Case Report

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Recovery of Acute Pulmonary Edema Following Drowning Due to Seizure: Report of Two Cases

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ABSTRACT

BACKGROUND AND OBJECTIVE: Drowning is a process of respiratory impairment due to the full immersion under fluids that about one third of patients with drowning experience pulmonary edema. In this article, two patients with acute pulmonary edema after drowning due to seizure who were admitted to the ICU department at Ayatollah Rouhani Hospital in Babol have been presented.

CASE REPORT: An 18-year-old man with a history of epilepsy was drowned while swimming in the pool after a seizure. Due to hypoxia, he was treated with supplemental oxygen and NIV for 12 hours. After partial recovery, he was treated with oxygen for three days. The patient on the fourth day was discharged with a good general condition.

Second patient: An 36-year old man, with a previous history of brain trauma was drowned while swimming in the sea after a seizure. The patient was intubated due to severe hypoxemia despite administration of oxygen (pao2 = 44mmHg) and low blood pressure (BP = 80 / 50mmHg), and was transferred to ICU at Ayatollah Rouhani Hospital. The patient was treated for mechanical ventilation and positive end expiratory pressure (PEEP) for 12 days. After recovery, he was separated from the ventilator and was discharged on the 14th day.

CONCLUSION: In acute pulmonary edema after drowning, administration of oxygen and non-invasive ventilation is recommended. In the absence of response, tracheal intubation and invasive mechanical ventilation are recommended.

KEY WORDS: *Drowning, Acute pulmonary edema, Noninvasive Ventilation.*

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Introduction

Drowning is a process of respiratory dysfunction due to full fluid immersion and is the third cause of accidental death. Annually, about 372,000 deaths from drowning occur in the world, accounting for more than 50% of deaths, aged less than 25 years (1-3). The main risk factors for drowning include male gender, age less than 14 years old, alcohol consumption, low income, poor education, exposure to aquatic animals, risky behavior and lack of supervision. In epilepsy, drowning is 15 to 19 times more common than normal people (3). Despite the pathophysiological differences in experimental models, in humans, there is no significant difference between drowning in saline water and fresh water (3). Lung edema is one of the most common drowning complications. About one third of these patients have pulmonary involvement (non-cardiac lung edema). In addition, in most patients, vomiting and aspiration occur, which ultimately causes airway obstruction and increases respiratory problems (4, 3,1). The first occurrence in drowning is to keep breathing. In the awake person, the water inside the mouth is either swallowed or thrown out. The first symptom of aspirating water is coughing, or rarely spasm of the larynx. By creating hypoxia, more water enters the lungs and exacerbates hypoxia. In cases where oxygen consumption is higher, such as seizures or extreme congestion, this trend is faster and ultimately hypoxia is exacerbated by apnea, brain damage and cardiac arrest (3). Water aspiration results in degradation of surfactant, alveolitis, and ultimately increased shunting and decreased lung compliance and non-cardiogenic edema or acute respiratory distress syndrome (5, 3). In 2001, a ten-year study was conducted on 46080 patients in terms of management and treatment by category (Table 1) with regard to the severity of injuries of drowned patients (6-8, 3). Sleeping pills were prescribed for endotracheal tube and mechanical ventilation. Fio2 initially started with 100% and then reduced to less than 45% with improvement in oxygenation. PEEP started with 5 cm of water and then, with an arterial oxygen control, each time 2 cm of water was added up to Pao2 / Fio2 ratio to 250. If decreased blood pressure was not corrected by improving oxygenation, crystalloid infusion may be given prior to lowering PEEP (9, 3). In grade 6 patients, in addition to advanced cardiovascular support, the diagnosis and treatment of arrhythmias are also done. Hypothermia (temperature lower than 34 ° C) should be corrected. Hospital care is recommended for drowning grades of 2-6. Patients in grade 2 should be monitored for 24 hours in the emergency room, but grade 3-6 are admitted to hospital (3). Beaches and pools do not have enough bacteria to cause pneumonia in a short time after drowning. Antibiotic prophylaxis has little value at the onset of drowning treatment. The tracheal tube secretion is daily evaluated and in case of suspicion of pneumonia, the aspirated discharge of the tracheal tube is examined in terms of coloring, culturing, and sensitivity after 48-72 hours in ICU (10, 3). About 15,000 deaths occur annually due to drowning in Iran (11). Acute pulmonary failure is one of the main causes of death in these patients. The management of non-cardiac acute pulmonary edema is one of the problems that is underestimated. The management of the patient with diffuse lung involvement (NIV = Non-invasive ventilation) is one of the new issues in Iran. Due to the high prevalence of drowning in northern Iran, two patients with acute pulmonary edema after drowning due to seizure that recovered completely are presented.

