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Case Report

Complications of drowning: a case report

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Unintentional drowning is the sixth most common cause of accidental death, accounting for 4,086 deaths (1.4 per 100,000) in the United States in 2007.[1] In children, drowning is the second leading cause of injury-related death, and those aged 1-3 years have the highest rate of drowning.[2] More than 1,400 pediatric drownings were reported in the United States in 2008.[3] Many drowning deaths are due to lack of supervision in the bathtub, unprotected access to a pool, or lack of swimming skills.[3] For every death by drowning, six children are hospitalized for drowning, and up to 10% of survivors experience severe brain damage.[2] **[Paediatr Indones. 2019;59:284-8; doi: http://dx.doi.org/10.14238/pi59.5.2019.284-8**].

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Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid. In 2010, drowning was the leading cause of injury death for children 1 to 4 years of age and the second leading cause of injury death for children 1 to 18 years of age.[4] Submersion injuries occur in domestic settings such as swimming pools, hot tubs, bathtubs, large buckets, rainwater tanks, and in all forms of natural bodies of water. Age, gender, and race affect the incidence of drowning. According to *WHO*, in 2015, an estimated 360.000 people died from drowning, making drowning a major public health problem worldwide.[5] Toddlers and older teenagers are at greatest risk of death by drowning, with annual incidences of 2.46 and 1.47 per 100,000, respectively.[1,6] Boys account for almost 80% of victims older than 1 year. Black males between 15 and 19 years of age have the highest annual incidence of drowning mortality (3.92 per 100,000), and black children between the ages of 5 and 14 years drown at nearly three times the rate of white children of the same age.[1] The risk of death by drowning within the American Indian population is twice as high as it is for the white population.1 Other risk factors include a history of seizure, alcohol use, and lack of supervision.[2,7]

The drowning process begins with respiratory impairment as the person's airway goes below the surface of the liquid (submersion) or water splashes over the face (immersion).[8] Unexpected submersion triggers breath-holding, panic, and struggling to surface. Air hunger and hypoxia will develop, and the victim begins to swallow water.1 Breath-holding is overcome by involuntary gasps resulting in aspiration, leading to laryngospasms.[1,7] The progressive decrease in arterial blood oxygen saturation (SaO2) soon causes the victim to lose consciousness due to hypoxia.[7]

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At the same time, the cardiovascular response progressively decreases cardiac output and oxygen delivery to other organs. By 3-4 minutes, myocardial hypoxia leads to abrupt circulatory failure.[1] Profound hypoxia as well as metabolic and respiratory acidosis ensue, leading to cardiovascular collapse, neuronal injury, and ultimately death.[1]

Organs such as the brain, lungs, and kidneys are mainly affected by drowning accidents. However, the greatest permanent harm in drowning accidents is to the brain, which has negligible metabolic substrate reserves to subsist upon in the absence of continuous delivery of oxygenated blood. Much of the literature on near-drowning has concentrated on the respiratory effects of aspiration and on the management of both early and late respiratory complications such as aspiration pneumonia and adult respiratory distress syndrome.[8]

Many factors may influence the pathophysiologic sequence of events in submersion injury and affect the chance of survival, including age, water temperature, time of submersion, duration and degree of hypothermia, diving reflex, presence of aspiration (and pulmonary parenchymal injury), and effectiveness of resuscitative efforts.[1,3] Poor outcome risks include victim age younger than 3 years, submersion for longer than 5 to 10 minutes, and initiation of cardiopulmonary resuscitation (CPR) more than 10 minutes after rescue. But specifically, the outcome of drowning is determined by the success of immediate resuscitation efforts and the severity of the hypoxic-ischemic injury to the brain. Hypoxia, which is usually dependent on submersion time, is the most important factor related to outcome and subsequent quality of life in drowning victims.[1] Patients who have regained consciousness on arrival to the hospital will likely survive with intact neurologic function.[4]

The Case

A girl aged 1 year and 8 months was admitted to the emergency room of Wangaya Regional Hospital, Denpasar, Bali on September 27, 2018 due to loss of consciousness after submersion. The child's father had been bathing her and was called away by the sister. He left the child alone in the bathtub, never thinking about the possibilty of drowning. After approximately 5 minutes, the father returned to the bathroom and found his child unconscious, not moving at all, and cyanotic. Immediately, the father took his child to the emergency room of Wangaya Regional Hospital, about 5 minutes from their house. The vital signs showed that she was unconscious, not breathing, pulseless, and hypothermic. The Glasgow coma scale was 1 for eye response, 1 for motor response, and 1 for verbal response. The patient was immediately resuscitated with 1 cycle of cardiopulmonary resuscitation (CPR), had an oropharyngeal tube inserted, and given Ringer's lactate infusion. Suctioning of the oropharnyx was done and brown fluid was extracted. The patient cried for 20 seconds and vomited a few times, but she was apathetic. The pulse began to be palpable at 128 beats per minute, respiratory rate was 34 times per minute, body temperature was 35.8oC, and oxygen saturation was 89%. The patient received non-rebreathing mask treatment of 10 liters per minute and was wrapped in a blanket.

