RSS SESSION SIGN-IN SHEET

Pediatric Care Echo Series
How Am I Supposed to Breathe With No Air: Management of Pediatric Drowning
April 19, 2018
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RSS Global Objective(s): Assess pediatric trauma given the news skills and guidelines determined to be safe for children. Identify proper tool and standardized measurement practices to improve diagnosis and treatment of pediatric patients.

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Pediatric Near Drowning: How am I Supposed to Breath with No Air

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Introductions

- Ben Eithun, MSN, CRNP, RN, CPNP-AC, CCRN

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Objectives

- To describe the assessment and management of pediatric drowning patients
- To describe the reasons to consider transfer to a higher level of care following a submersion injury

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Definitions

- Drowning: To die within 24 hours of a submersion incident
- Non-Fatal (formerly known as Near Drowning): To Survive at least 24 following submersion incident

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Who is at Risk?

- Infants
  - No head control, can drown in less than 1 inch of water
  - Must suspect abuse
- Toddlers
  - Top heavy
    - Toilets
    - Bathtubs
    - Buckets

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Who is at risk?

- School Age Kids
  - Groups
  - Over estimate skills
- Teenagers
  - Risk taking behavior
  - Drinking

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“ But my child knows how to swim”

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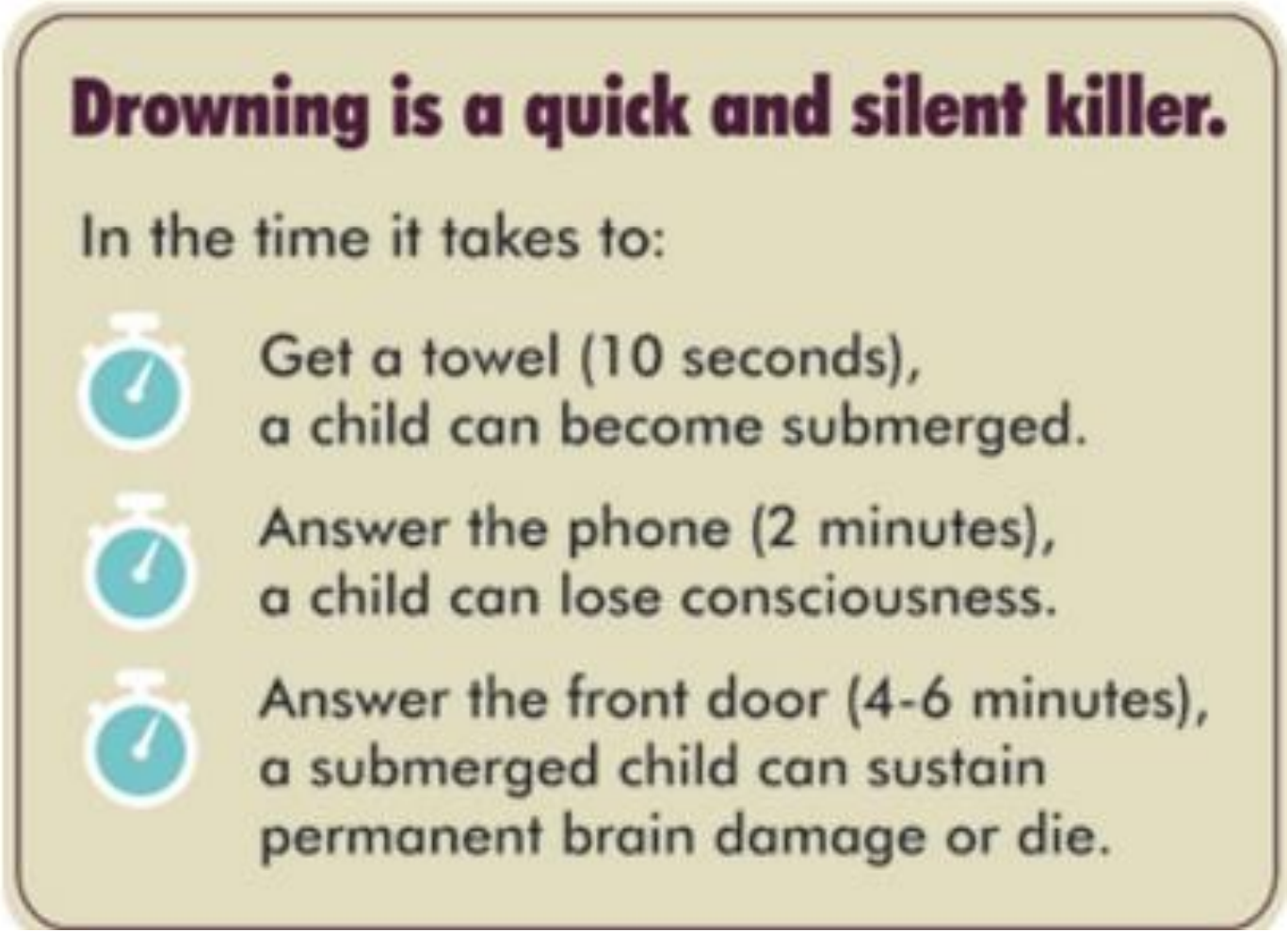
Hollywood V. Reality



