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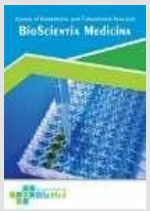

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Intensive Management of A 21-Year-Old Male Patient with Acute Respiratory Failure Due to Near Drowning: A Case Report

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A B S T R A C T

Background: The mechanism of near drowning involves decreased lung compliance and aspiration of water into the lungs, which damages surfactants and disrupts alveolar capillary membranes. This leads to the development of alveolar oedema, and ventilation-perfusion mismatch, which causes hypoxemia leading to acute respiratory distress syndrome (ARDS) and cause other organ dysfunction and death. **Case presentation:** The patient was found drowned by his friends while on vacation and swimming in the river. Initial physical examination in the ED obtained a Glasglow coma scale (GCS) score of 14/15 (E3-V5-M6), blood pressure 124/70 mmHg, and pulse 124 beats/min. The patient breathed spontaneously 25 breaths/min with oxygen saturation (SpO_2) of 90% on room air. The patient was initially managed with oxygenation using a non-rebreathing mask (NRM semi-fowler positioning and peripheral access. Chest X-ray and other radiologic examinations, including a brain CT scan, were performed before the patient was immediately transferred to the ICU, and there was no evidence of other trauma. During the 9 days of intensive management in the ICU, there was a good improvement from GCS 14 to 15. **Conclusion:** Intensive management of a 21-year-old male patient with acute respiratory failure due to near drowning.

1. Introduction

According to WHO, near drowning is the third leading cause of unintentional injury death worldwide, accounting for 7% of all injury deaths. There are an estimated 236,000 near-drowning deaths each year worldwide. Global estimates may significantly underestimate the actual public health problem related to near drowning.[1] Near drowning begins with panic and continues with the loss of normal breathing patterns and the victim's attempt to stay above the water for air resulting in reflex laryngospasm and hypoxemia due to aspiration.[2]

The mechanism of near drowning involves decreased lung compliance and aspiration of water into the lungs, which damages surfactants and disrupts alveolar capillary membranes. This leads to the development of alveolar oedema, and ventilation-perfusion mismatch, which causes hypoxemia leading to acute respiratory distress syndrome (ARDS) and cause other organ dysfunction and death.[2,3] Treating lung injury with the principles of lung protective ventilation and reversing hypoxia is the foundation of near-drowning management. It is also related to the patient's survival and neurological status due to hypoxic encephalopathy.[3] This case report highlights the successful intensive management of non-fatal near-drowning-related acute Respiratory failure with early mechanical ventilation.

2. Case Presentation

A 21-year-old male patient was admitted to the hospital emergency department (ED) with decreased

consciousness 4 hours before admission. The patient was found drowned by his friends while on vacation and swimming in the river. From his friend's description, the patient disappeared for 5 minutes before being rescued and taken to the nearest hospital.

Initial physical examination in the ED obtained a Glasglow coma scale (GCS) score of 14/15 (E3-V5-M6), blood pressure 124/70 mmHg, and pulse 124 beats/min. The patient breathed spontaneously 25 breaths/min with oxygen saturation (SpO_2) of 90% on room air. On chest examination, there was a symmetric scar on the chest wall. Breathing was symmetric, no crepitations were found, and rales were found in both lung fields. The acrals were cold, and the fingertips were cyanotic with a hypothermic temperature of 36.5°C. The patient was initially managed with oxygenation using a non-rebreathing mask (NRM) of 15 liters/min and semi-fowler positioning and peripheral access. Chest X-ray and other radiologic examinations, including a brain CT scan, were performed before the patient was immediately transferred to the ICU, and no evidence of other trauma. Chest X-ray showed increased and blurred bronchovascular pattern, hillar haze (+), batwing appearance (+), cotton wool appearance (+), suggestive of alveolar type pulmonary edema, and bilateral pneumonia. Initial Arterial blood gas analysis found hypoxemia with an initial PaO_2/FiO_2 was 86.5. Renal function was normal, and electrolytes were slightly hyponatremia and hypokalemia.