Table 1. Clinical symptoms and severity of drowning and the necessary therapeutic actions

necessary therapeutic action	clinical signs	Severity of drowning
does not require oxygen	The patient has cough, but the sounds of the lungs is normal	Grade 1
Oxygen with nasal cannula, monitored in the hospital for 6 to 48 hours	Crackles can be heard in some areas of the	Grade 2
high flow oxygen with a mask and in the absence of response, non-invasive ventilation, intubation and mechanical ventilation, venous fluid and vasopressor	There are signs of acute pulmonary edema in these patients, but they have not low blood pressure. Rarely, pulmonary edema does not appear for up to 12 hours, and then it shows itself bluntly. Sometimes neurogenic pulmonary edema is caused by hypoxia of the brain.	Grade 3
Mechanical ventilation is the basis of treatment. Before intubation, oxygen is administrated with a mask of 15 liters per minute.	These patients have signs of acute pulmonary edema but also have a low blood pressure. Despite the administration of less than 90% Sao2 oxygen, Paco2 is more than 45 mm Hg, high respiratory rate, and secondary muscle use.	Grade 4
is usually intubated and placed under mechanical ventilation	respiratory arrest	Grade 5
usually begins with CPR and after the preparation of the device, the tracheal intubation is done.	Cardio-respiratory arrest	Grade 6

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Case 1

First patient: 18-year-old male, 76 kg with 168 cm height due to seizure-induced drowning (with epilepsy history) while swimming in the pool, with an indefinite period of drowning, vigilant, temperature of 35.5 ° C, respiratory rate of 60 per minute, heart rate of 110 per minute, blood pressure 130/80 mmHg and Spo2 = 65% within a half hour with oxygen was transferred to the emergency department of Ayatollah Rouhani Hospital. In the electrocardiogram, sinus tachycardia was seen and the chest radiograph showed severe pulmonary edema (Fig. 1). Renal and blood electrolytes tests were normal. In ICU, oxygen was initially injected with a mask of 15-10 liters per minute, and then the patient was subjected to non-invasive ventilation (NIV) with PSV with PEEP for 12 hours, analysis of arterial blood gas was improved (Table 2). The patient was then separated from the NIV and treated with oxygen and gradually stopped for 72 hours. On the fourth day, the oxygen saturation with room air was 96% based on pulse oximeter and the patient was transferred to the department on the fourth day with a good general condition. Chest X-ray on the third day showed relative recovery (Fig. 2).



Figure 1. Chest radiograph, diffusion infiltration in both lungs, one hour after drowning

Table 2. Analysis of arterial blood gas of the first patient

Time of admission	PH	Pao2 (mm/Hg)	Paco2 (mm/Hg)	HCo3 (meq)	Sao2 (%)
When entering the emergency room	7.21	44	38	17	66
Oxygen with a mask of 10 liters per minute	7.31	58	39	18	89
under NIV ventilation	7.44	85	38	26	96



Figure 2. Chest radiograph after 48 hours, relative cleansing of the lungs

Case 2

Second patient: A 36-year-old male with a history of traumatic brain injury (Fig. 3) and seizure treated with prophylaxis with anticonvulsants, suffered seizures and drowning while swimming in the sea. In the initial examinations, a decrease in the level of consciousness, temperature of 35.7 ° C, respiratory rate of 30 per minutes, heart rate of 130 per minutes, blood pressure 80/50 mmHg, and Spo2 = 60% were observed in the patient. There was no other finding in the electrocardiogram other than sinus tachycardia. Due to severe hypoxia, the intubation was done and was transferred to the ICU at the Ayatollah Rouhani Hospital in spite of the administration of oxygen (pao2 =44 mmHg) and low blood pressure. The patient was mechanically ventilated with ACMV mode with the following instructions:

TV = 450 mlRR = 16 / min, PEEP = 10 cm H2O FIO2 = 100%

The analysis of arterial blood gas was:

PH: 7.39, PCO2: 43mmHg, HCO3: 23, PO2: 66mmHg

The patient's initial tests were as follows:

BUN = 20 mg / dL, Cr = 1.4 mg / dL, Na = 133 mEq / L, K = 4.5 mEq / L

On the second day, blood pressure (130/81 mmHg) and arterial oxygen saturation (99%) were normal. In the CT scan of the brain other than the place of the old trauma, no new lesion was observed (Fig. 3).