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Marketing Department

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Reality

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Comorbidities

- Trauma
- Seizures
- Cardiac Events
- ETOH/Drugs

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Pathophysiology

- Aspiration of 1-3 ml/kg fluid destroys integrity of pulmonary surfactant (decreases lung compliance)

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Pathophysiology

- Leads to alveolar collapse, atelectasis, non-cardiogenic pulmonary edema (ARDS), Intrapulmonary shunting/V/Q mismatch

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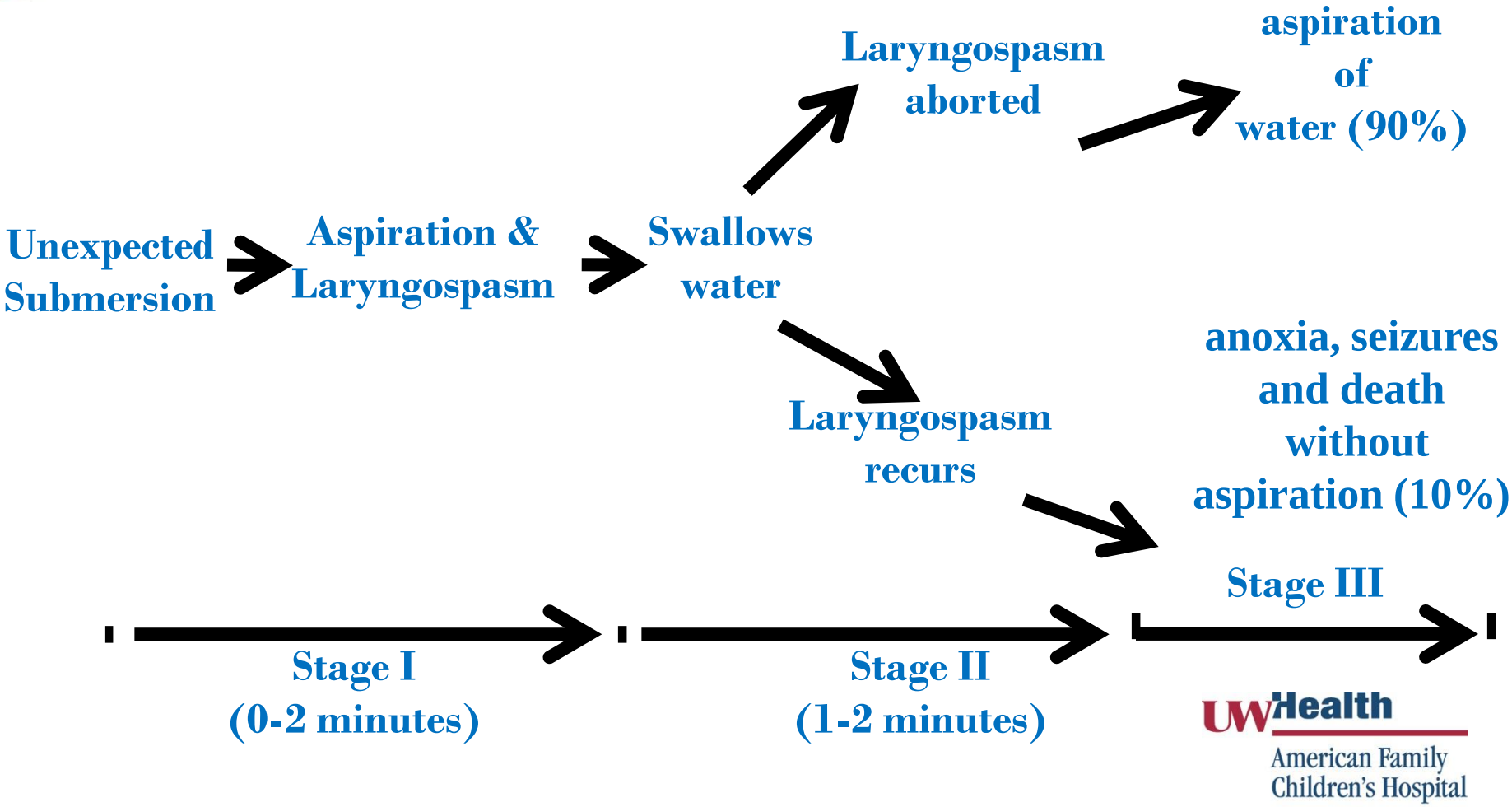

