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Case Report

High-Quality Cardiopulmonary Resuscitation: An Opportunity in Pediatric Drowning. Case Report

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Abstract

Drowning is defined as the process resulting from the alteration in the physiology of breathing, as a result of a phenomenon of immersion or submersion in a liquid environment. Current scientific evidence demonstrates a strong positive impact on prognosis and mortality when high-quality resuscitation begins at the accident site. Below is the case of a previously healthy pediatric patient, who suffers from a drowning event and receives basic life support by eyewitnesses, developing Severe Respiratory Distress Syndrome and clinical data of hypoxic encephalopathy. The patient progressed with favorable evolution and was admitted from the hospital without evidence of neurological sequelae. The case is relevant due to the duration of the event, early cardiopulmonary care, and its association with prognosis.

Keywords: *Drowning; Resuscitation; Good Prognosis*

Introduction

Around the world, every hour of every day more than 40 people lose their lives by drowning [1]. In children aged 1 to 14 years, drowning is one of the leading causes of death from unintentional injuries [2], in addition, anoxic brain injury (ABI) is a common consequence of drowning and can cause severe neurological morbidity in survivors [3]. Early cardio-pulmonary resuscitation at the drowning site is the main determinant of neurological prognosis, and neurological examination is the best indicator [4]. The occurrence of these accidents (drownings) is a preventable public health problem [1]. Multiple strategies have been developed for the prevention and timely care, including training and education on cardio-pulmonary resuscitation which, if initiated by eyewitnesses, can completely change the neurological prognosis with high probability and impact the long-term quality of life. In this way, we consider cardio-pulmonary brain resuscitation the main strategy to improve the evolution of the drowning patient, of course, which must be initiated from the site of the accident as soon as possible, and once the safety of the scene has been corroborated [5,6].

Clinical Case

The clinical case of an 8 -year-old male patient, previously healthy, who was in the care of his parents at a family event, while in a pool, is presented. When the attention of caregivers is distracted, the patient remains unmonitored for approximately 7 to 10 minutes. Subsequently, the patient is located floating face down in the water and is extracted from the pool by witnesses and relatives, who find him without response and pulse. Cardio-pulmonary resuscitation was initiated immediately by a health professional who was a guest for approximately 10 minutes. The patient is transferred to the emergency department of the nearest hospital and admitted with generalized tonic-clonic seizures that were resolved with benzodiazepine administration and, subsequently, isolation of the airway was performed. Subsequently, the patient was transferred to the General Hospital of Zone No. 67 "Bicentenario de la Independencia" of the Mexican Institute of Social Security in Nuevo León, Mexico to continue with his comprehensive medical management. Upon arrival at the emergency department, arterial blood gases with severe respiratory acidosis and hypoxemia were observed, in addition to hemodynamic instability. In X-rays, the bilateral interstitial infiltrate was evident (Image 1 and 2), with the extension in the right hemithorax predominating.

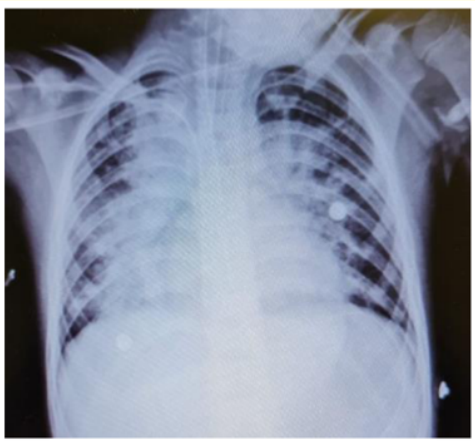

Image 1: *Chest X-ray was taken on admission. Diffuse bilateral interstitial infiltrates observed.*

Image 2: *Chest X-ray is taken after 72 hours of admission. Evolution of the bilateral diffuse interstitial infiltrate is observed.*

A simple cranial CT scan was performed, which reported data compatible with cerebral edema, as well as discrete hypodensity in the bilateral frontal region (Image 3). Due to this fact, the patient was admitted to the Pediatric Intensive Care Unit.

