

Journal Reading

報告者:PGY 黃莉婷
指導者:Fellow 李 尚
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REVIEW ARTICLE

CURRENT CONCEPTS

Drowning

David Szpilman, M.D., Joost J.L.M. Bierens, M.D., Ph.D.,
Anthony J. Handley, M.D., and James P. Orlowski, M.D.

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Introduction- Death

- Unintentional drowning
 - worldwide
 - 0.7% of all deaths (WHO)
 - 5-14 y/o boys: a leading cause of death
 - In the U.S.
 - 1-4 y/o children: the 2nd leading cause of injury-related death
 - Africa and Central America
 - The incidence of drowning: 10 to 20 times of U.S.

Risk Factors

- Male sex
- < 14 y/o
- Alcohol use
- Low income
- Poor education
- Rural residency
- Aquatic exposure
- Risky behavior
- Lack of supervision
- Epilepsy
 - The risk of drowning: 15 to 19 times

Definition- WHO 2002

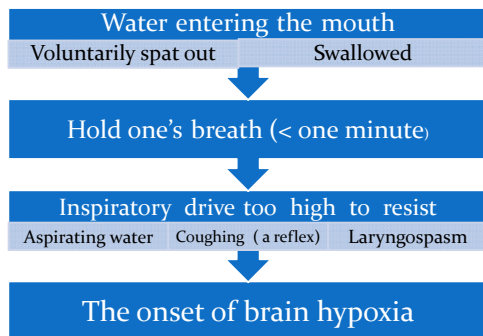
- Drowning
 - The process of experiencing respiratory impairment from submersion/immersion in liquid
- Submersion
 - Airway below the surface of the liquid
- Immersion
 - Water splashes over the face
- Nonfatal drowning
 - Rescued at any time, the process of drowning is interrupted
- Fatal drowning
 - Die at any time as a result of drowning
- Water rescue
 - Any submersion or immersion without respiratory impairment

Definition- WHO 2002

- Avoid:
 - Near drowning
 - Dry or wet drowning
 - Secondary drowning
 - Active and passive drowning
 - Delayed onset of respiratory distress

Pathophysiology of Drowning

No longer keeping an airway clear...



Continuing aspiration of water

• Respiratory

Hypoxemia

Loss of Cons'

Apnea

• Heart

Tachycardia

Bradycardia

PEA

Asystol

Not Rescued-2

- The whole drowning process (submersion or immersion ~ cardiac arrest)
 - Seconds ~ a few minutes
- Hypothermia or in ice water
 - An hour

Rescued Alive

The amount of water that has been aspirated

- The alveoli
 - Surfactant dysfunction and washout
 - Salt water and fresh water
 - Similar injury
- Alveolar-capillary membrane disrupted
 - Permeability ↑
 - A massive pulmonary edema
- Results:
 - Lung compliance ↓
 - V/Q mismatch ↑
 - Atelectasis
 - Bronchospasm

Neurologic Damage CPR (+)

- The risk
 - Similar to that in other instances of cardiac arrest
- Hypothermia associated with drowning
 - A protective mechanism
 - O₂ consumption ↓
 - 5% / 1°C (20°C ~ 37°C)
 - ATP depletion ↓
 - The electrical and metabolic activity of the brain ↓

Rescue and In-water Resuscitation-1

- Lifeguards (+)
 - < 6% of all rescued persons need medical attention
 - 0.5% need CPR
- Bystanders (+)
 - 30% need CPR
- Un-trained rescuers, safe rescue techniques
 - Reaching by an object (pole, towel, or tree branch)
 - Throwing a buoyant object

Rescue and In-water Resuscitation-2

- Conscious
 - Brought to land
 - BLS
- Unconscious
 - In-water resuscitation
 - Good outcome ↑
 - Only a highly trained rescuer
 - Ventilation alone
 - Chest compression: useless

Rescue and In-water Resuscitation-3

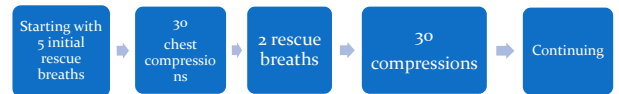
- The cervical spine injury
 - < 0.5%
 - Immobilization of the spine in the water
 - Head and neck injury is highly suspected (e.g., accidents involving diving, water-skiing, surfing, or watercraft)
- A vertical position
 - keeping the airway open
 - Prevent vomiting
 - Prevent aspiration of water and stomach contents