In the ICU, the patient was still somnolent, with fingertip cyanosis and 95% peripheral saturation with NRM 15 liters/minute. The patient was immediately performed endotracheal intubation and then connected to the ventilator with the initial mode: duo positive airway pressure (DuoPAP) inspiratory pressure (Pins) = 16 cm H_2O, pressure support (PS) = 7 cm H_2O, positive end-expiratory pressure (PEEP) = 7 cm H_2O; FiO_2 70%. The ventilator settings were gradually adjusted based on clinical, arterial blood gas analysis and other examinations with close monitoring. In addition, the neurological status, hemodynamics, chest X-ray, signs of sepsis, and other laboratory tests were thoroughly and closely monitored.

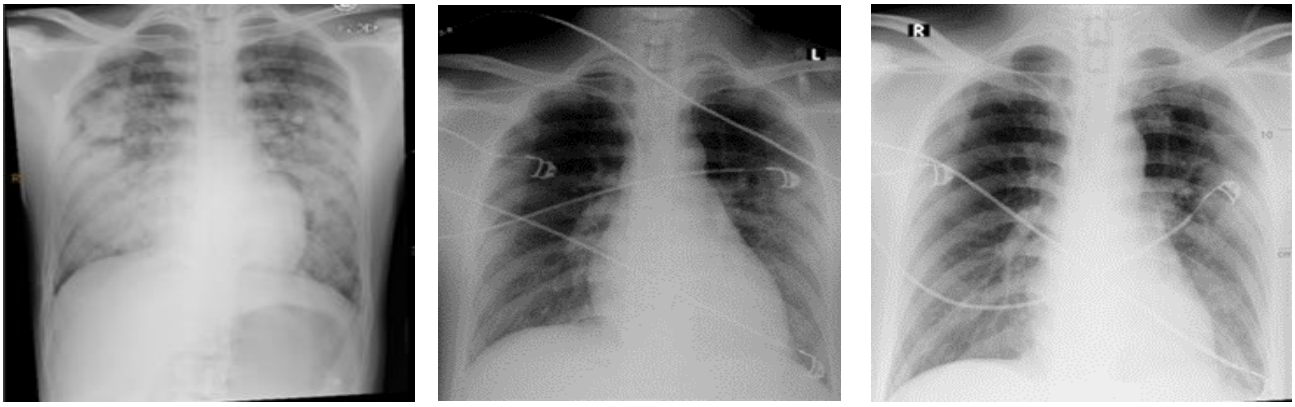
During the 9 days of intensive management in the ICU, there was a good improvement from GCS 14 to 15, gradual improvement in the condition of the Chest x-ray until the patient could be extubated, and the sepsis condition from procalcitonin>100 ng/ml to 1,21 ng/ml with comprehensive management.

3. Discussion

Near drowning can usually occur within seconds to minutes (in cases of extreme hypothermia > 1 hour). The long-term morbidity of survivors depends on the severity and duration of oxygen deprivation to the brain. The clinical picture is mainly determined by the amount of water that enters the body, especially the respiratory tract. Near-drowning cases in the world generally occur around 500,000 people each year, where deaths occur around 32.8/100 near-drowning victims.[4] Risk factors for near drowning include head trauma, seizures, cardiac arrhythmia, hypoglycemia, hypothermia, alcohol and drug use, suicide, panic attacks, myocardial infarction, depression, scuba, and natural disasters.[5] However, in this patient, the organic risk was not found. The patient was previously not good at swimming, increasing the leading risk factor for near drowning. This case report aligns with Asadi's study, where near drowning cases in Guilan from 2016 to 2017 were primarily male with an average age of 27 years and located in coastal areas.[6] Nearly 80% of near-drowning deaths in men are associated with increased exposure to water, risk-taking behavior, and alcohol use. The other most common factor is a lack of swimming skills / not knowing how to swim. Many cases are adults and children without proper swimming training. Safety knowledge and informal/formal swimming education and under lifeguard/river supervision can dramatically reduce the risk of near drowning.[7]

Table 1. Improvement of neurological status, oxygenation, and infection.