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Pathophysiology

- **Part I**
  - Voluntary breath-holding
  - Aspiration of small amounts into larynx
  - Involuntary laryngospasm
  - Swallow large amounts
  - Laryngospasm abates (due to hypoxia)
  - Aspiration into lungs

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Pathophysiology

- **Part II**
  - Decrease in sats
  - Decrease in cardiac output
  - Intense peripheral vasoconstriction
  - Hypothermia
  - Bradycardia
  - Circulatory arrest, while VF rare
  - Extravascular fluid shifts, diuresis

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Pathophysiology

- **Diving reflex**
  - Bradycardia, apnea, vasoconstriction
  - Relatively quite weak in humans
    - better in kids
  - Occurs when the face is submerged in very cold water (<20°C)
  - Extent of neurologic protection in humans due to diving reflex is likely very minimal

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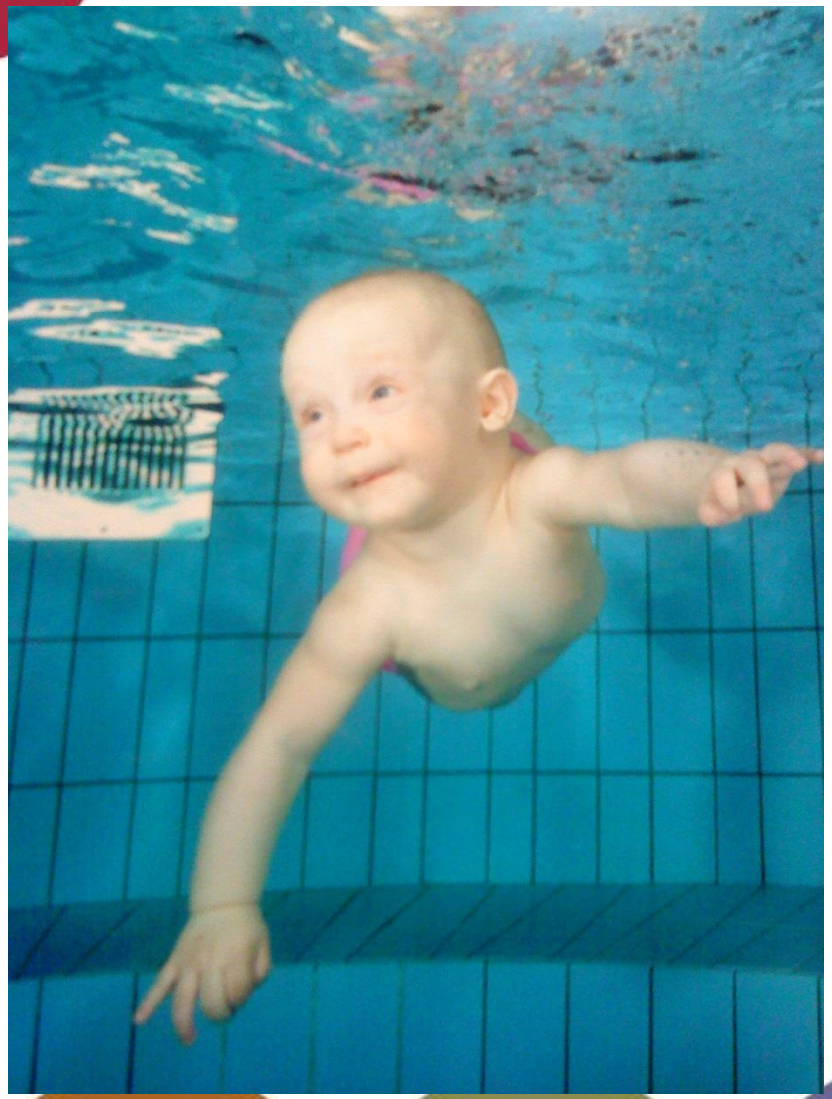
Diving Reflex



