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MANAGEMENT OF ARDS IN DROWNING PATIENT IN INTENSIVE CARE UNIT

[1*]Heru Susilo, [1]Akhmad Yun Jufan

[1]Faculty of Medicine, Public Health and Nursing, Gadjah Mada University, Indonesia Universitas Padjadjaran / Dr. Sardjito National Referral and Teaching Hospital, Special Region of Yogyakarta, Indonesia*

Correspondence Author:
heruanestesi@gmail.com

ABSTRACT

Acute Respiratory Distress Syndrome (ARDS) occured in drowning patients in both fresh or salt water. This is a consequence of aspiration of fluid into the lungs. This condition can be made worse by the possibility of hypothermia, arrhythmia, or neurological impacts as a result of anoxia. A male, 16 years old, 60 kg without comorbid was drowned in a well, came on referral from a another hospital, he was admitted to the ward for 2 days. The patient arrived in emergency room and the patient is in respiratory failure state and ARDS. This patient was given intubation in the emergency room, after this patient is stable he was transfered to ICU. In the ICU, the patient was given mechanical ventilation therapy on 4th day and then he was given weaning gradually, on 7th day the patient was given extubation.

In general, treatment outcome of drowned patient really depends on how effective and fast the maangement of the respiratory distress in the incident location and until taken to hospital. Mechanical ventilation therapy follows the general ARDS management pattern, using PEEP and lung protection strategies. Monitoring and caution is needed during the weaning process to prevent recurrence of pulmonary edema and re-intubation.

KeyWord : *Drowning, ARDS, Intensive Care Unit*

INTRODUCTION

Drowning is the third cause of death in the world due to unexpected injuries. According to WHO, in 2019 there were 370.000 death caused by drowning. This number accounts for 7% of injury deaths. In poor and developing countries, the death rate due to drowning reaches 91% [1]. In the pediatric population, drowning is also the third leading cause of death due to injury. The highest incidence of drowning in children aged 1-4 years, followed by the second highest incidence in children aged 15-19 years. Risk factors in early childhood are caused by a lack of adult supervision and high curiosity but not yet recognizing the dangers. In adolescence, risk factors for drowning include alcohol use, drug abuse and diving [2].

There is very little data that states the epidemiology of drowning in Indonesia. In research at Sanglah Hospital Bali which collected data from 2010-2014 there were 209 drowning incidents with a death rate of 1.73/100,000 and in research at Prof. Hospital. Dr. R.D. Kandou, who collected data from 2007-2011, showed that the average death due to drowning was 0.18/100,000. However, this data is still provincial in scope, there has been no research that covers a wider area, so it is possible that a lot of data is still unknown [3].

The main process when drowning occurs is respiratory distress and hypoxia which will cause disruption to other systems and organs [4]. Drowning is defined as a process of respiratory disturbance due to immersion or submersion [5]. Immersion is when the upper airway is still above water, while submersion is when the airway is below water level. Immersion occurs more often in cold water which causes hypothermia. A body temperature of 30˚C will cause loss of consciousness and a heart temperature below 28˚C will cause cardiac arrest. The lungs are an organ that is very vulnerable when drowning, aspiration of hypotonic fluid into the alveoli will cause damage and dilution of surfactant as well as decreased lung compliance which causes atelectasis. These things will further reduce ventilation-perfusion resulting in increased shunting. Meanwhile, in aspiration of hypertonic fluid (sea water), the plasma will be drawn into the alveoli, thereby destroying the surfactant and causing foam which further reduces the effectiveness of the lungs. This condition is like acute respiratory distress syndrome. [6]

Several other mechanisms of lung injury may occur with nonfatal drowning. Bacterial pneumonia, barotrauma, mechanical damage from cardiopulmonary resuscitation (CPR), chemical pneumonitis, centrally mediated apnea, and oxygen toxicity can cause respiratory disturbance in the postresuscitation period. It should be considered along with ARDS in cases of respiratory distress occurring 1 to 48 hours after the event. [7]

