Pulmonary Contusion

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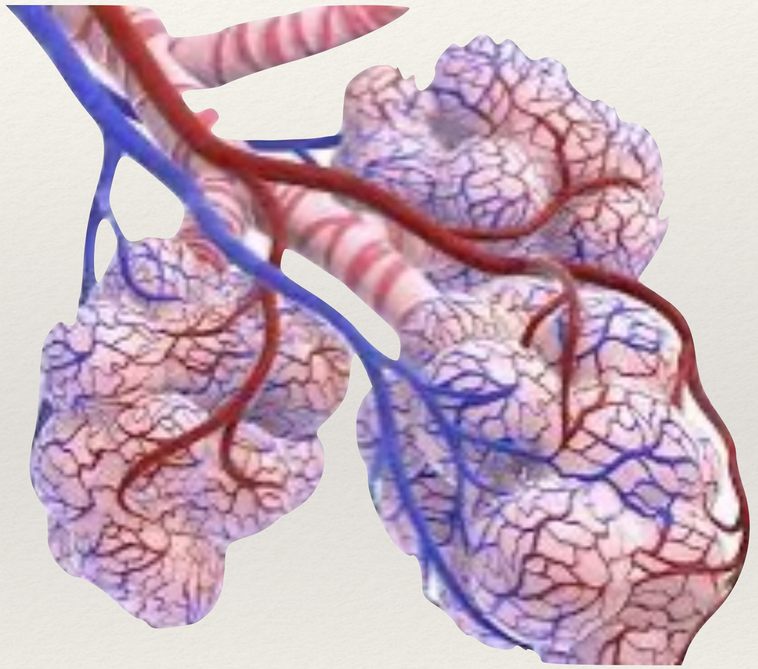
Small Animal Emergency Care

Introduction

- Pulmonary contusion:
  - pulmonary interstitial and alveolar hemorrhage and edema
  - blunt chest trauma
    - compression-decompression injury of the thoracic cage



Etiology

- Most common:
  - Hit by car and high-rise fall
- But also:
  - Thoracic bites, animal interaction, human abuse and others

Etiology

- JVECC 2009
  - 235 severe blunt trauma in dogs
  - 91,1%: hit by car
- Chest: 72.3% (!!!)

Retrospective Study

Journal of Veterinary Emergency and Critical Care **19**(6) 2009, pp 588–602
doi: 10.1111/j.1476-4431.2009.00468.x

Severe blunt trauma in dogs: 235 cases (1997–2003)

Stephen A. Simpson, DVM; Rebecca Syring, DVM, DACVECC and
Cynthia M. Otto, DVM, PhD, DACVECC

