

Project: Ghana Emergency Medicine Collaborative

Document Title: Near-Drowning and Drowning

Author(s): Jim Holliman, M.D., F.A.E.C.P., Uniformed Services University, 2012

License: Unless otherwise noted, this material is made available under the terms of the **Creative Commons Attribution Share Alike-3.0**

License:

<http://creativecommons.org/licenses/by-sa/3.0/>

We have reviewed this material in accordance with U.S. Copyright Law **and have tried to maximize your ability to use, share, and adapt it.** These lectures have been modified in the process of making a publicly shareable version. The citation key on the following slide provides information about how you may share and adapt this material.

Copyright holders of content included in this material should contact open.michigan@umich.edu with any questions, corrections, or clarification regarding the use of content.

For more information about **how to cite** these materials visit <http://open.umich.edu/privacy-and-terms-use>.

Any **medical information** in this material is intended to inform and educate and is **not a tool for self-diagnosis** or a replacement for medical evaluation, advice, diagnosis or treatment by a healthcare professional. Please speak to your physician if you have questions about your medical condition.

Viewer discretion is advised: Some medical content is graphic and may not be suitable for all viewers.

for more information see: <http://open.umich.edu/wiki/AttributionPolicy>

Use + Share + Adapt

{ Content the copyright holder, author, or law permits you to use, share and adapt. }


-  **Public Domain – Government:** Works that are produced by the U.S. Government. (17 USC § 105)
-  **Public Domain – Expired:** Works that are no longer protected due to an expired copyright term.
-  **Public Domain – Self Dedicated:** Works that a copyright holder has dedicated to the public domain.
-  **Creative Commons – Zero Waiver**
-  **Creative Commons – Attribution License**
-  **Creative Commons – Attribution Share Alike License**
-  **Creative Commons – Attribution Noncommercial License**
-  **Creative Commons – Attribution Noncommercial Share Alike License**
-  **GNU – Free Documentation License**

Make Your Own Assessment

{ Content Open.Michigan believes can be used, shared, and adapted because it is ineligible for copyright. }

-  **Public Domain – Ineligible:** Works that are ineligible for copyright protection in the U.S. (17 USC § 102(b)) *laws in your jurisdiction may differ

{ Content Open.Michigan has used under a Fair Use determination. }

-  **Fair Use:** Use of works that is determined to be Fair consistent with the U.S. Copyright Act. (17 USC § 107) *laws in your jurisdiction may differ

Our determination **DOES NOT** mean that all uses of this 3rd-party content are Fair Uses and we **DO NOT** guarantee that your use of the content is Fair.

To use this content you should **do your own independent analysis** to determine whether or not your use will be Fair.

Near-Drowning and Drowning

Jim Holliman, M.D., F.A.C.E.P.

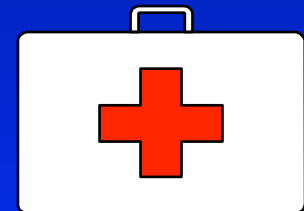
**Program Manager, Afghanistan Health Care Sector
Reconstruction Project**

Center for Disaster and Humanitarian Assistance Medicine

Professor of Military and Emergency Medicine

Uniformed Services University

Bethesda, Maryland, U.S.A.



Drowning : Definitions

- f Drowning : death by suffocation after submersion in a liquid (pt. dies within 24 hours of submersion)**
- f Near drowning : survival (short or long term) following asphyxia secondary to submersion**
- f Secondary drowning (or delayed drowning or postimmersion syndrome) : death more than 24 hours post submersion from complications related to submersion (pulmonary injury, sepsis, renal failure, etc.)**

Controversies or Unclear Points

f Drowning

- Should the Heimlich maneuver be a routine part of resuscitation ?
- Should patients without symptoms after submersion be taken to an ED and admitted ?
- Should patients arriving in the ED in cardiac arrest continue to have resuscitation attempted ?
- Does ICP monitoring do any good ?
- Does surfactant administration help ?