Initial Resuscitation on Land-1

- A supine position
- The standard checks for responsiveness and breathing
- Unconscious
 - Breathing(+)
 - The recovery position (lateral decubitus)
 - Not breathing
 - Rescue ventilation

Initial Resuscitation on Land-2

- Cardiac arrest from drowning
 - Primarily due to lack of oxygen
- CPR
 - ABC sequence



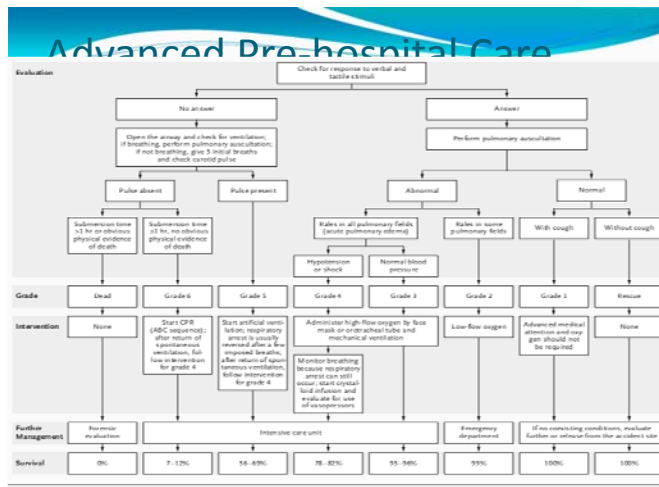
- Stop
 - Signs of life reappear
 - Exhausted
 - ACLS available
- The European Resuscitation Council
 - Water in the airways >> effective alveolar expansion ↓

Initial Resuscitation on Land-3

- The most frequent complication during a resuscitation
 - The regurgitation of stomach contents
 - > 65% need breathing alone
 - 86% need CPR
- **Avoid** active efforts to expel water from the airway
 - abdominal thrusts or placing the person head down
 - Delay the initiation of ventilation
 - The risk of vomiting ↑ ↑
 - Mortality ↑ ↑

Initial Resuscitation on Land-4

- Difficult circumstances
 - Problems in bringing the person to dry land
 - The delay of resuscitation
- The young persons
 - The rate of successful resuscitation ↑
 - Hypothermia affects young people more quickly than adults



Advanced Pre-hospital Care-Air

- Adequate oxygenation
 - SaO₂: 92% ~ 96%
- Ventilation with PEEP
 - As soon as possible

Advanced Pre-hospital Care-IV

- Peripheral venous access
 - Favored
- Intra-osseous access
 - Alternation
- Endo-tracheal administration
 - Not recommended
- A rapid crystalloid infusion
 - If hypotension is not corrected by oxygenation

Advanced Pre-hospital Care-Cardiac rhythm

- Common types of pulse absence
 - PEA
 - Asystol
- Ventricular fibrillation
 - Rare
 - Hx of CAD
 - Norepinephrine or epinephrine (myocardial irritability ↑)
 - Severe hypothermia
- AED
 - Controversial
- During CPR
 - A series of norepinephrine or epinephrine (1 mg)
 - Higher subsequent dose: controversial

Table 1. Use of CPR in Cases of Drowning.*

CPR	Recommendation
When to <u>initiate</u>	Initiate <u>ventilation</u> in persons with <u>respiratory distress</u> or <u>respiratory arrest</u> in order to prevent cardiac arrest ^{21,29} Initiate <u>CPR</u> in persons who have been <u>submerged for <60 min</u> and who <u>do not</u> have obvious physical evidence of death (rigor mortis, body decomposition, or livor mortis) ^{21,29}
When to <u>discontinue</u>	Continue basic life support unless <u>signs of life reappear</u> , <u>rescuers are exhausted</u> , or <u>advanced-life-support team takes over</u> Continue advanced life support until patient has been <u>rewarmed</u> (if hypothermic) and <u>asystole</u> has persisted for <u>>20 min</u> ²⁸

Care in The Emergency

Department-1

1st step:

- Airway secured
- Oxygenation improved
- Circulation stabilized
- A gastric tube inserted
- Thermal insulation

Care in The Emergency

Department-2

2nd step:

- Physical examination
- Chest X ray
- Arterial gas
 - Metabolic acidosis
 - Increase RR spontaneously
 - Setting a higher minute ventilation (30 ~ 35 L/min)
 - A higher peak inspiratory pressure (35 cm of water)
 - Routine use of sodium bicarbonate: not recommended

Care in The Emergency

Department-3

3rd step:

- The recorded history
 - Information on the rescue and resuscitation activities
 - Current or previous illness

Care in The Emergency

Department-4

- Unresponsive without an obvious cause
 - A toxicologic investigation
 - CT of the head and neck
- Electrolytes, BUN, Cr., and hematocrit
 - Rarely helpful
 - Rarely abnormal

Care in The Emergency

Department-5

- Discharged
 - Good arterial oxygenation without adjuvant therapy
 - No other associated morbidity
- Hospitalization
 - All patients grade 2 ~ 6
 - Grade 2:
 - Noninvasive oxygen
 - Normalization within 6~8 hours
 - Discharged
- ICU
 - Grade 3 to 6
 - Intubation + mechanical ventilation

Treatment in The ICU

Respiratory System

- Follow guidelines for ventilation in ARDS
- A temporary and local lung injury
 - Recovering much faster
 - Rare late pulmonary sequelae
- Don't initiate weaning
 - <24 hrs (even PaO₂/ FiO₂ >250)
 - Recur pulmonary edema
 - Re-intubation
 - Hospital stay ↑
 - Morbidity ↑
- Glucocorticoid therapy for lung injury
 - Little evidence
 - Bronchospasm (bronchodilator failed)

Treatment in The ICU

Respiratory System

- Pneumonia
 - Misdiagnosed: water in lung
 - 12% need antibiotics
- Monitor daily
 - Fever
 - Sustained leukocytosis
 - Persistent or new pulmonary infiltrates
 - Sputum

Treatment in The ICU

Respiratory System

- Early-onset pneumonia
 - The aspiration of polluted water / endogenous flora/ gastric contents
- Prolonged mechanical ventilation
 - Risk of pneumonia ↑
 - The 3rd -4th day of hospitalization (pulmonary edema resolved)
- Empirical therapy with broad-spectrum antibiotic
- Definitive therapy
 - Culture & sensitive tests

Treatment in The ICU

Respiratory System

- ECMO (+)
 - Not recommended
 - Artificial surfactant
 - Inhaled NO
 - Partial liquid ventilation with perfluorocarbons

Treatment in The ICU

Circulation System

Most persons

- Adequate circulation
 - Oxygenation
 - Rapid crystalloid infusion
 - Normal body temperature
- Crystalloid infusion failed
- Cardiac echo
 - The use of inotropic agents/ vasopressors

Treatment in The ICU

Neurologic System

- Permanent neurologic damage
 - Most worrisome outcome
- ICU care
 - Coma
 - Neurologic deterioration
- Goals
 - Normal glucose/ PaO₂/ PaCO₂
 - Hypothermia (neuroprotection): 32°C ~ 34°C , 24 hrs.

Unusual Complications

- A systemic inflammatory response syndrome
- First 72 hr. after resuscitation
 - Sepsis
 - DIC

Table 2. Important Facts and Predictors of Outcome in Resuscitation of a Person Who Has Drowned.

Early basic life support and advanced life support improve outcome ^{21,24,33,54}
During drowning, a reduction of brain temperature by 10°C decreases ATP consumption by approximately 50%, doubling the duration of time that the brain can survive ⁵⁵
Duration of submersion and risk of death or severe neurologic impairment after hospital discharge ^{19,21,24,32}
0–5 min — 10%
6–10 min — 56%
11–25 min — 88%
>25 min — nearly 100%
Signs of brain-stem injury predict death or severe neurologic sequelae ^{21,24,33,41}
Prognostic factors are important in the counseling of family members and are crucial in informing decisions regarding more aggressive cerebral resuscitation therapies ⁵¹



Prevention

- >85% drowning prevented by
 - Supervision
 - Swimming instruction
 - Technology
 - Public education

Table 3. Guidelines for Prevention of Drowning.^a

Keep yourself safe
Learn swimming and water-safety survival skills
Always swim with others
Obey all safety signs and warning flags
Never go in the water after drinking alcohol
Avoid inflatable swimming aids, such as "floaters"; know how and when to use a life jacket
Swim in areas with lifeguards
Know the weather and water conditions before going in the water
Always enter shallow or unfamiliar water feet first
Do not overestimate swimming capability ²⁷
Know how to stay away from rip currents, which are involved in more than 85% of drowning events at the beach ²⁷
Keep others safe
Help and encourage others, especially children, to learn swimming and water-safety survival skills
Swim in areas with lifeguards
Set rules for water safety
Always provide close and constant attention to children you are supervising in or near water



Thank You!