use of antibiotics after drowning is not recommended; however, a possible exception is considered if the incident occurs in contaminated water. It is known that

Table 2. Drowning severity classification with initial approach.

Grau	Mortality	Signs and symptoms	First aid
Rescue	0,0%	• Conscious victim • No of coughing or foaming at the mouth and nose • Possibility of experiencing hypothermia, nausea, vomiting, malaise, fatigue, muscle aches, chest pain and diarrhea	Discharged from the accident site after evaluation
I	0,0%	• Cough without foam at the mouth or nose • Pulmonary: rhonchi and wheezing present • Lucid, drowsy, or agitated patient	Rest, heating and measures to reassure the victim without the need for O2 or hospitalization
II	0,6%	• Little foam at the mouth or nose • Lucid, drowsy, or agitated patient • Pulmonary: rhonchi present, wheezing and mild to moderate rales	Nasal O2 at 3 L/min Body warming + calming + rest Hospital observation for 6 to 24 hours
III	5,2%	• Lots of foam at the mouth and/or nose • Palpable radial pulse	O2 by face mask at 15 L/min Lateral safety position (right side) In the hospital: admission to the ICU
IV	19,4%	• Lots of foam at the mouth and/or nose • Palpable radial pulse • coma	O2 by face mask at 15 L/min until OTI is performed Breathing assessment Lateral safety position (right side) Ambulance - best procedure: ventilation and intravenous fluid infusion In the hospital: admission to the ICU
V	44%	• Respiratory arrest with central pulse present	mouth to mouth ventilation No external cardiac massage With return of spontaneous breathing: approach equal to grade IV In the hospital: admission to the ICU
VI	93%	• CRA	Cardiopulmonary and cerebral resuscitation After pulse and respiration return: approach equal to grade IV In the hospital: admission to the ICU
Cadaver	-	• CRA + submersion time > 1 h • Cadaveric rigidity • Livor present • Body decomposition	Recommendation not to start CPR Call police – issue document to the coroner

O_2= oxygen; ICU = intensive care unit; OTI = orotracheal intubation; CRA = cardiorespiratory arrest; CPR = cardiopulmonary resuscitation; SOURCE: Adapted from Szpilman et al. (2016).

pneumonia after drowning can be fatal, being more commonly seen in intubated patients, in these cases, consider treatment with broad-spectrum antibiotics to cover upper oropharyngeal pathogens that may have migrated to the lungs due to reduced pulmonary clearance. Late-onset pneumonia or meningitis associated with Pseudallescheria boydii and other pathogens have been described; therefore, attention should be paid to respiratory and neurological symptoms even weeks after the event[2,22].

Another aspect to be considered are associated conditions that may be related to the event, such as epilepsy, autism, cardiac arrhythmias, hypoglycemia, hemorrhage, intoxication and use of alcohol or other drugs, ensuring adequate support in these situations. In addition to immediate care, it is important to pay attention to the differential diagnosis of drowning with non-accidental trauma or neglect in patients who present incongruent histories, obvious lapse in supervision, delay in seeking care, and injuries suggestive of non-accidental trauma,