Drowning : Epidemiology

- f* Third leading cause of accidental death in U.S. (2nd in children)
- f* 8000 deaths / year
- f* Most involve teenage boys and toddlers (male to female ratio = 5 : 1)
- f* Most urban drownings are in private swimming pools
- f* Most non-urban drownings are in rivers or canals (ocean drownings are actually rare)

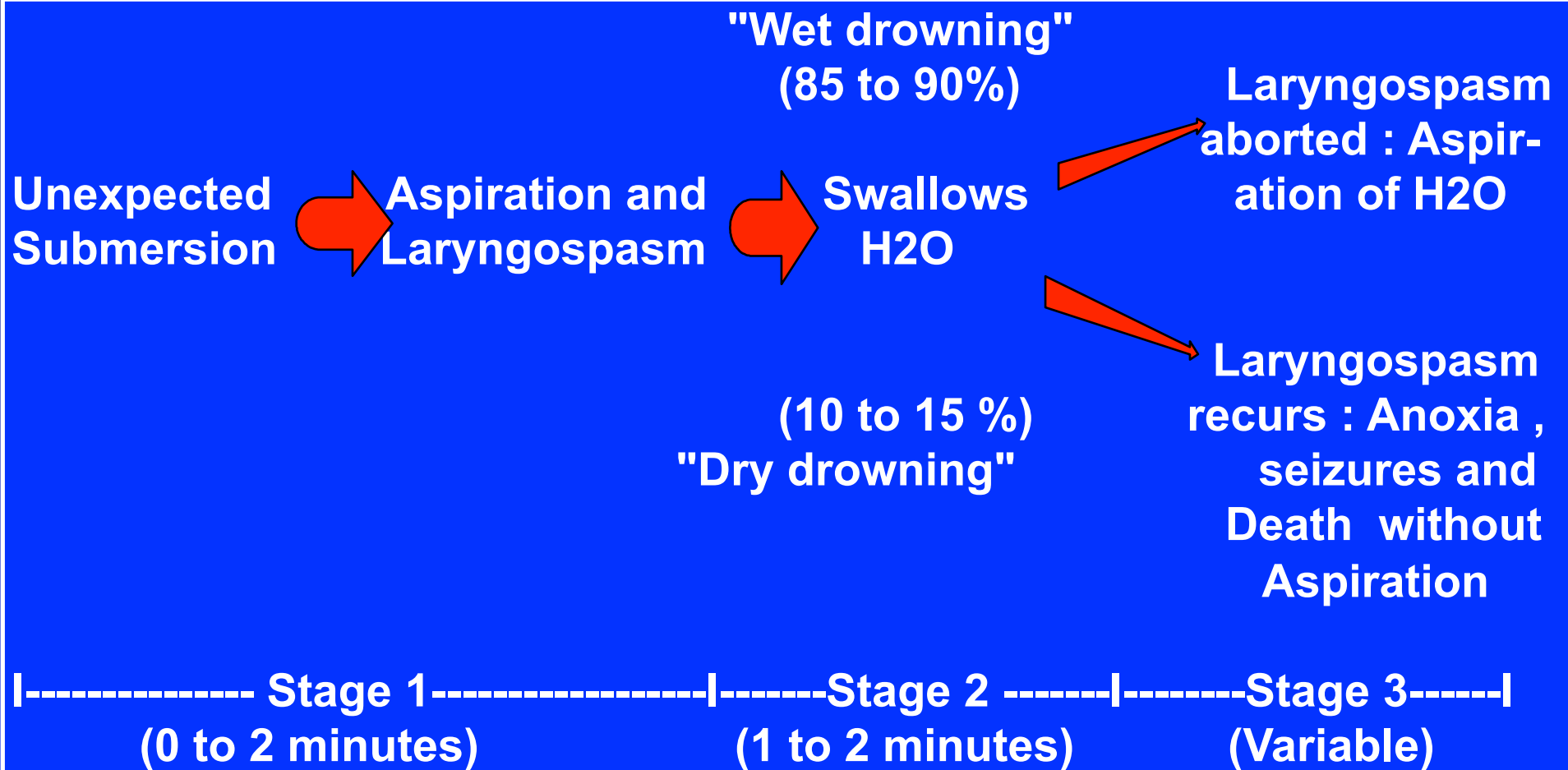
Locations & Types of Submersions in Drowning Accidents (in the U.S.A.)