Wisconsin Swimming

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Immersion Syndrome

- Syncope secondary to cardiac arrhythmias when immersed in cold water
- QT prolongation combined with massive release of catecholamines coupled with vagal stimulation leads to VF/Asystole

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Fatal Consequences

- Profound hypoxia
- Respiratory Acidosis
- Cardiovascular collapse
- Neuronal injury
- Death

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Prognosis

- Better outcomes associated with early CPR (bystander)
- C-spine protection:
- Transport
  - Continue effective CPR
  - Establish airway
  - Remove wet clothes
  - Hospital evaluation

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“Wet” Vs “Dry” Drowning

- Patient is submersed for critical time (usually 3-5 min but vary greatly)
- Involuntary gasping syndrome (water into the hypopharynx)
- Laryngospasm
  - If severe, airway obstruction “Dry”
  - If mild, aspiration of water into lungs “Wet”

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Does it matter what kind of water?

- Fresh water Vs. Salt Water
  - Historically felt to affect electrolytes, fluid shifting if hypertonic
  - Most of the time, the amount aspirated is not sufficient to be clinically significant
  - Theoretically hyperosmolar therapy could have higher instance of laryngospasm →dry drowning

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Early Vs. Late Effects

- Many patients will have fatal drownings and will not regain consciousness
- Those who do are still at risk and need to be monitored

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Complicating Factors

- Spinal Cord Injury
- Hypothermia
- Panicking
- Syncope
- Seizures

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Prehospital Care

- Resuscitation
  - Time optimizes outcome
- Removal from water
  - C-Spine protection
- CPR

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Prognosis

- No CPR
  - Full recovery usually possible
  - May develop ARDS
- Bystander CPR
  - Steady recovery
  - Steady decline
- ED CPR
  - Very poor prognosis

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Prognosis predictors

- Poor outcomes
  - Age < 3yrs
  - Submersion time: >10 min
  - Time to BLS >10 min
  - Serum pH: <7.0
  - CPR >25 min
  - Initial core temp <33°C
  - GCS <5

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Late Effects

- Cerebral Edema
  - Initial Hypoxemia
  - Post resuscitative cerebral hypoperfusion
    - Increase ICP
    - Cytoxic cerebral edema

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Late Effects of Submersion Injury

- 70% of cases develop within 7-8 hours
- Alertness→Agitation→Coma
- Cyanosis, Coughing & Pink Frothy Sputum
- Tachypnea, Tachycardia
- Low Grade Fever
- Rales, Rhonchi and less often wheezes

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ED Treatment

- Observation (Vital signs, mental status)
- Evaluate Oxygen requirement (especially after 6 hours)
- Parent/Family support

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Treatment: ED discharge

- ED eval
- Admit if: CNS or respiratory symptoms
- Observe for 4-6 hours if
  - Submersion >1min
  - Cyanosis on extraction
  - CPR required

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Predicting Ability for ED Discharge

- Several studies support selected ED discharge
- Child can safely be discharged home if at 6 hours after ED presentation:
  - GCS > 13
  - Normal physical exam/respiratory effort
  - Room air pulse oximetry oxygen saturation > 95%

-Causey et al., Am J Emerg Med, 2000

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Case Study 1

- 4 year old male found at bottom of pool by bystander
  - Removed from pool and was cyanotic and unresponsive
  - Bystander back blows with improvement of cyanosis

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Case Study 1 EMS

- EMS arrived 6 min after 911 call
- Patient was breathing and had a pulse on EMS arrival but decreased mental status
- EMS Vitals: HR 154, RR 34 BP 127/68 Sats 98% on 15 L NRB