CASE REPORT

A male, 16 year old, 60 kg came to the emergency room as a referral patient from another hospital, and had previously been treated in the ward for 2 days. When the patient arrived at the emergency room, he was short of breath, conscious and looked anxious, the respiratory rate was 28x/minute using an oxygen mask (NRM) of 15 L/minute, the oxygen saturation was measured at 80%, and he had crackles in the right and left lung fields. Blood pressure is 130/80 mmHg with a pulse rate of 116 x/minute and a temperature of 36°C. There is also swelling on the right eyelid, abrasions on the left arm and left knee. The patient was diagnosed as respiratory failure, post drowning ARDS, aspiration pneumonia. Intubation was carried out in the emergency room, after being stable the patient was transferred to the ICU.

When the patient arrived at the ICU in a sedated state, mechanical ventilation therapy was given with VCV (volume control ventilation) control mode, tidal volume 400ml with PEEP 8 cmH2O, FiO2 100-80% with a respiratory rate of 20x/minute. The patient's vital signs are sedated, blood pressure 115/74 mmHg, RR 20x/minute, saturation 99%, pulse 109x/minute with temperature 36.7˚C. After 2 hours of blood gas analysis and serum electrolytes, the lab results were obtained: PH 7.43, PO2 216, PCO2 41, HCO3 27.2 BE 2.9, FiO2 80% (PF ratio 270). For serum electrolytes: sodium 132 mmol/L, potassium 4.3 mmol/L, chloride 106 mmol/L.

The fluid therapy program provided with Ringer's lactate solution 1500 cc/24 hours (BW = 50 kg), and meropenem 1g/8 hours was given to patient. Midazolam 3mg/hour syringe pump, Atracurium 20 mg/hour with analgesic ketorolac 30mg/8 hours. Patients are also given a blanked warmer. The patient was hemodynamically stable in the first 6 hours, with a urine output of 0.2 cc/kgBW/hour. Samples were taken for sputum culture. The patient is positioned head up 30 degrees, and close observation is carried out.

The initial ventilator mode used was control mode (VCV) with FiO2 100% RR 20x/minute, tidal volume 400 ml, PEEP 8 cmH2O, I:E 1:2 with midazolam and continuous atracurium relaxant. The patient's oxygen saturation ranged from 99-100%, after 2 hours of AGD evaluation the results were pH: 7.43 PCO2: 41 PO2: 216 HCO3: 27.2 BE: 2.9 SpO2: 100 AaDO2: 304 pAO2: 519 FiO2: 80 % PF ratio: 270. There was an improvement in oxygenation, even though the patient with a PaO2/FiO2 ratio: 270 entered the mild ARDS criteria, the lactic acid level was found to be 1.4 mmol/L. This control mode was maintained during the first day in the ICU and then after being relatively stable for more than 24 hours the patient was changed to SIMV mode for 4 days by weaning FiO2 40% or RR 20x/minute and PEEP 5 cmH2O on the 5th

day. On the 6th day CPAP fan mode Psupport 10-8-6 cmH2O PEEP 6 cmH2O FiO2 60-40%. Until the 7th day CPAP Psupport 6 cmH2O PEEP 5 cmH2O FiO2 40%, the patient was fully conscious and cooperative, a T-piece and extubation were performed.

