Near Drowning

- Aka “submersion injury”
- “survival, at least temporarily after suffocation by submersion in a liquid medium”
- “wet” near drowning - aspiration of fluid into lungs
- “dry” near drowning – period of asphyxia secondary to laryngospasm

Near Drowning Syndrome

- Depends on:
  - Duration of submersion
  - Amount of fluid aspirated
  - Severity of hypoxia

“One tough little lady…”

- Aboriginal, 73 year old female
- PMHX: DM2; HTN; Hypothyroidism
- PSHX: Cholecystectomy; R knee replacement
- Meds
  - ASA
  - Atorvastatin
  - Norvasc
  - Lipitor
  - Enalapril
  - Glyburide
  - Metformin
  - Lambic
  - L-thyroxine

“One tough little lady…”

- October 1 @ 1800
- Hunting moose in the Island Lake water system, Northern Manitoba
- Fell out of canoe while trying to assist her group
- Submerged for unknown amount of time
- Son performed rescue breathing
- Walked over an hour to STP nursing station
@ STP nursing station

Initial vitals:
- Pulse 74
- Resp. rate 30-40
- Temperature 30 degrees C
- O2 sats- unable due to temp
- Neuro: intact
- EKG- no acute changes; sinus rhythm
- C/S: crackles to bases; pink frothy sputum
- Projectile emesis
- RBS: 22.6

During Medivac Transfer

- Frequent desaturations during flight
  - c/o:
    - Generalized pain
    - SOB
    - Cough

Arrives @ HSC

- T 34  P 84  BP 96/59  RR 32
- O2 sats with 15L 92%
- GCS 15/15
- Transferred to MICU
  - RR 53
  - BIPAP
  - Resp crackles at bases

Pathophysiology

- Drowning begins with:
  - Period of panic
  - Loss of normal breathing pattern
  - Breath holding
  - Air hunger
  - Struggle by victim to stay above water

Patient outcomes affected by:

- Aspiration > 11 ml/kg of body weight...before blood volume changes occur
- Aspiration > 22 ml/kg of body weight before electrolyte changes occur

- Initial treatment & time to treatment centre
- Temperature of water
- Length of submersion time
- Presence of contaminants
- Freshwater / saltwater different microorganisms
Patient outcomes affected by:

- Gram negative bacteria in drowning victims more virulent
  - Can cause immediate lethal sepsis or infections months after incident
- Strep or staph can also be present
- Fungus: incubation time 1-4 weeks to 6 months; often resistant

Near Drowning: Pulmonary Effects

- Pulmonary insufficiency can develop insidiously or rapidly
- Leads to varying degrees of hypoxemia
  - S/s:
    - SOB
    - Rales
    - Wheezing
- CXR / CT: vary from normal to localized, perihilar, or diffuse pulmonary edema

Causes of Hyoxemia

- Reflex inspiratory effort
- Damage to surfactant
- Decreased lung compliance
- Ventilation perfusion mismatching
- Intrapulmonary shunting

...causes diffuse organ dysfunction

Near Drowning: Pulmonary Effects

- Surface tension properties of surfactant affected
- Surfactant “washed out”
- Water in alveoli
  - Damages type 2 pneumocytes
  - Prevents production of new surfactant
- Loss of surfactant function

Near Drowning: Pulmonary Effects

- Alveoli become unstable
- Complete/partial alveolar collapse...
- Loss of ventilation resulting in intrapulmonary shunting & hypoxemia

Near Drowning: Pulmonary Effects

- Increased airway resistance secondary to:
  - Plugging of airway with debris
  - Release of inflammatory mediators that result on vasoconstriction
  - May impair gas exchange

Combination ... damage to alveolar capillaries & interstitium...... leads to ARDS
Near Drowning: Pulmonary Effects

- ARDS: develops within 48 hours in approximately 40% of neardrowning victims
  - Hallmarks of ARDS:
    - Decreased lung compliance
    - Severe hypoxemia
    - Bilateral infiltrates on CXR
  - Recovery occurs in 80% of cases
  - Only effective treatment is reversal of hypoxemia with mechanical ventilator support

Neurologic Effects

- Hypoxemia & ischemia cause neuronal damage
- Can produce cerebral edema & elevation in ICP
- 20% sustain neurologic damage … limits functional recovery

Cardiovascular effects

- Arrhythmias secondary to hypothermia & hypoxemia
- Sinus bradycardia & atrial fibrillation more common than ventricular fibrillation or asystole

Acid – Base & Electrolytes

- Metabolic & respiratory acidosis
- Significant electrolyte balances do not generally occur except those submerged in unusual media
- Dead Sea: extremely concentrated seawater leads to:
  - Hypernatremia
  - Hypermagnesemia
  - Hypercalcemia

Renal Effects

- Failure rarely occurs
- If it does…
  - Usually due to acute tubular necrosis
- Results from:
  - Hypoxemia
  - Shock
  - Hemoglobinuria
  - Myoglobinuria

Back to our case study...

- Respiratory complication:
  - Bipap Oct 2 – 4th
  - ABG Oct 2:
    - pH 7.41 / 33 / 92 / 21
- Pre intubation further decompensation:
  - pH 7.42 / 35 / 60 / 22
  - Sats: 88% with decrease to 20% during intubation attempts
- CXR: bilateral edema
### Case study cont’d…
- Required AC ventilation with paralysis
  - Fentanyl, midazolam, propofol, & rocuronium
- AC : ARDS net protocol ventilation with trials of PSV for 8 days
- Hospital day 11: able to tolerate PSV ventilation
- Hospital day 14: transfer to Seven Oaks Hospital ICU
  - PSV 20; peep 14
  - ABG: pO2 76; sats 94

### CXR results
- Oct 2: bibasilar pulmonary opacities with probable bilateral pleural effusions
- Oct 3: opacities predominate in mid/lower lungs; significant progression; pulmonary edema
- Oct 4: @ 0830- no new changes; later in day- R sided effusion; intubated

### CXR results cont’d…
- Oct 5: worsening L base R/T pulm. Edema or ARDS
- Oct 6: extensive alveolar consolidation
- Oct 10: extensive bilateral opacities and consolidation; ARDS
- Oct 11: increasing degree of consolidation

### Culture Reports
- Oct 3: MSU- >10^8 E. Coli
- Oct 4:
  - SPT - 3+ PMN; 4+ GPC; 3+ GPB; 1+ GNB
  - ETT – 4+ PMN; 1+ GPB; 2+ GPC; 1+ GNB
- Positive ETT secretions: strep pneumonia & staph aureus
- Temp did not elevate; WBC elevated
- ABx: cefuroxime; cefotaxime; azithromycin; & vancomycin

### Renal Function
- Scanty urinary output throughout hospital stay
- Lasix used
- On transfer: fluid balance +ve: 17 L
- Creatinine rise to 85 (admission 67)
- No dialysis required

### Culture Reports
- Possible GI bleed (no source found)
  - Hgb drop to 68
- CT abd: normal
- CT brain: normal
Patient's final outcome…

- Transferred out of Seven Oaks ICU to general ward
- Died November 15, 2007 due to persistent pulmonary issues

Conclusion: Near Drowning

- Effects on surfactant key to treatment requirements and survival
- Initial hypothermia may be protective to CVS & neurological systems
- Importance of water source debatable in regards to treatment & patient outcome
- Amount of water & length in elements more important

- Be vigilant…
- Be prepared…
- It's just a matter of time…
- Appropriate, aggressive respiratory & multisystem support is key

Questions???