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Case Study 1 First Hospital

- Arrived to Hospital 9 min after 911 call
- Initial Vitals: HR 101, BP 108/75, RR 44 Sats 98% 2L NC GCS 15
- Exam: Normal

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Case Study 1 ED Cont

- Patient evaluation including:
- Blood work
  - VBG and Chemistry: pH 7.38, Na 130
- Head CT: Unremarkable
- C Spine CT: Unremarkable
- Chest Xray: Unremarkable

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Treatment: ED discharge

- ED eval
- Admit if: CNS or respiratory symptoms
- Observe for 4-6 hours if
  - Submersion >1min
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  - CPR required

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Case Study 1 ED Cont

- Patient with desaturations later in course
- Repeat Chest X-ray: (4 hours later) bilateral airspace opacities
- Albuterol: increased coughing and desaturations.
- Started on Abx

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Case Study 1 PICU

- Patient Transferred to PICU
  - Concern for developing ARDS
  - Concern for cerebral Edema
- Patient on 15 L NC on admission, weaned over 24 hours
- Lasix

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Case Study 2

- 22 month old male at park with family and slipped and fell into creek.
- Patient taken by current approximately 30 yards down stream, parent able to reach patient approximately 30 sec after patient went in water.

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Case Study 2 Cont

- Parent describes patient as trying to keep head above water at first but “limp and unresponsive upon recovery”
- Parent shook patient, patient gasped and spit up water.
- Regained normal mental status within 60 secs of being removed from water

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Case Study 2 ED

- Parent brought patient to ED immediately following event
- Vitals: GCS 15, HR 113, RR 40, Sats 99% RA, BP 93/57
- Temp: 100.9F

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Case Study 2 Hospital Course

- Patient admitted for observation
- Discharged after approximately 24 hours
- No residual effects

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Case Study 3

- 4 year old Female on vacation at waterpark. Family was out of water, turned around and couldn't find patient.
- Lifeguard found patient in pool, unresponsive.

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Case Study 3 EMS

- Patient had pulse when removed but required rescue 3 rescue breaths
- Emesis followed by spontaneous breathing
- Transferred to nearest ER

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Case Study 3 Hospital

- On arrival (approximately 20 min after event) patient with decreased mental status (GCS 10)
- Patient became combative and was intubated for airway protection

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Case Study 3 ED Cont

- Intubated approximately 10 min after arrival (30 min from event)
- Vitals prior to intubation:
  - HR 128, RR 40, BP 157/105, T 96.5F
  - Sats 100 15 L NRB
- Head CT: Unremarkable
- Chest Xray: Large infiltrate on left

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Case Study 3 PICU

- Patient transferred to PICU (ground, helicopter not flying)
- On arrival to PICU patient with Fever (40 C)
  - Placed on cooling blanket

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Case Study 3 PICU

- Antibiotics for aspiration pneumonia
- Extubated to HFNC after 72 hours, escalated to CPAP but ultimately weaned to RA

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Case Study 3 Prognosis

- Discharged home after 8 days
- No end organ dysfunction
- No neurological sequela

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Case Study 4

- 6 year old female at waterpark. Swimming in 4-5 feet deep pool with several cousins and siblings.
- Found by lifeguard floating on top of the water for unknown period of time.

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Case Study 4 EMS

- Patient pulseless and apneic
- CPR 6-8 minutes after which patient had ROSC and spontaneously breathing.
- Upon EMS arrival patient was awake and alert crying for mother

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Case Study 4 ED

- Upon arrival to the ED patient was awake and alert, but agitated.
- HR 120s, RR 30s, BP WNL, Sats 88 RA (placed on blow by)

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Case Study 4 ED

- Chest X-ray: unremarkable
- Labs: pH 7.4 Lactate 4.3
- Physical Exam: Complains of abdominal pain (crying during exam so abdomen firm)

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Case Study 4 Hospital

- Transferred to PICU for monitoring of respiratory status and concern for reperfusion injury (elevated lactate)

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Case Study 4 Outcome

- Patient has resolution of lactate following IV hydration after approximately 24 hours
- Abdominal pain resolved following passing gas.
- Discharged after approximately 24 hours

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