The patient had no previous history of drowning or other disease, nor did the family. She was born vigorous, during the 38th week of gestation, by normal delivery, with birth weight of 2,700 grams, and body length of 50 cm. Her growth and development was normal. She could lift up her head at 3 months, sit well at 7 months, stand up at 11 months, and walk properly at 12 months. She could speak two-syllable words such as "ma-ma" and "da-da" beginning at the age of 9 months. Her basic immunizations were complete.

Her nutrition history included breast milk from birth to the date of the event. She started eating complementary food at 6 months of age and solid food at 12 months of age. Her body weight was 12 kg, with weight/age score of 0-2 standard deviation (SD). Her body height was 88 cm with height/age score of 0-2 SD. Her weight/height score was 0 SD, indicating that her nutritional status was normal.

Physical examination was held after the resuscitation. Eyes examination revealed isocorous pupils and positive reflex in both corneas. We found no abnormalities of the heart or abdomen. There was no asymmetrical chest movement. There was a decrease in both vesicular lung sounds and rales in both lungs. The extremities were cyanotic, but improved after resuscitation, with capillary refill time of less than three seconds. There was no sign of

physical injury. Chest x-rays showed patchy shadowing with air bronchograms in both lung fields (**Figure 1**). Laboratory tests revealed increased leukocyte, plaletet count, lymphocyte, and random glucose level (**Table 1**).

Figure 1. Chest x-ray showed patchy shadowing with air bronchograms in both lung fields

The patient was transferred to the PICU, where she was intubated, and received mechanical ventilation, as well as Ringer's lactate infusion at 15 drops per minute. She was given ceftriaxone at 600 mg every 12 hours as an antibiotic, dexamethasone at 2 mg every 8 hours as a corticosteroid, ranitidine at 15 mg every 8 hours as a histamine type-2 receptor antagonist, furosemide at 10 mg every 12 hours as a diuretic, and budesonide as a corticosteroid nebulizer alternating with salbutamol as a bronchodilator nebulizer, every 6 hours.

After 24 hours the patient was fully conscious and extubated. She had a cough, but no other complaints. Gradually the patient's condition improved to normal. The patient was discharged from the hospital on the fourth day after admission.

Discussion

Most drowning deaths (71%) in children occur in the bathtub.[7] Infant tub seats or rings may exacerbate the risk by giving caregivers a false sense of security that the child is safe in the tub.[7] In our case, the child was left alone in the bathtub by the father.

In the emergency room, the patient immediately received resuscitation after assessing that she was unconscious, apneic, and pulseless. Resuscitation

Table 1. Laboratory test results

Hematology	Results		Reference range
	September 27, 2018 (16.37 UTC+08.00)	September 28, 2018 (21.00 UTC+08.00)	
Hemoglobin	11.1 g/dL	-	12.0-16.0 g/dL
Erythrocyte (RBC)	4.22 x 106/µL	-	4.00-5.30 x 106/µL
Leukocyte (WBC)	21.09 x 103/µL	-	5.0-13.0 x 103/µL
Hematocrit	35.3 %	-	35.0-45.0 %
Platelet count	499 x 103/µL	-	150-400 x 103/µL
MCV	83.6 fL	-	75.0-91.0 fL
MCH	26.3 pg	-	25.0-33.0 pg
MCHC	31.4 g/L	-	31.0-37.0 g/L
Neutrophil	10.2 %	-	32-52 %
Lymphocyte	85.9 %	-	30-60 %
Monocyte	3.4 %	-	2-8 %
Random glucose	249 mg/dL	160 mg/dL	80-200 mg/dL

included the basic ABCs (airway, breathing, and circulation), which were head tilt chin lift, oropharyngeal tube, cardiopulmonary resuscitation, and Ringer's lactate infusion, simultaneously.[1,4,7] Initial resuscitation of drowning victims must focus on rapidly restoring oxygenation, ventilation, and adequate circulation.[7]

Vascular access should be established as quickly as possible for the administration of fluids or pressors. Intraosseous catheter placement is a potentially lifesaving vascular access technique that is usually associated with multiple attempts to establish intravenous access in critically ill children. Epinephrine is generally the initial drug of choice in victims with bradyasystolic cardiopulmonary arrest.[7] But for this case, it was not necessary to give epinephrine because after intial resuscitation, the patient's vital sign was improved.

Hypothermia in pediatric drowning victims may be observed even after drowning in relatively warm water and in warm climates.[7] The symptoms and severity of hypothermia are categorized based on body temperature. Mild hypothermia is defined as a temperature of 34-36°C (93.2-96.8°F), with intact thermogenic mechanisms (shivering and nonshivering thermogenesis, vasoconstriction) and active movements. With moderate hypothermia [30 to <34°C (86 to <93.2°F)], loss of consciousness leads to water aspiration. At body temperatures <28°C (82.4°F), extreme bradycardia is usually present with decreases in cardiac output, and the propensity for spontaneous ventricular fibrillation or asystole is high. Central respiratory center depression with moderate to severe hypothermia results in hypoventilation and eventual apnea. A deep coma, with fixed and dilated pupils and absence of reflexes at very low body temperatures [<25-29°C (77-84.2°F)], may give the false appearance of death.[7] The patient in this case experienced mild hypothermia with a body temperature of 35.8°C, which was high enough to rewarm her with only a blanket.