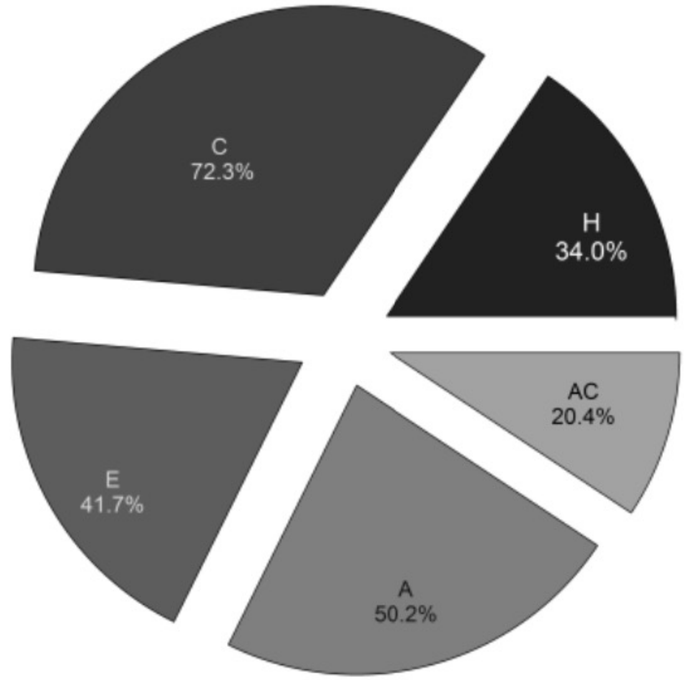
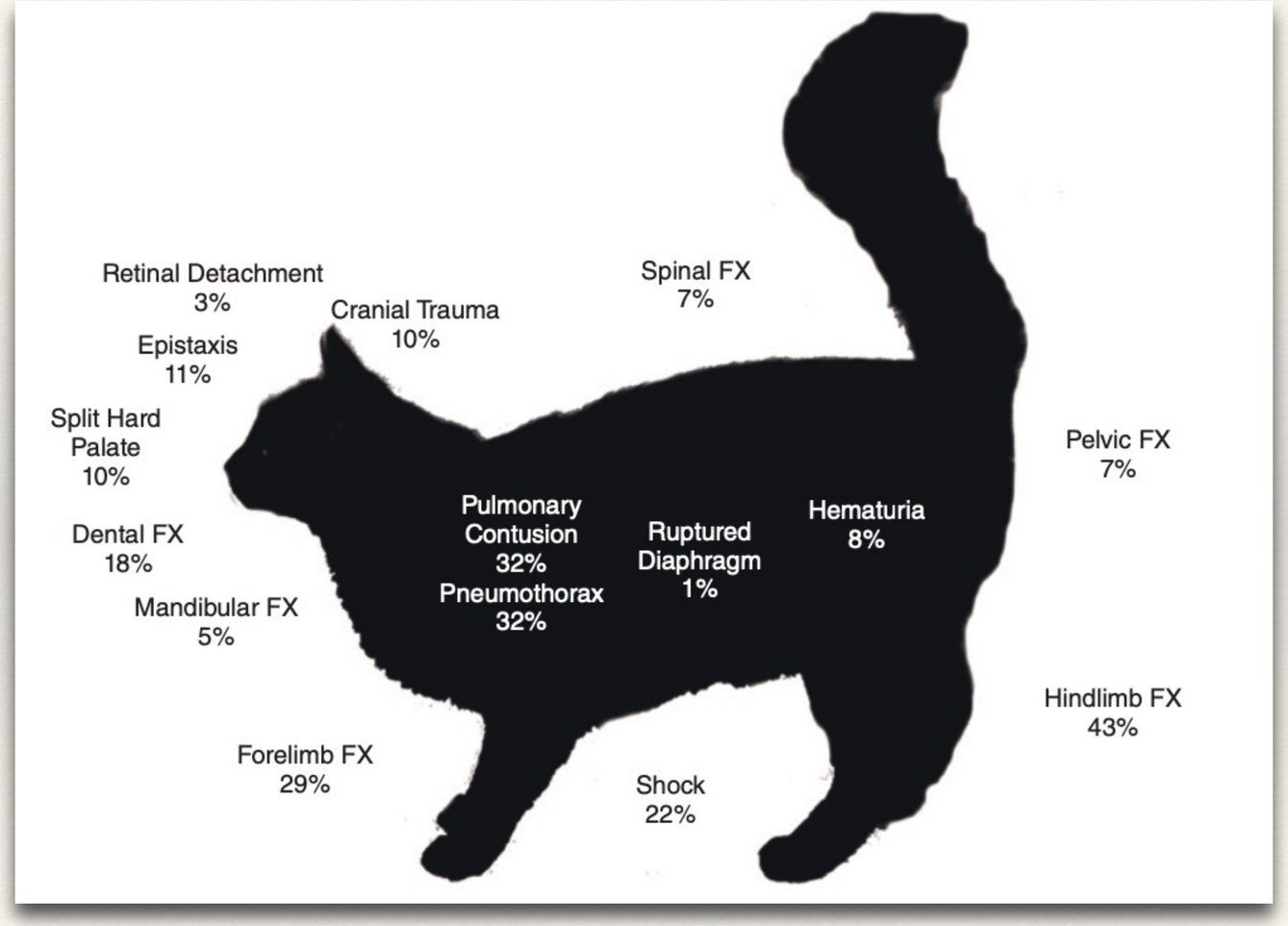


Figure 2: Percentage of anatomic blunt trauma distributions in all 235 dogs for head/neck trauma (H), chest (C), extremity (E), abdomen (A), and abdomen and chest (AC). Other combinations were <9% and trauma in all regions accounted for 2.6%. Because of polytrauma results do not add to 100%.