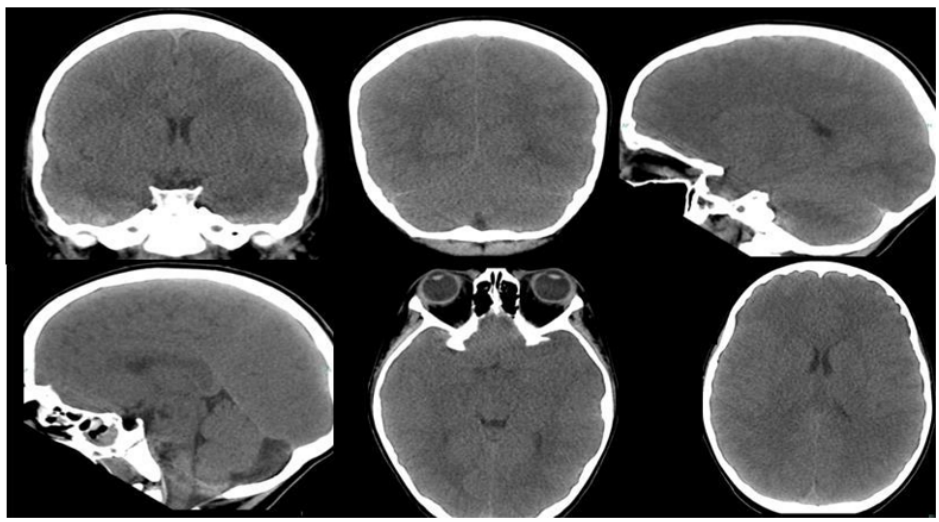

Image 3: *Simple computed axial cranial CT scan. Data compatible with cerebral edema and a discrete area of hypodensity in the bilateral frontal region are observed.*

The patient underwent pressure-controlled mechanical ventilation, seeking pulmonary protection measures; the diagnosis of Acute Respiratory Distress Syndrome (ARDS) was added after the 24-hour hospital stay, so therapy with alveolar recruitment strategies was optimized.

Attached, blood gases test (Table 1).

	Admission		**12h**		**72h**	
	Artery	**Vein**	**Artery**	**Vein**	**Artery**	**Vein**
pH	7,23	7,21	7,23	7.23	7.37	7.34
$CpCO_2$	60	58	54	55	48	50
pO_2	50	38	76	57	92	76
HCO_3	24	25.1	21	23	22.3	23
DB/EB	-2.5	-4.5	-6.3	-4.6	-2	-1.8
SO_2	69%	60%	92%	83%	90%	69%
CaO_2	9.35		12.53		12.3	
CvO_2		8.02		11.2	9.45	
Dav		1.33		1.33	2.85	
IEO2		9%		9%	21%	
IO		30		19	8.4	
PaO_2/FiO_2		50		76	142	

Table 1: *Blood gases test.*

Analysis of blood gases in critical periods of the patient stay in intensive care is attached. It is worth observing, particularly, the behavior of the oxygenation index since his admission and after 72 hours, showing a rapid tendency to improve within the severity of ARDS.

On the other hand, the alteration of the hemodynamic state stands out in the interpretation of the gases, behaving predominantly with a hyperdynamic profile, however, it should be noted that in the clinic, during his stay, he had a mixed profile.

From admission, laboratory studies were requested (Table 2 and 3) and inotropic drugs were administered as part of post-cardiac arrest care, in addition to norepinephrine as a vasopressor. Prophylactic antimicrobial therapy with ceftriaxone and clindamycin was indicated. Febrile peaks occurred only during the first 24 hours of admission. Enteral nutrition was initiated within 12 hours of admission with gradual increases according to tolerance. The evolution gradually progressed towards improvement, so the invasive ventilatory support lasted 5 days. After 24 hours without invasive ventilatory support, the patient was discharged from the hospital.