Salt Water	1 to 2 %
Fresh Water :	98 %
Swimming pools : private	50 %
 public	3 %
Lakes, rivers, streams, storm drains	20 %
Bathtubs	15 %
Buckets of water	4 %
Fish tanks or ponds	4 %
Toilets	1 %
Washing machines	1 %

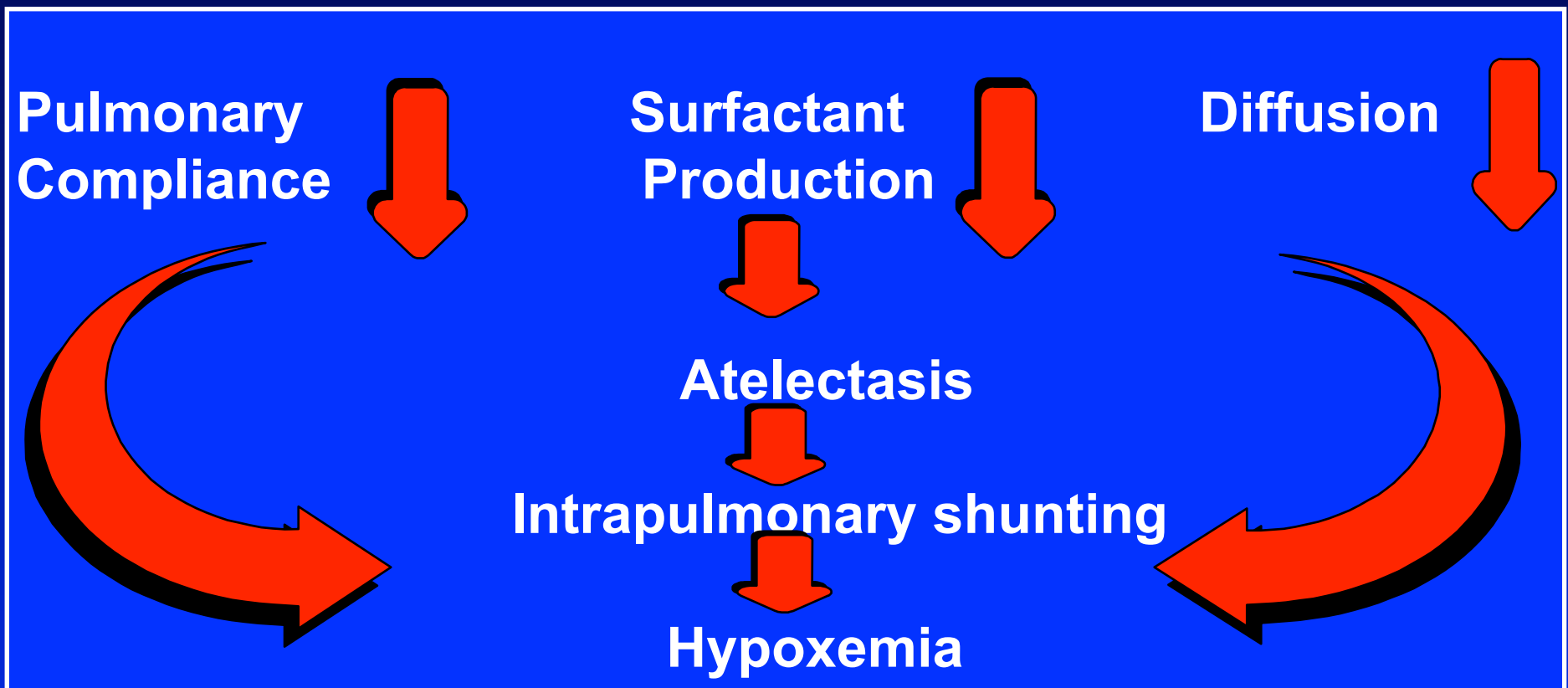
Human Near-drowning Sequence

1. Violent struggle to reach the surface
2. Period of calmness and apnea
3. Swallowing large amounts of fluid,
followed by vomiting
4. Gasping respirations and aspiration
5. Convulsions, coma, and death