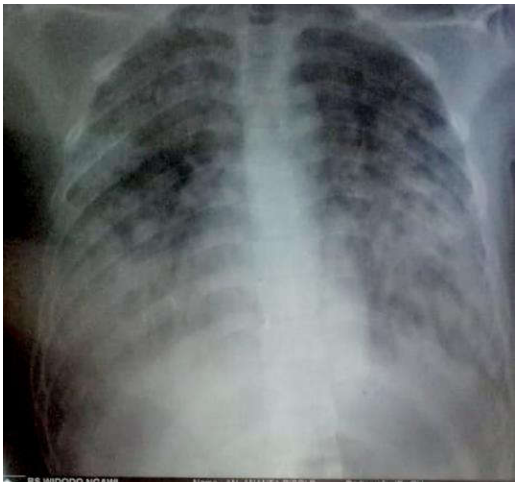


Figure 1. First day chest X-ray

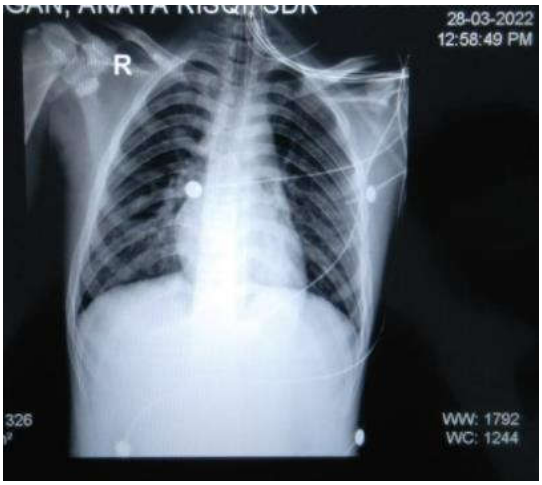


Figure 2. Third day chest X-ray in ICU

Figure 1 is the chest X-ray on the first day after the patient was drowned and was brought to the emergency room. Figure 2 is the chest X-ray of the patient after treated in the ICU for 3 days.

DISCUSSION

Drowning is defined as a process of respiratory disturbance due to immersion or submersion. The drowning process has 6 stages, namely (1) trying to keep water from entering the respiratory tract, (2) the beginning of submersion and holding your breath, (3) aspiration of water, (4) loss of consciousness, (5) cardiac arrest and (6) death [8].

Aspiration in drowning will cause hypoxia which ends in cardiac arrest. However, these deaths can be prevented. Drowning patients with minimal symptoms will improve after 4-8 hours, while patients with symptoms such as coughing, shortness of breath within 8 hours after drowning must immediately go to the hospital [9].

The mechanism of drowning involves aspiration of water into the lungs which destroys surfactant, disrupts the alveolar capillary membrane and leads to the development of alveolar edema, resulting in syndromes such as acute local respiratory distress syndrome (ARDS) [6]. Most drowning patients are hypoxic and have a PaO2/FiO2 ratio <300 mm Hg [10].

Acute Respiratory Distress Syndrome (ARDS) according to the latest literature slightly revised the 2012 Berlin definition of ARDS. ARDS is established if : [11]

1. Use high flow nasal oxygen with a minimum of ≥30L/minute
2. PaO2: FiO2 ≤300 mmHg or by measuring oxygen saturation SpO2: FiO2 ≤315 (oxygen saturation with an oximeter ≤97%) to identify the presence of hypoxemia
3. Bilateral lung opacity that persists on chest X-ray, or can be replaced with ultrasound modalities in limited areas showing consolidation
4. Acute onset or worsening of hypoxemia over 1 week in the presence of predisposing factors or worsening respiratory symptoms
5. Precipitating factors include pneumonia, infection, trauma, transfusion, aspiration or shock Click or tap here to enter text.

Acute Respiratory Distress Syndrome (ARDS) is divided into mild, moderate and severe according to the following classification: [12]

1. Mild, 200 mmHg < PaO2/FiO2 ≤ 300 mmHg with PEEP and CPAP ≥ 5cmH2O
2. Moderate, 100 mmHg < PaO2/FiO2 ≤ 200mmHg with PEEP ≥ 5cmH2O
3. Severe, PaO2/FiO2 ≤ 100 mmHg with PEEP ≥ 5 cmH2O