Etiology

- High-rise fall
  - Collard et al 2005, Vnuk et al 2004, Papazoglou et al 2001 e Whitney et al 1987
  - n= 500 cats



Norsworthy , 2011

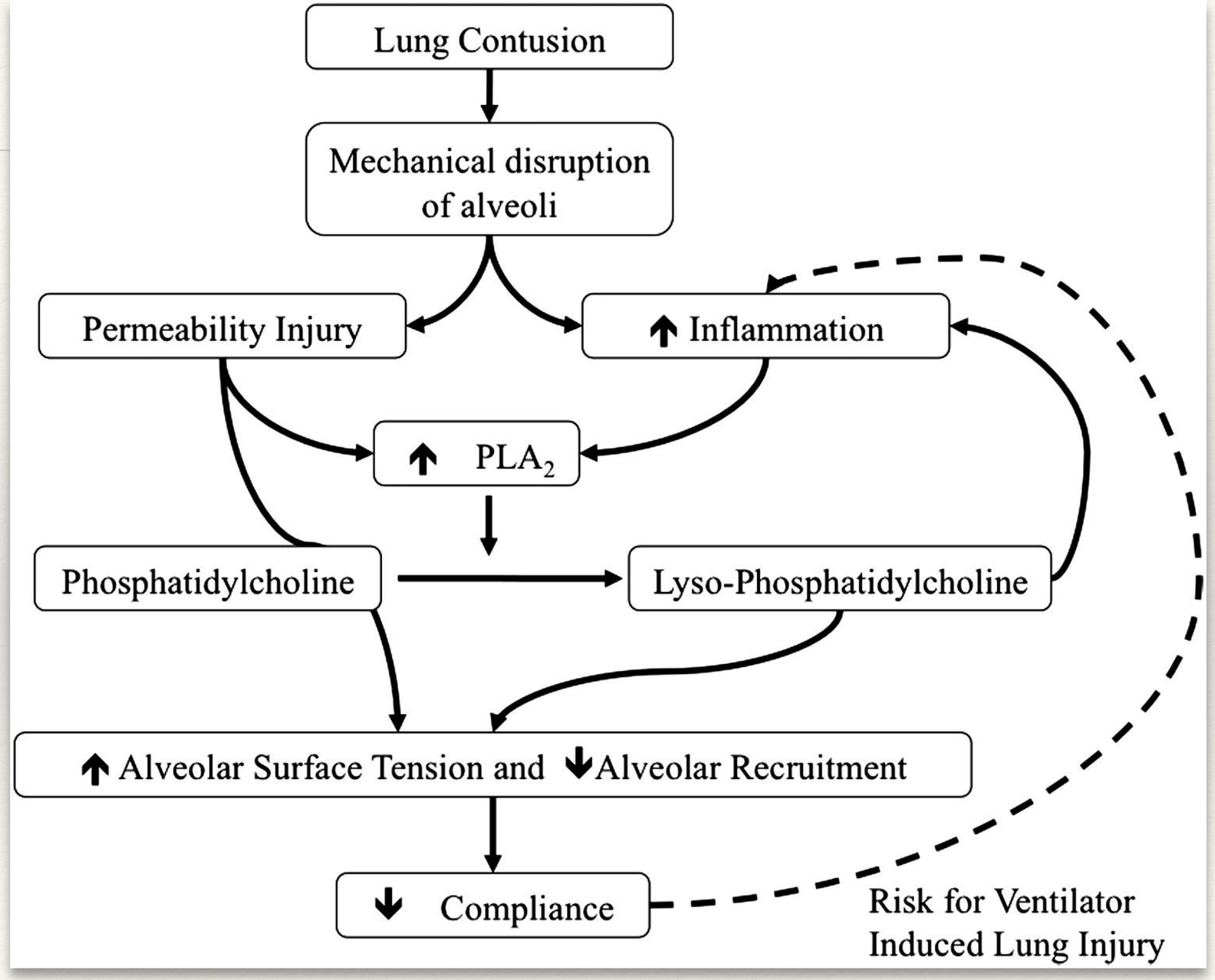
Pathophysiology

Increased phospholipase A_2 and lyso-phosphatidylcholine levels are associated with surfactant dysfunction in lung contusion injury in mice