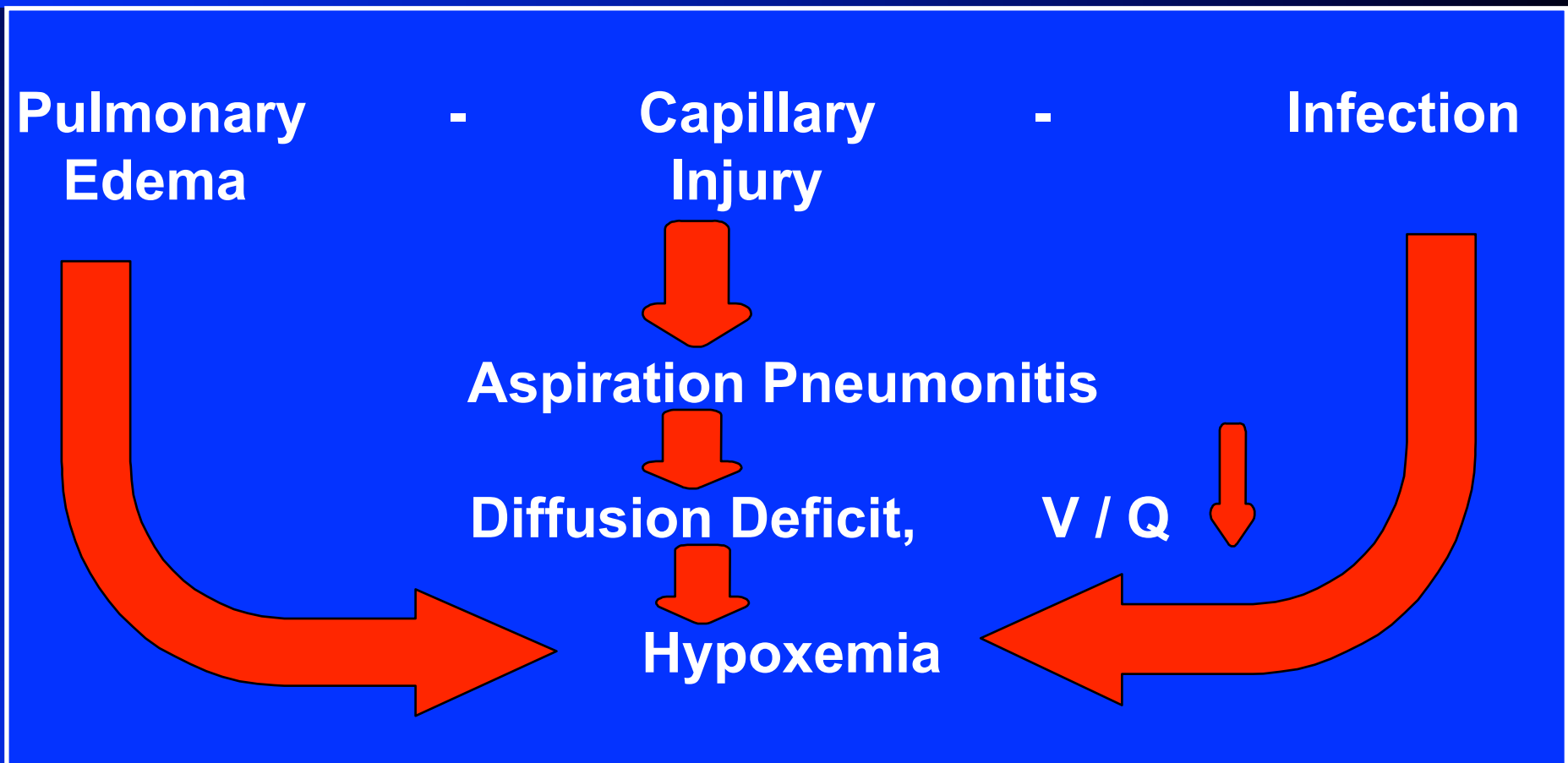
Typical Human Response to Unexpected Submersion



Initial & Delayed Effects of Water Aspiration



Initial & Delayed Effects of Water Aspiration (cont.)