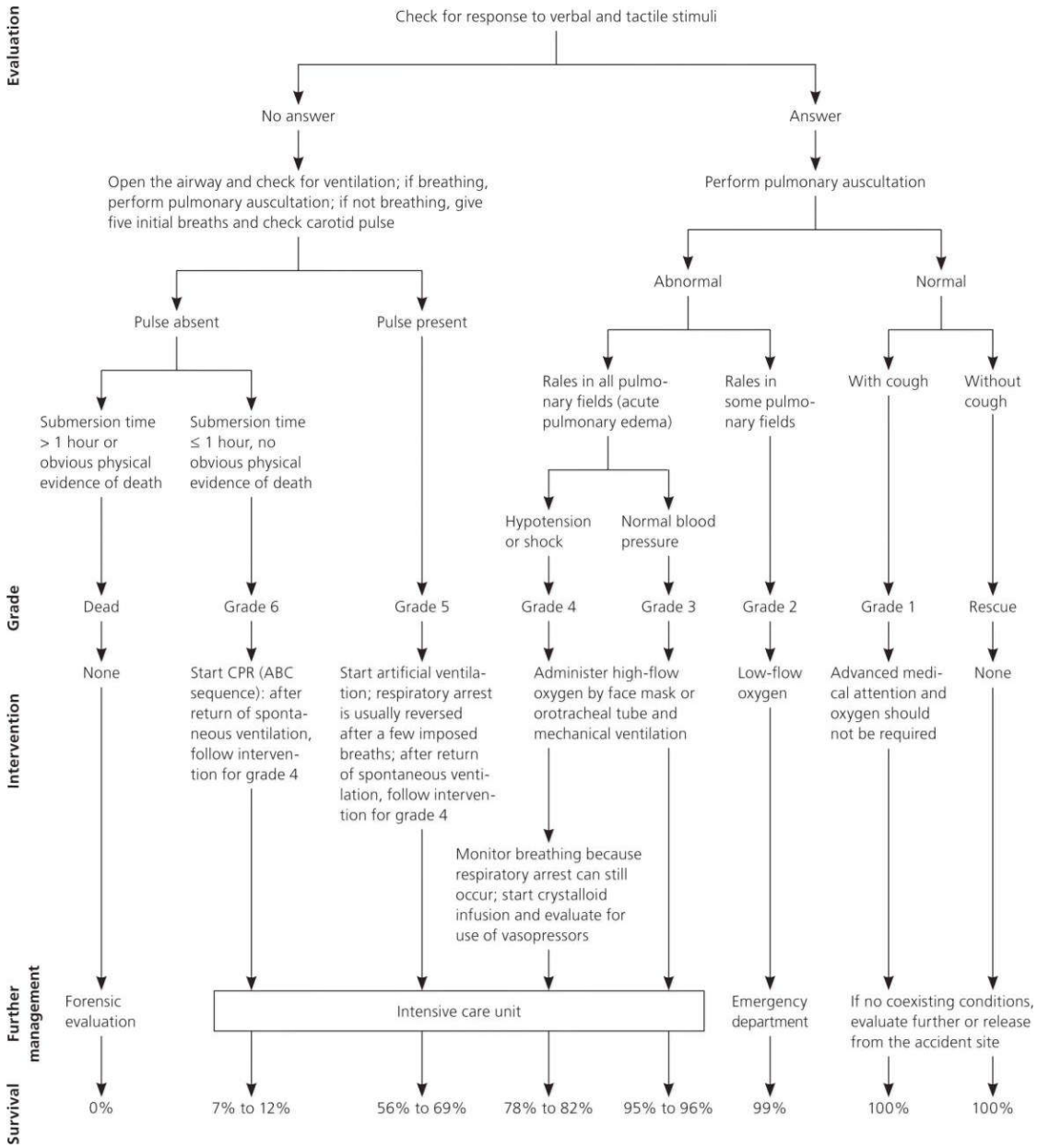
This condition correlates with with what the patient undergoes, apart from the supporting data of chest X-ray shwoing infiltrates in both lung fields, shortness of breath, 80% saturation with an oxygen mask with a respiratory rate of 26-28x/minute. And after evaluation with blood gas analysis, PaO2/FiO2 = 270 (Mild ARDS) was obtained.

In the results of Reizine et al.'s multicenter cohort study, it was found that patients who drowned in fresh water had a worse prognosis than patients who drowned in salt water. Reasons for such differences include differences in underlying psychiatric comorbidities, circumstances of drowning and severity of immersion. Patients with early cardiac arrest due to drowning have a very poor prognosis. [7]

From the family history regarding the drowning incident, the patient fell into a pump well in a rice field area. Shortly after he woke up at the scene of the incident he complained of shortness of breath, and it got worse during the 2 days of treatment at the hospital, so he was referred to another hospital to receive intensive treatment.