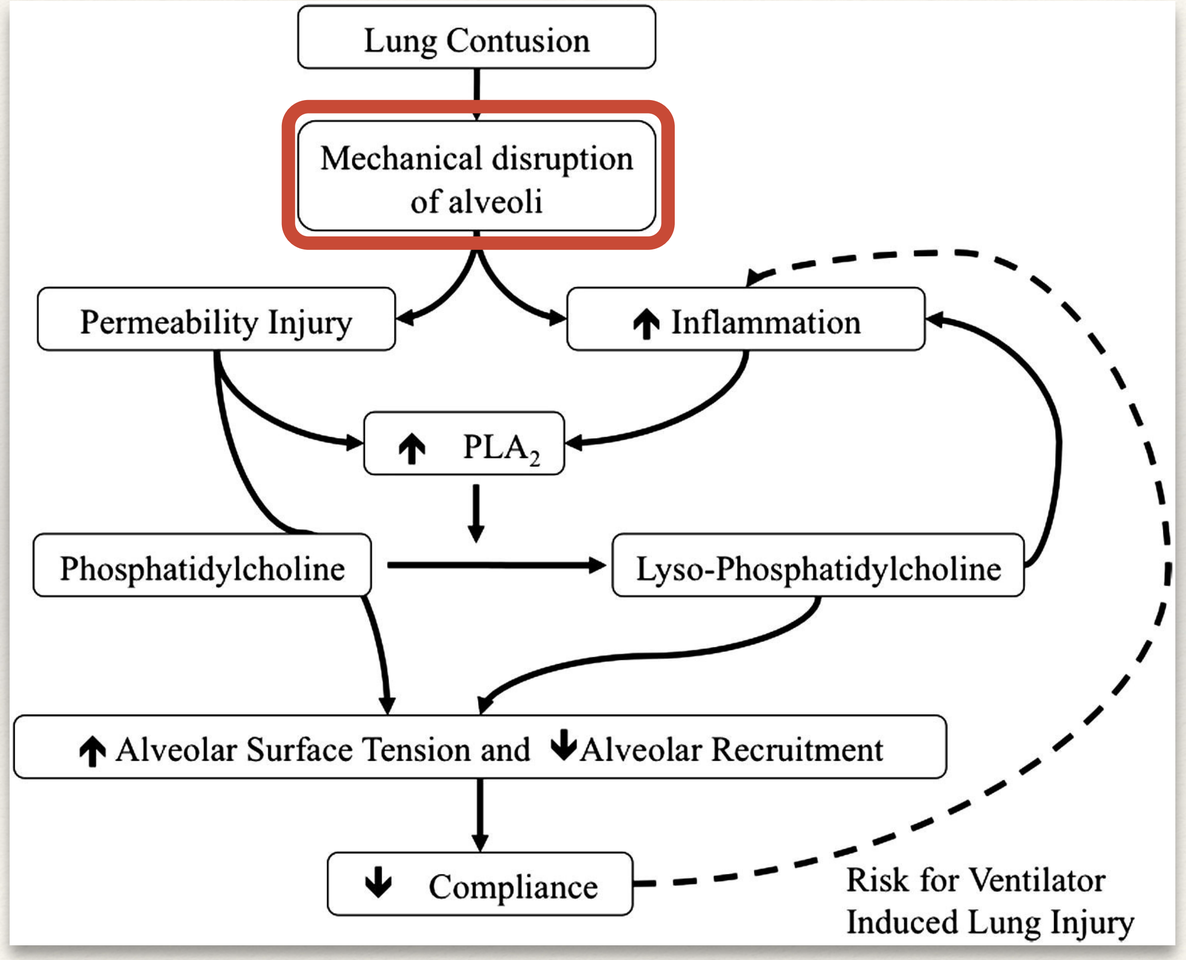
David Machado-Aranda, MD,[a] Zhengdong Wang, MS, MD,[b] Bi Yu, PhD,[a] M. V. Suresh, PhD,[a] Robert H. Notter, MD, PhD,[b,c] *and* Krishnan Raghavendran, MD,[a] *Ann Arbor, MI, and Rochester, NY*