Mammalian Diving Reflex

(may operate if submersion in cold water)

Apnea

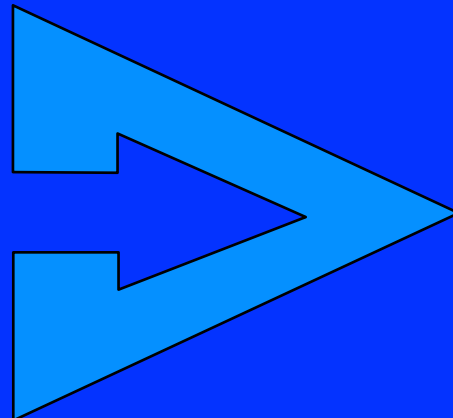
Bradycardia

Redistribution of blood supply :

Skin

Muscle

Gut



heart

lung

brain

Drowning : Important Aspects of the History

- f* Estimated time of submersion
- f* Type and temperature of water
- f* Amount and type of water contamination
- f* How and when victim was rescued
- f* Whether vomiting occurred
- f* How soon after rescue the victim first gasped
- f* How soon and what type of resuscitation measures
- f* How soon the patient was transported
- f* History of epilepsy, drugs or alcohol
- f* Possibility of child abuse (especially in bathtub drownings)

"Shallow Water Blackout"

f Normal duration voluntary apnea :

–87 seconds

f then $PCO_2 = 51$, $PO_2 = 73$

f Hyperventilation followed by exercise & breath hold :

–87 seconds

f then $PCO_2 = 43$, $PO_2 = 34$ to 43

f Therefore can cause loss of consciousness from hypoxia before PCO_2 increases and stimulates resp. drive (thereby causing drowning)

Drowning : First Aid

- f* Start mouth to mouth ventilation while patient in water, with Sellick maneuver if possible
- f* Immobilize neck early if diving
- f* Clear airway of debris
- f* ? Heimlich maneuver (may cause emesis & aspiration)
- f* Do not rely on estimated submersion time
- f* On beach : position patient parallel to surf line (so head not above or below heart level)
- f* O2 always, if available

Drowning : Salt Water Vs. Fresh Water : Features Common to Both

- f* Surfactant loss (washout vs. denatured)
- f* Persistent hypoxemia due to intrapulmonary shunt
- f* Pulmonary edema
- f* Focal lung hemorrhages
- f* No major change in blood volume
- f* No major change in serum electrolytes
- f* No dysrhythmias (unless Vfib due to hypoxia or hypothermia)

Drowning : Patient Classification

f Group A ("Awake")

f Group B ("Blunted") : conscious but obtunded

f Group C ("Comatose") :

–C1 : Flexion response to pain

–C2 : Extensor response to pain

–C3 : Flaccid

f Prognosis decreases A to C3

The "ABC" Classification System for Victims of Near-drowning

Category	Prognosis
<u>A</u> Patient awake, alert, and oriented	100 % survival with normal brain function
<u>B</u> Patients with blunted consciousness who are lethargic, semicomatose, combative, agitated or disoriented	89 % of adults and 92 % of children survive with normal brain function
<u>C</u> Comatose patients	73 % of adults and 44 % of children survive with normal brain function; an additional 17 % of children survive with incapacitating brain damage

Drowning Rx : Group A

- f* CXR, pulse oximetry for all
- f* Maybe ABG and CBC
- f* O2 (usually by nasal prongs)
 - +NG tube ; NPO X 12 hours
 - Admit overnight
- f* Discharge if stable & no pulmonary symptoms next day