Drowning in fresh water or in hypotonic fluid causes aspiration of fluid into the alveoli, which will damage and dilute the surfactant and reduce lung compliance, leading to atelectasis [6]. Apart from that, many hypotonic fluids are also swallowed into the digestive tract and will be easily absorbed by the body due to the difference in osmotic pressure with blood. A rapid increase in blood volume in a short time causes hemolysis and disrupts electrolytes [13]. Although hemolysis and electrolyte disturbances in drowning patients have not been proven in humans [14], there are case studies that show an association between drowning in fresh water and hemolysis in Disseminated Intravascular Coagulation microangiopathy [15]. In this patient, hyponatremia was found (132mmol/L).

Figure 3. Classification and strategy for treating drowned patient based on severity level [16].



Grade 3 to 6 patients usually come to the hospital and should require mechanical ventilation to ensure adequate oxygenation. Oxygen starts at 100%, but should be reduced as soon as possible. Positive End Expiratory Pressure (PEEP) should be added initially at a rate of 5 cmH2O and then increased by 2 to 3 cmH2O if necessary and possible. PEEP should be used until the desired intrapulmonary shunt (QS:QT) of 20% or less, or a PaO2:FiO2 of 250 or more is achieved. (17). Low PEEP is around 5-10cm H2O, high PEEP will reduce venous return due to pulmonary hypertension [14].

In grade 4 if hypotension is not corrected with oxygenation, a rapid crystalloid infusion should be administered before attempting to reduce PEEP. Once the desired oxygenation is achieved, the PEEP level should be maintained unchanged for at least 48 hours before attempting weaning. This is the minimum time required for adequate surfactant regeneration. Premature ventilator weaning may result in return of pulmonary edema requiring re-intubation, and anticipated prolonged hospital stay and further morbidity. The clinical picture is very similar to acute respiratory distress syndrome (ARDS), but with rapid recovery and no pulmonary sequelae that are common after significant drowning episodes (grades 3 to 6). Ventilation strategies for lung protection (eg, low tidal volumes [6 mL/kg ideal body weight) similar to ARDS should be used. Permissive hypercapnia should be avoided to prevent further neurological deterioration in those with significant hypoxic-ischemic brain injury (usually grade 6). Continuous Positive Airway Pressure (CPAP), Positive Support ventilation (PSV) and/or NIV are weaning strategies that can be used if the lung condition and the patient's level of consciousness is possibly stable. [17]

This patient was found to be conscious but weak with crackles found in both lung fields but blood pressure was still normal, so the patient was classified as grade 3. Initially the patient underwent mechanical ventilation with VCV mode FiO2 100% RR 20x/minute, low tidal volume 400ml, The initial PEEP of 8 cmH2O was gradually replaced by SIMV mode, CPAP and on the seventh day CPAP mode Psupport 6 cmH2O PEEP 5 cmH2O FiO2 40%, the patient was fully conscious and cooperative, a T-piece was performed and then extubation.

Pools, rivers, and beaches generally have limited bacterial colonization to trigger pneumonia in the early post-drowning period. Pneumonia is often misdiagnosed initially due to the initial radiographic appearance of water in the lungs, but few require antibiotic therapy (12%). If the victim requires mechanical ventilation, the incidence of (ventilator-associated) pneumonia increases to 34-52% on the third or fourth day of hospitalization when pulmonary edema resolves. Vigilance not only for pulmonary but also other infectious complications is important. Prophylactic antibiotics tend to select only the more resistant and aggressive organisms. The first signs of pulmonary infection are at 48 to 72 hours and are persistent fever, ongoing leukocytosis, persistent or new pulmonary infiltrates, and leukocyte response in the tracheal aspirate. Broad spectrum antibiotic therapy covering both gram positive and gram negative should be used immediately if drowning occurs in water with high pathogenicity [17].