Surgery

Volume 153, Issue 1, January 2013, Pages 25-35



Pathophysiology



Compression-decompression

Inertial effect

the lighter alveolar tissue is sheared from the heavier hilar structures

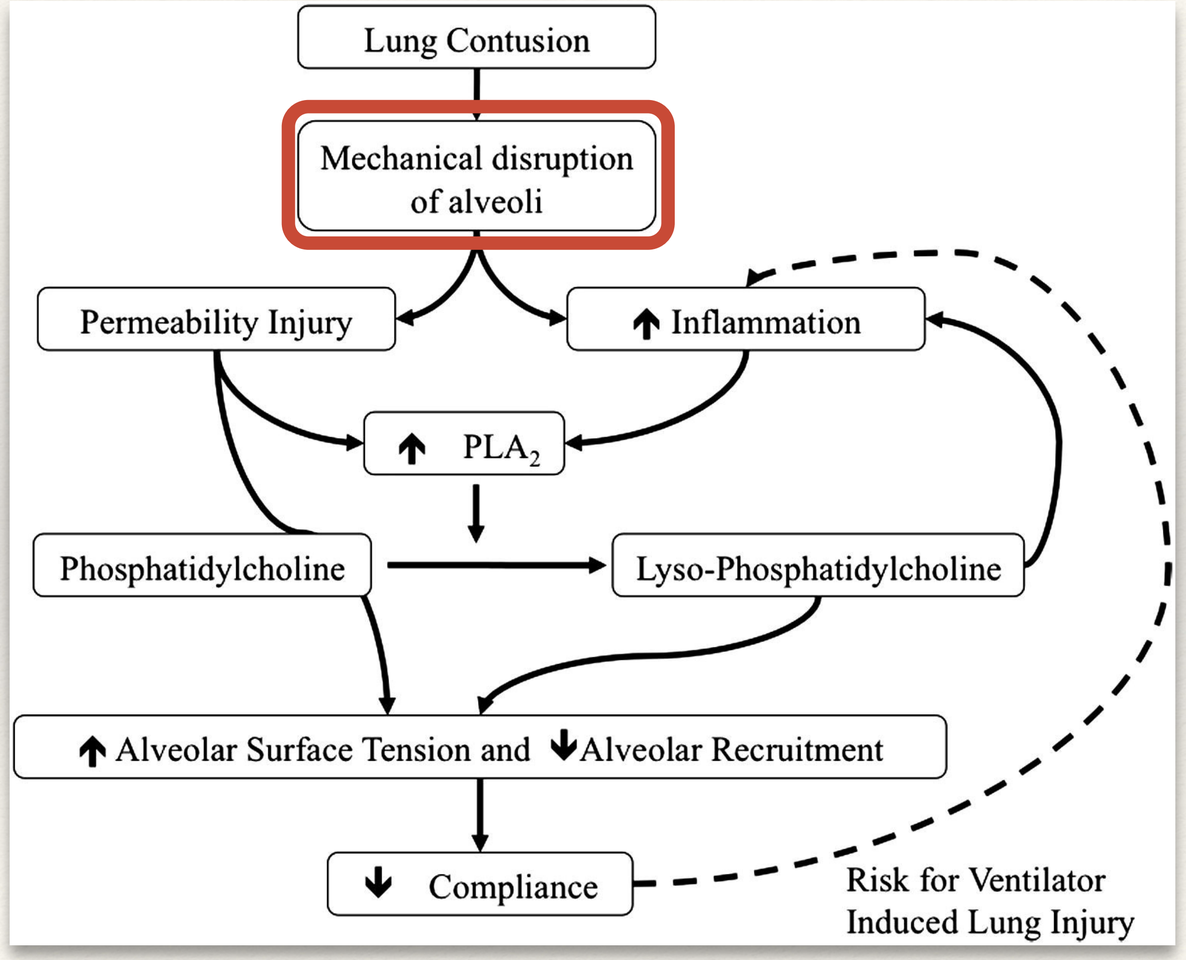
Spalling effect

lung tissue bursts or is sheared where a shock wave meets the lung tissue, at interfaces between gas and liquid