Drowning Rx : Group B

f ABG's, CXR, CBC, Electrolytes

f O2 ; may need intubation

- NG tube

- Admit to ICU

- Serial ABG's and CXR's

- Restrict fluids to prevent cerebral edema

f Discharge if no later secondary deterioration ; usually need at least a 2 day admission

Drowning Rx : Group C *

f ABG's, CXR, CBC, Electrolytes

f O₂, intubation, hyperventilation, ± PEEP

f Admit to ICU

f Fluid restriction ± diuretics

f Temperature control

f ± paralytic agents

–± barbiturates

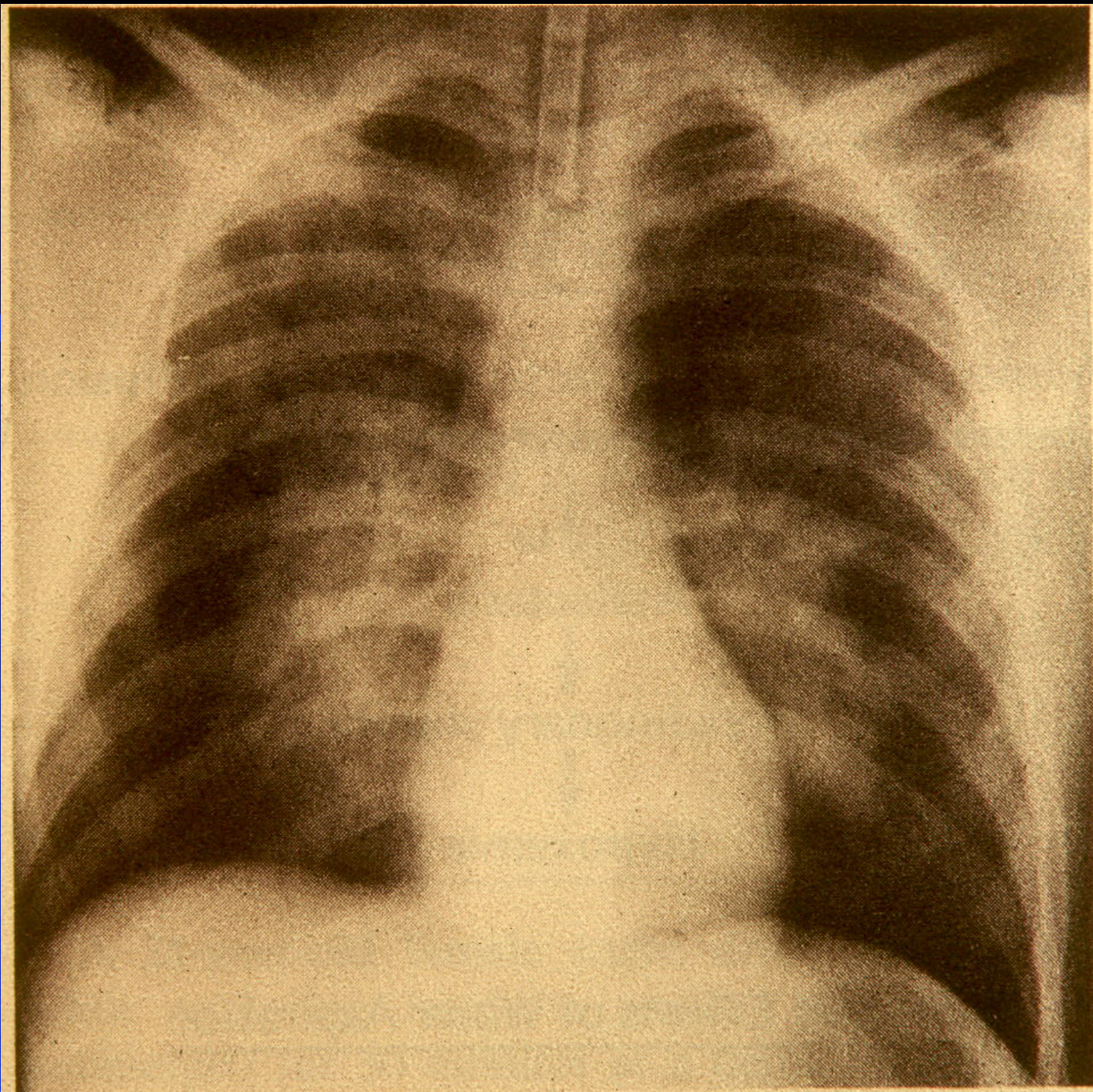
–± antibiotics

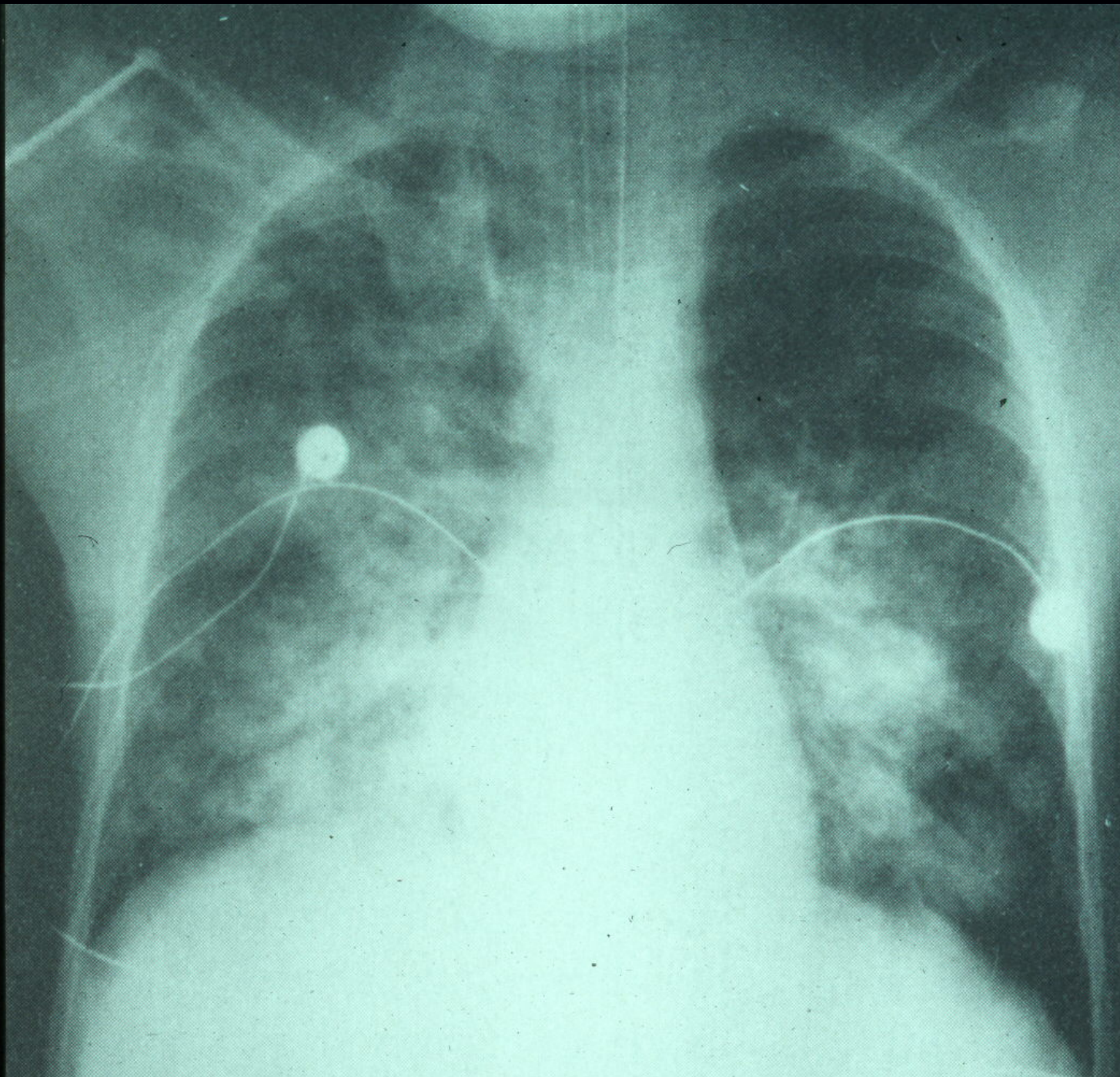
* Generally similar to management of closed head injury