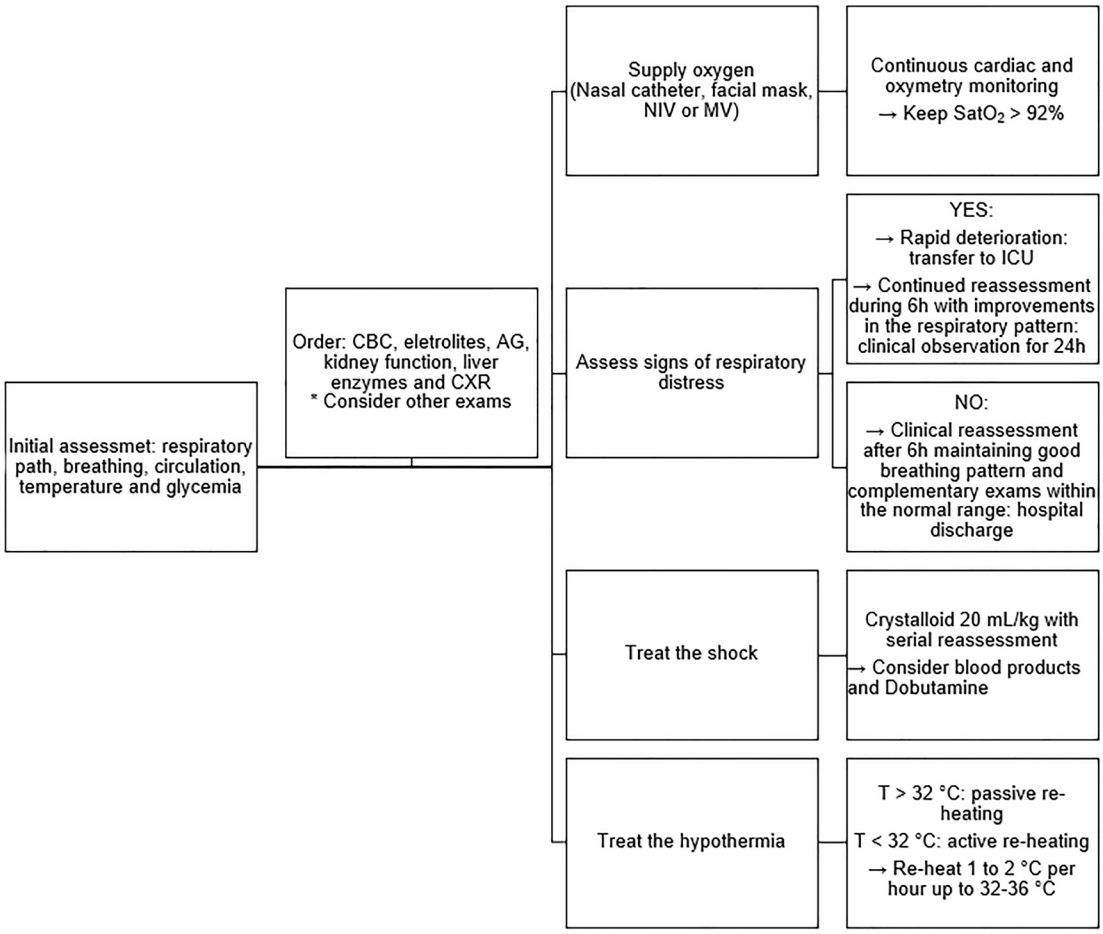


Figure 2. Algorithm for care for children and adolescents victims of drowning in the emergency service. CBC =complete blood count; AG = arterial gases; CXR = chest x-ray; NIV = Non-invasive ventilation; MV = mechanical ventilation; $SatO_2$ = oxygen saturation; T = temperature; ICU = intensive care unit. SOURCE: The authors (2021).

such as old bruises and fractures. After hospital discharge, every child victim of non-fatal drowning should be carefully followed up by a primary care physician and specialists, as needed[22].

PROGNOSIS

Drowning accidents in the pediatric age group, in relation to other traumas, are associated with higher rates of serious outcomes and mortality, with the highest rates of hospitalization and the worst results in children aged 0 to 4 years and in males, with the highest poor supervision by inexperienced caregivers as a contributing factor in under 5 year-olds mortality. The shorter the interval between the drowning and rescue, the better the outcome, with the majority of those whose time was less than or equal to 6 minutes without serious neurological sequelae; however, drowning for more than 10 to 15 minutes usually results in irreversible neurological damage due to hypoxia. Prompt and adequate intervention after recognition with CPR and rescue breaths were associated with a lower likelihood of complications[23].

A poor result can be assumed when the patient presents one of the following factors: GCS at admission with lack of motor response and no pupillary reaction, higher Szpilman score, submersion time > 5 minutes, body temperature < 30 ºC, pH < 7 , hyperglycemia, hypernatremia, hyperkalemia, elevation of lactate and liver enzymes, kidney injury and abnormal CXR with infiltrate[21,24]. From a clinical point of view, it is reasonable not to consider a single factor, but to analyze several values together, with a higher risk of death for patients hospitalized with arrhythmia, kidney injury, cerebral edema, seizures or who require invasive ventilation[25-27]. ECMO was not associated with higher mortality, which may indicate efficacy in the treatment of acute respiratory distress syndrome, with studies indicating better chances of survival[28].

With regards to morbidity, hypoxic brain injury is the main determinant after drowning incidents. Children and adolescents with more severe outcomes may have severe neurological disorders such as epilepsy, myoclonus, spasticity and severe functional restrictions. As for therapeutic hypothermia for survivors in coma due to drowning, there is no consensus in the literature regarding survival with good functional outcome compared to normothermia[6,29].

PREVENTION

Drowning may represent a smaller percentage of admissions to pediatric emergency rooms, but it is associated with high mortality rates and severe consequences, so it is necessary to invest in prevention measures. Multiple forms of protection are recommended, since a single strategy is unlikely to prevent deaths and injuries resulting from accidents. Therefore, efforts are needed to understand how, why and where the event occurred, as well as the related risk factors[1,3,30].

Education and the Role of the Pediatrician

Guidance on care and ways to prevent drowning are very important, and pediatricians must constantly learn about this topic, since many have little knowledge. Ideally, they should teach CPR and assist with programs that increase access to swimming for all children, as rescue is typically performed by non-medical professionals and the speed with which CPR is initiated results in a better prognosis. For education to be more effective, it is necessary that protective measures are available and appropriate knowledge for each age group[1,3,21].

Swimming classes

The American Academy of Pediatrics recommends that all children over age 4 who do not have motor developmental delay should take swimming lessons. It is not recommended for children under 4 years of age due to its association with increased respiratory infections and risk of death, but it should be remembered that water skills never prevent drowning and measures such as pool fences and adult supervision are necessary. The frequency of exposure to water, health problems, emotional maturity and physical limitations of children and adolescents should be considered, individualizing each one of them[1,3].

Adult Supervision

Constant and strict supervision by adults should be maintained, with the guardian staying less than 1 arm's length away from the child in the water[1,3].

Bath Care

Children should not be left unsupervised in water tanks and bathtubs, regardless of the volume of water present, since even a small amount can cause drowning; therefore, water tanks and bathtubs should be emptied immediately after use and children should never be left alone in the bathroom[1,3].

Care in the Pool Area

It is necessary to put a fence around the pools, so that the visibility inside is not compromised. Indoor pools are not always safe, as there have been reports of children walking on the cover and becoming trapped under them. Beware of pool drains that suck in water, as they can trap hair and body extremities, leading to tragic events[1,3].

Safe Diving Guidelines

Never swim alone or after using alcohol or drugs. It is not recommended to go headfirst into deep or unfamiliar water, as this can lead to head and neck injuries. One should never overestimate swimming abilities[1,3].

CONCLUSION

Drowning is an important and preventable cause of morbidity and mortality. The worst outcomes in the pediatric age group are statistically significant and associated with age < 5 years, submersion time > 5 minutes, higher Szpilman score and, on admission, lower GCS, hypothermia, acidosis, hyperglycemia, hypernatremia, hyperkalemia, lactate elevation and liver enzymes and abnormal CXR. Through this review, an algorithm was proposed to approach children and adolescents victims of submersion accidents in the emergency room and reinforce the importance of strategies and collective interventions for its prevention.

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