Parameters	Day 1		Day 3	Day 5	Day 7	Discharged from ICU
	Before intubation	3 hours after intubation				
GCS	14	14	15	15	15	15
SpO^2	95	99	100	100	100	100
PaO_2/FiO_2	86,5	248	380	396	437,5	345
Procalcitonin	-	>100	58,0	14,8	3,39	1,21



A B C

Figure 1. Radiological improvement. A (Day 1); B (Day 7); C (Day 9).

The near-drowning mechanism occurs due to the aspiration of water into the lungs. After the initial breath hold, when the victim's airway is below the surface of the liquid, a period of laryngeal spasm occurs involuntarily. This is triggered by the presence of fluid in the oropharynx or larynx. At this time, the victim cannot inhale air, causing oxygen depletion and carbon dioxide retention. Water entering the respiratory tract damages surfactant disrupts alveolar capillary membranes, and causes the development of alveolar edema, resulting in syndromes such as localized acute respiratory distress syndrome (ARDS).[8] The two main sequelae of near-drowning are the central nervous system and the heart. Within 2 minutes, most victims lose consciousness, and within 4-6 minutes, they will have an irreversible brain injury. Global central nervous system (CNS) hypoperfusion induces the release of excitotoxic neurotransmitters, free radicals, and lipid peroxidation. Cerebral edema followed by autonomic instability is often accompanied by ST-segment changes, indicating stress-related myocardial damage. Hypoxemia also induces ventricular arrhythmias and severe pulmonary hypertension.[8] Most near-drowning patients are hypoxic and have a PaO_2/FiO_2 ratio <300 mmHg.[9] Management of lung injury and overcoming hypoxia are the cornerstones of near drowning management.[5]

The essential management principle in near-drowning cases is whether a respiratory and cardiac arrest requires immediate resuscitation. If not, then make sure the airway is adequate. When there is no respiratory problem, it should be closely observed (Figure 1).[11] If the person is not rescued, aspiration will continue, and hypoxemia causes loss of consciousness and apnea within seconds to minutes.[12] There was no respiratory failure or cardiac arrest, but the patient had increased respiration frequency which had to be managed adequately. This patient was also warmed to prevent sudden hypothermia and a protective effect. In

line with the theory that the target temperature during the first 12 - 72 hours is 32°C-34°C. Management aims to prevent ischemic brain injury, increase oxygen supply to the ischemic brain area, reduce brain metabolic demand, and reduce intracranial pressure.[13]