Further treatment is based on the patient response to initial resuscitation. Some children begin breathing spontaneously and awaken before arrival at an emergency department. If the episode was significant, these children still require careful observation for pulmonary complications over the subsequent 6 to 12 hours.[1] Children should be monitored in an intensive care unit for advanced life support and management of multiorgan dysfunction.[7] Pulmonary dysfunction often results in hypoxemia. Oxygen supplementation should be implemented to maintain normal oxygen saturations. Mechanical ventilation may be needed in patients with significant pulmonary or neurologic dysfunction.[4] In our case, after resuscitation, the patient was still apathetic with pulse rate 128 times per minute, respiratory rate 34 times per minute, and oxygen saturation 89%. Hence, we decided to perform intubation and mechanical ventilation in the PICU.

Submersion victims swallow a significantly greater volume of water than is aspirated, and gastric distention from positive-pressure ventilation during rescue is common. As a result, 60% of patients vomit after a submersion event.[1,5] Aspiration of gastric contents greatly compounds the degree of pulmonary injury and increases the probability that acute respiratory distress syndrome will ensue.[7] In addition, aspiration of particulate contaminants such as pathogenic organisms, toxic chemicals, and other foreign matter may obstruct the smaller bronchi and bronchioles and greatly increase the risk of infection (both bacterial and fungal in nature).[1,7] Our patient had pulmonary complications of pulmonary edema and bronchopneumonia caused by drowning, as evidenced by her increased respiratory rate and audible rales in both lungs. Chest x-ray revealed patchy shadowing with air bronchograms in both lung fields. Laboratory test showed leukocytosis. Management of our patient included antibiotics to eliminate infection, corticosteroid as an anti-inflammatory agent, histamine type-2 receptor antagonist, diuretic to resolve pulmonary edema, and corticosteroid nebulizer alternating with bronchodilator nebulizer to help resolve symptoms.

Neurologic examination and progression during the first 24-72 hours are the best prognostic factors of long-term central nervous system outcomes. Children who regain consciousness within 48-72 hours, even after prolonged resuscitation, are unlikely to have serious neurologic sequelae. In a small series of comatose victims of non–icy water submersion, all survivors with a good outcome had spontaneous purposeful movements and normal brainstem function within 24 hours; good recovery did not occur in any child with abnormal brainstem function or absence of

purposeful movements at 24 hours.5 Fortunately for this case, the patient regained consciousness within 24 hours with no sequelae. On the fourth day after admission, patient was discharged from the hospital with a good outcome.

Parental education on water safety is important to prevent such incidents. In 2010, the American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention revised its policy statement on the prevention of drowning to advocate for more anticipatory guidance regarding the appropriate supervision of children, access to swimming lessons, the presence of lifeguards, barriers to swimming pools, and CPR training for adults.[5,6]

Conflict of Interest

None declared.

References

1. Richards DB, Jacquet GA. Drowning. In: Marx JA, Hockberger RS, Walls RM, Biros MH, Ling LJ, Danzl DF, *et al*., editors. Rosen's emergency medicine concepts and clinical practice. 8th ed. Vol. 1. Philadelphia: Elsevier Saunders; 2014. p. 1941-4.
2. Treitz M, Bunik M, Fox D. Ambulatory and office pediatrics. In: Hay WW, Levin MJ, Deterding RR, Abzug MJ, editors. Current diagnosis and treatment pediatrics. 23rd ed. New York City: McGraw-Hill Education; 2016. p. 238-327.
3. Tsai W, Fine KS. Poisoning, burns and injury prevention. In: Marino BS, Fine KS, editors. Blueprints Pediatrics. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2013. p. 21-358.
4. Lee KJ. The acutely ill or injured child. In: Marcdante KJ, Kliegman RM, editors. Nelson essentials of pediatrics. 7th ed. Philadelphia: Elsevier Saunders; 2015. p. 43-136.
5. World Health Organization. Drowning. 2018, January 15 [cited 2019, July 31]. Available from: https://www.who.int/news-room/fact-sheets/detail/drowning.
6. Mott TF, Latimer KM. Prevention and treatment of drowning. Am Fam Physician. 2016;93:576-82.
7. Caglar D, Quan L. Drowning and submersion injury. In: Kliegman RM, Stanton BF, Geme III JWS, Schor NF, Behrman RE, editors. Nelson textbook of pediatrics. 20th ed. Vol. 1. North York: Elsevier Saunders; 2016. p. 74561-8.
8. Restrepo CS, Ortiz C, Singh AK, Sannananja B. Near-drowning: epidemiology, pathophysiology and imaging findings. J Trauma Care. 2017;3:1026.