Figure 3. Brain CT Scan of second patient

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The patient suffered from fever (39.2 ° C), leukocytosis (16000) and increased pulmonary secretion from the third day after partial recovery. In CT Scan, bilateral pulmonary infiltration was observed (Fig. 4). The patient was treated with intravenous meropenem 1 g every 8 hours and intravenous ciprofloxacin 400 mg every 12 hours. The patient's endotracheal tube was removed on day 12 after the admission and the patient was transferred to ward without nasal oxygen 48 hours later.



Figure 4. Lung CT Scan, Pneumonia aspiration in second patient on day three. Notice the air bronchogram view.

Discussion

In the first case report, the patient had a grade 3 drowning due to respiratory distress and normal blood pressure, and responded to oxygen therapy and non-invasive ventilation, but in the second patient the patient had a degree 4 of drowning due to decrease in blood pressure and mechanical ventilation. Pulmonary edema responded to treatment in both patients and recovery was achieved. Ruggeri and colleagues introduced a 45-year-old man with a history of epilepsy who suffered from seizure drowning in the seawater. First, 60% oxygen was injected with Venturi mask (to administer high flow-oxygen). Chest X-ray (CXR) showed bilateral infiltration. The patient was then subjected to non-invasive ventilation with a 10 -15 cm water PSV method plus a PEEP of five centimeters of water for 12 hours, the analysis of the arterial blood gas of the patient improved. Gradually, the oxygen was discontinued and after 96 hours the patient was discharged and the researchers concluded that noninvasive ventilation is effective in treating acute lung edema due to drowning (9). The course of the patient's illness and its treatment was similar to our patient. In our patient, CXR showed a relative recovery on the third day and patient was transferred to the department with a good general condition on the fourth day. Acute lung edema following by drowning grade 6-3 is common. But, relative to other causes of ARDS, recovery is faster (3, 12, 13). Acute pulmonary edema improved in the first patient on the fourth day, but continued in the second patient for 12 days. Usually drowned patients with grade 4-6 require intubation and mechanical ventilation. The PEEP level should remain unchanged for 48 hours in order to allow surfactants to be restored (3). The second patient had need of mechanical ventilation and PEEP for a long time. Koh et al (2017) introduced a 29-year-old woman who was drowned in water after drinking alcohol. The patient was brought to the emergency department within 30 minutes. In the initial examinations, the patient experienced a decrease in consciousness and severe hypoxia. Extracorporeal membrane oxygenation (ECMO) was initiated for the patient in addition to supportive treatments including tracheal intubation and mechanical ventilation, and the patient's hypoxemia recovered after 24 hours, concluding that ECMO should be initiated during the recovery period in drowned patients should be considered (14).

Sellmann et al. also showed the effect of extracorporeal membrane oxygenation (ECMO) and decreased mortality in drought-induced hypoxia (15). Unlike our patients who responded to oxygen therapy and ultimately mechanical ventilation, the patient introduced by Koh et al. did not respond to oxygen therapy and mechanical ventilation and was resistant to hypoxia. However, in the study of Koh and colleagues, in addition to pulmonary involvement, patient had an intracranial hematoma in the brain CT scan. Cerland et al. in their study investigated the incidence and consequences of post-drowning pneumonia in 144 patients (111 adults and 33 children), and concluded that bacterial pneumonia aspiration due to drowning is rare and does not affect mortality (10).

Our patient also suffered from pneumonia and responded to antibiotic treatment. The first patient had a grade 3 drowning due to the diagnosis of acute pulmonary edema and normal blood pressure and responded to oxygen therapy and non-invasive ventilation, but the second patient had a degree of 4 drowning due to the diagnosis of acute pulmonary edema and decreased blood pressure, therefore was placed under mechanical ventilation and PEEP. Due to fever, leukocytosis, pulmonary infiltration was treated with diagnosis of aspiration-induced pneumonia. Treatment for acute lung edema in drowning is non-invasive ventilation with the PSV method along with PEEP. In the presence of hypoxia, despite the

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administration of oxygen and non-invasive ventilation, intubation, mechanical ventilation and PEEP are recommended. In case of drowning in the presence of fever, leukocytosis, pulmonary infiltration, it should be mindful of aspiration-induced pneumonia and also cover gram-negative bacteria.

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