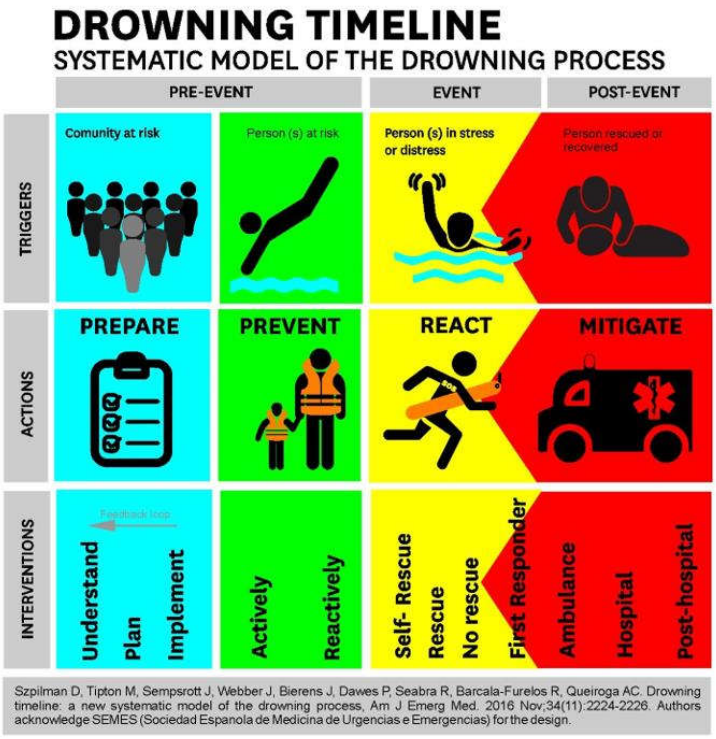
In a study regarding pneumonia in children after drowning, it was shown that in fresh water there were more gram-positive bacteria, so broad-spectrum antibiotics could be used as initial antibiotic therapy, then the antibiotics were adjusted according to the results of the sensitivity test [18].

In ventilator-associated pneumonia, predominant microorganisms from the ICU or available cultures should be considered. Corticosteroids should not be used unless there is bronchospasm. Clinicians must be vigilant and alert to volutrauma and barotrauma during mechanical ventilation [17].

As one of the most common causes of unintentional injury-related morbidity and mortality worldwide, drowning remains a significant public health problem and a highly complex process for which there is no simple, or single, solution. The most efficient and effective way to reduce deaths due to drowning is prevention. When prevention fails, further reductions in morbidity and mortality are only achieved by effective rescue, and early clinical intervention when indicated. In the medical field, it is clear that prevention is better than cure, efforts are needed to motivate and educate populations at highest risk. The process of drowning may involve a complex interaction between acute injury or illness and the inability to maintain an airway. The simple skill of remaining conscious and the ability to float face up will prevent many complications from this potentially fatal process. After a successful rescue, the key therapy is oxygenation and improving oxygen delivery to body tissues [17]

When drowning prevention fails, drowning survival is influenced by the duration of drowning, immediate resuscitation at the scene if necessary and further ICU treatment. Initial resuscitation for drowning is prioritized with rescue breathing because there is no remaining air in the lungs and cardiac arrest is more likely to be caused by hypoxia. Hypoxemia treatment is the main treatment for drowning patients [19].

Gambar. 6. *Drowning Timeline* (17)



Gambar 7. *Drowning chain of survival* (17)

CONCLUSION

Acute Respiratory Distress Syndrome (ARDS) is a worsening of lung function that can occur in drowning victims. In general, the outcome of the management of drowning victims who experience ARDS is greatly influenced by how quickly and effectively the respiratory problems are treated, both at the scene and at the hospital. In patients who experience respiratory problems that may lead to mild to severe ARDS, they should receive aggressive therapy, both adequate oxygen supplementation and mechanical ventilation in the ICU.

Conflict of Interest

No conflicts of interest are declared by the authors

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