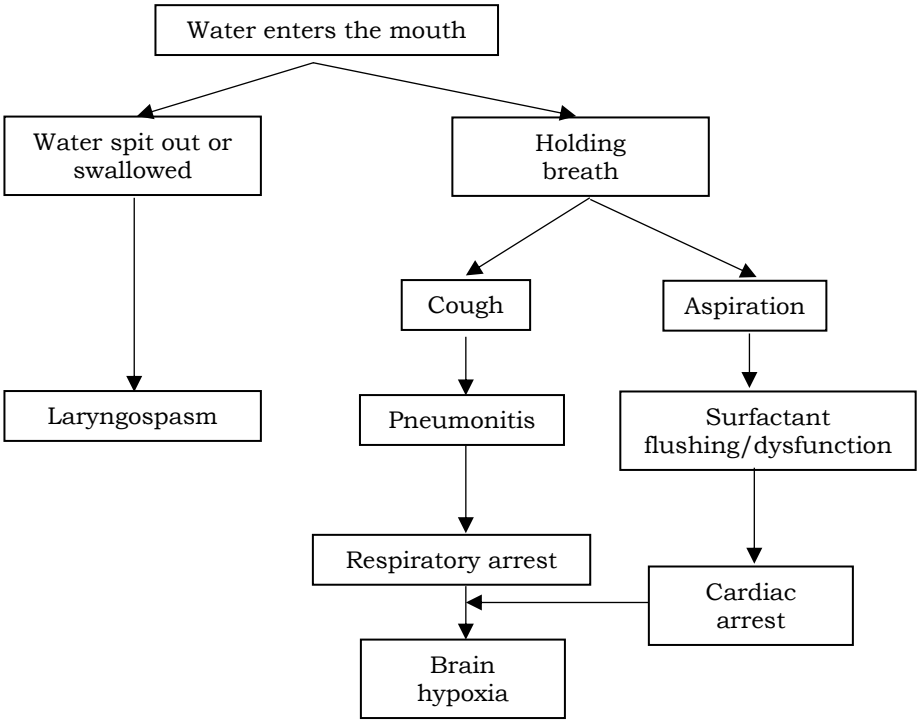


Figure 2. Near-drowning mechanism in the body (modified from [10]).

Mechanical ventilation (MV) is an option for patients to improve respiratory and tissue oxygenation. Mechanical ventilation is often used when supplemental oxygen alone is insufficient to overcome hypoxia. Other indications include decreased consciousness or cardiac arrest.[3] However, using MV in near-drowning cases may risk progressive pneumonia and barotrauma.[14] Although barotrauma is high in near-drowning patients with VM (10-12%), it did not occur in this case. VM should use a lung protective ventilation (LPV) system to reduce ventilator-induced lung injury. ARDS guidelines suggest using low tidal volume (Vt) according to IBW, and using higher PEEP to limit ventilator-induced lung injury (VILI).[15] The targets of MVVM include survival and neurological status. Given that most near drowning cases will experience hypoxic encephalopathy in many of these patients and the patient's condition in this case before VM was performed already had signs of hypoxic encephalopathy.[16] The length of treatment and average stay of patients in this case report and near drowning patients in the ICU do not align with the existing theory of 4.5 days. This happened because the patient developed sepsis (secondary infection).[16]

Antibiotic administration in near-drowning cases is basically to avoid infectious complications. However, in this case, clinical and labor results supported the report that infection was already present in the patient. Pneumonia is often difficult and misdiagnosed because the initial thoracic photograph shows fluid images in the lungs and overlaps with ARDS images. In some cases, pneumonia occurs in 12% of near-drowning cases and requires antibiotics. Prophylactic antibiotics are not recommended as they increase germ resistance and aggressiveness. Patients should

be monitored daily for fever, persistent leukocytosis, additional infiltrates, and sputum culture sampling.[17]

Most drowned patients have hyperfibrinolytic disseminated intravascular coagulation, partly due to hypoxia-induced release of tissue plasminogen activator. Antifibrinolytics and heparinases partially reverse the abnormal clotting pattern. Severe prolongation of activated partial thromboplastin time may be a combined marker of hyperfibrinolytic afibrinogenemia and auto heparinization in asphyxia due to near drowning.[10] In addition, the morbidity and mortality of near drowning cases are caused by laryngospasm, lung injury, hypoxemia, acidosis, and their effects on the brain and other organ systems. The risk of sequelae in near-drowning patients is high and needs further evaluation.[4] In this case report patient, no sequelae were found. The patient did not experience any post-treatment sequelae. This is in line with the theory that the prognostic case of near drowning is unfavorable if the age is less than three years, maximum immersion time is estimated to be more than five minutes, resuscitation is not attempted for at least ten minutes after rescue, the patient is in a coma at the time of hospital admission, and 5) arterial blood pH is less than or equal to 7.10.[18]

4. Conclusion

Near drowning cases have a high risk of death if not properly managed. Mechanical ventilation in near-drowning cases is an option in near-drowning cases that experience ARDS. Care needs to be taken in the use of mechanical ventilation to prevent complications.

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