	Admission	After 72h
Na	143	138
K	4.7	4.3
Cl	111	109
Ca	9.2	9.2
P	3.2	3.2
Mg	2.3	2.3

Table 2: *Serum electrolytes taken on admission and 72 hours after.*

	Admission	After 72h
Hb	13.1	12.6
Hto	40.2%	38%
Leukocyte	11,300	11,000
Neutrophil	78.6%	80%
Lymphocyte	11.3%	12%
Monocytes	9.8%	8%
Platelet	271,000	275,000

Table 3: *Blood biometrics on admission and 72 hours after.*

Discussion

The main goal of prehospital resuscitation is to normalize ventilation and circulation, in addition to gas exchange. Therefore, when there are people at the site of the accident with training in basic cardio-pulmonary resuscitation (Witnesses), the chances of a better prognosis will be greater [7]. Such has been the case of our patient who was assisted immediately - once he was extracted from the liquid environment by one of his relatives, who was trained in basic aspects of resuscitation; thus, granting him the first breaths and chest compressions. Despite what was mentioned as a prolonged time of immersion, our patient suffered from a compatible clinical hypoxic-ischemic encephalopathy, requiring an invasive airway handle and mechanical ventilatory support.

When reviewing the literature, it is found that it is possible to find this encephalopathy mainly derived from two factors: the first of them, the immersion time; and the second, regarding the water temperature. We consider with high probability that in the case of our patient it has been the immersion time, however, if we consider the Conn Modell scale, which is commonly used to evaluate prognosis in this type of case, it will apply a type B assessment for being received closer to a state of obnubilation, being for this degree a probability of

neurological sequelae less than 10% [8]. Thus, far from the estimate that can be made of the prognosis and based only on the immersion/submersion time, it is worth considering the quality of early resuscitation and the Conn Modell and Glasgow neurological assessment scale upon arrival at the emergency department.

Physiological differences in electrolyte concentration and blood volume after drowning in fresh or saltwater are reported in the literature. However, as can be seen in the analysis of our case, no difference goes beyond the normal and safe ranges, in terms of the number of electrolytes and blood biometry (Table 2 and 3). Thus, it should be clarified that aspiration of more than 11 ml per kilogram of weight is required for the blood volume to be altered [9]. In the same way, aspiration of more than 22 ml per kilogram of weight is required, before finding significant changes in the concentration of electrolytes [10,11].

Success or failure in cardio-pulmonary resuscitation at the site of the accident will often determine the outcome. In a study that included more than 900 episodes of drowning, neurologically favorable survival was associated with the initiation of basic support by one of the spectators [12]. This coincides completely with the experience that occurred in our case since the patient, in this case, was discharged in optimal conditions of neurological integrity. It is mentioned that in order to improve the survival of victims of cardiac arrest who are admitted to a hospital after the restoration of spontaneous circulation, a multidisciplinary, integrated, structured, and complete system of post-cardiac arrest care (respiratory, neurological, and cardiovascular support) must be implemented. The objective of resuscitation should not focus only on the return to spontaneous circulation, but on increasing the possibilities for a more favorable neurological evolution [13,14].

Unfortunately, even though early resuscitation is key to survival, only 30% of cardiac arrest victims, including drowning victims, receive cardio-pulmonary resuscitation (CPR) from spectators [15].

Conclusion

A key to prevention certainly includes careful supervision of children and education to the public about drowning prevention and drowning risks. Those children who are playing in the water or near the water should be supervised by a responsible adult, who will not be able to compromise their attention. It should be noted that alcohol intake should be avoided for those who care for children and for adolescents who practice swimming, canoeing, etc.

The primary care pediatrician must make efforts to include in pediatric follow-up consultations, information, and training for parents about the correct way to carry out chest compressions and ventilations, as well as the most frequent scenarios in which it may be necessary to use them, according to the age group, in addition to reinforcing prevention techniques according to the age of the patient.

On the other hand, it is important to mention that hospital treatment should emphasize respiratory, hemodynamic, and brain protection support, an issue with which we partially agree, this, because we consider this protection approach starts from the site of the accident, opening a field to the concept of cardio-brain-pulmonary resuscitation within the timely attention to the drowning event. In this way, we rethink that the objective of resuscitation to the drowning victim should not focus only on the return to spontaneous cardiac circulation, but we must also consider another factor of great importance: the long-term neurological evolution.

Conflict of Interest

The authors declare that they have no conflicts of interest in relation to this article.

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