Drowning : Direct Complications

f Monitor for :

- Atelectasis
- Pneumonia
- Pneumothorax & pneumomediastinum
- Pulmonary edema
- Progressive cerebral edema





Drowning :

Non-Pulmonary Complications

f Monitor for :

- Metabolic acidosis
- Renal failure
- Bowel mucosal necrosis (GI bleed)
- Disseminated Intravascular Coagulation (DIC)
- Decreased cardiac output
- Liver failure (rare)

Drowning :

Additional X-Rays to Remember

- f* C-spine series if diving accident**
- f* Skeletal survey (R/O non-accidental trauma) if bathtub drowning**
- f* Head CT scan if normothermic, ? for diving trauma, and persistent decreased mental status**

Drowning : Summary Criteria for Hospital Admission

f History

- Apnea or cyanosis
- LOC
- Required CPR (even if brief)

f Exam

- Hypoxemia
- Acidosis
- Abnormal CXR
- Abnormal physical exam

f Consider ICU Admission if :

- Prolonged resuscitation, or needs assisted ventilation, or persistent decrease in mental status

Drowning : Glasgow Coma Scale in Relation to Prognosis

<u>GCS</u>	<u>Outcome</u>
5	> 90 % normal
4 to 5	25 to 50 % normal
*3	0 to 39 % normal
3 & arrest	0 to 8 % normal
(*flaccid coma)	

Near-Drowning Prognosis : Time to First Spontaneous Gasp Post-Rescue

f If within 15 to 30 minutes post-rescue:

–Less than 10 % have mental retardation or spastic quadriplegia

f If not until 60 to 120 minutes post-rescue :

–50 to 80 % have serious neurologic sequelae

Prognostic Signs in Near-drowning Victims

GOOD	BAD
<ul style="list-style-type: none">- Alert on admission- Hypothermic- Older child or adult- Brief submersion time- On-scene basic and / or advanced life support (probably most important)- Good response to initial resuscitation measures	<ul style="list-style-type: none">- Age < 3 years- Fixed, dilated pupils in ED- Submerged > 5 minutes- No resuscitation attempts for more than 10 minutes- Preexisting chronic disease- Arterial pH ≤ 7.10- Coma on admission to ED

Near-Drowning Prognosis : Orlowski Scale

f Consider these 5 factors :

–Age < 3 years

–Submersion > 5 minutes

–No resuscitation during first 10 minutes
after rescue

–Coma on admission

–pH < 7.1 on admission

f If only one or two of above : 90 %
chance of recovery

f If 3 or more : only 5 % recovery

Near-Drowning : Problems in Some Long-Term Survivors

- f* Fine motor coordination
- f* Chronic lung disease :
 - Large airway dysfunction
 - Small airway dysfunction
- f* Fear of water environments

Drowning Prevention

f Home swimming pools

- Fully fenced & locked
- Maintain water level up to edge of pool
- Floats and pole available
- Splash alarms

f General

- Swimming training
- Wear life jackets
- Avoid alcohol or drugs
- ? avoid for epileptics or patients with recurrent syncope (at least they should never swim alone)
- Utilize lifeguards

Hypothermia and Drowning

- f* Rapid core cooling from aspiration and swallowing cold water
- f* BMR decreases to 50 % at 28 °C
- f* Children (large surface to weight ratio) cool rapidly
- f* Enhanced cooling from exercise or alcohol (such as struggling or swimming)
- f* ? action of diving reflex (? more minute ventilation with less breath holding ability ; ? less breath holding ability in children)