Implosion effect

occurs when a pressure wave passes through a tissue containing bubbles of gas: the bubbles first implode, then rebound and expand beyond their original volume

Pathophysiology



Compression-decompression

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Hemorrhage

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Bronchospasm

Mucous production

Decreased production of surfactant

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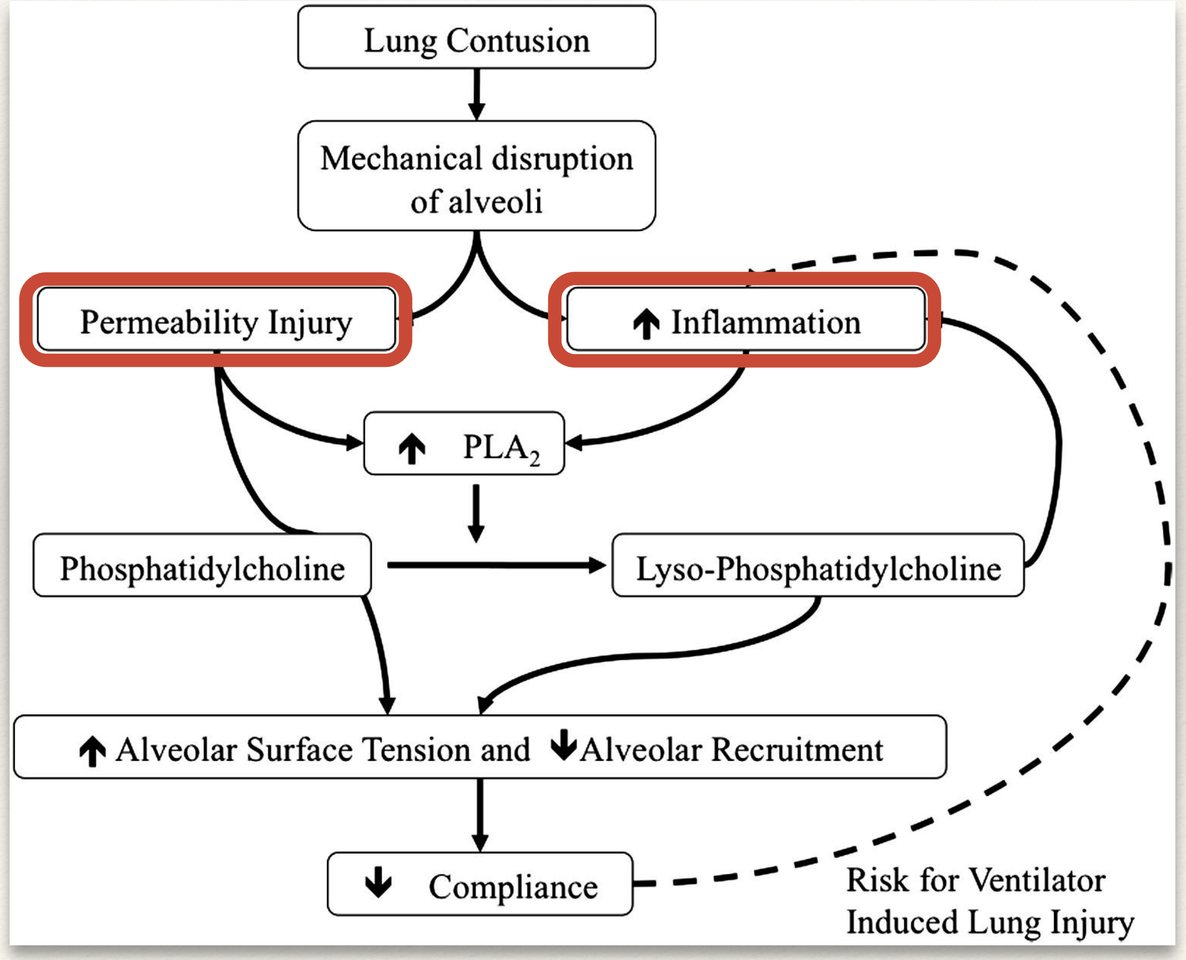
Alveolar collapse

Pathophysiology



Compression-decompression

Hemorrhage

Bronchospasm

Mucous production

Decreased production of surfactant

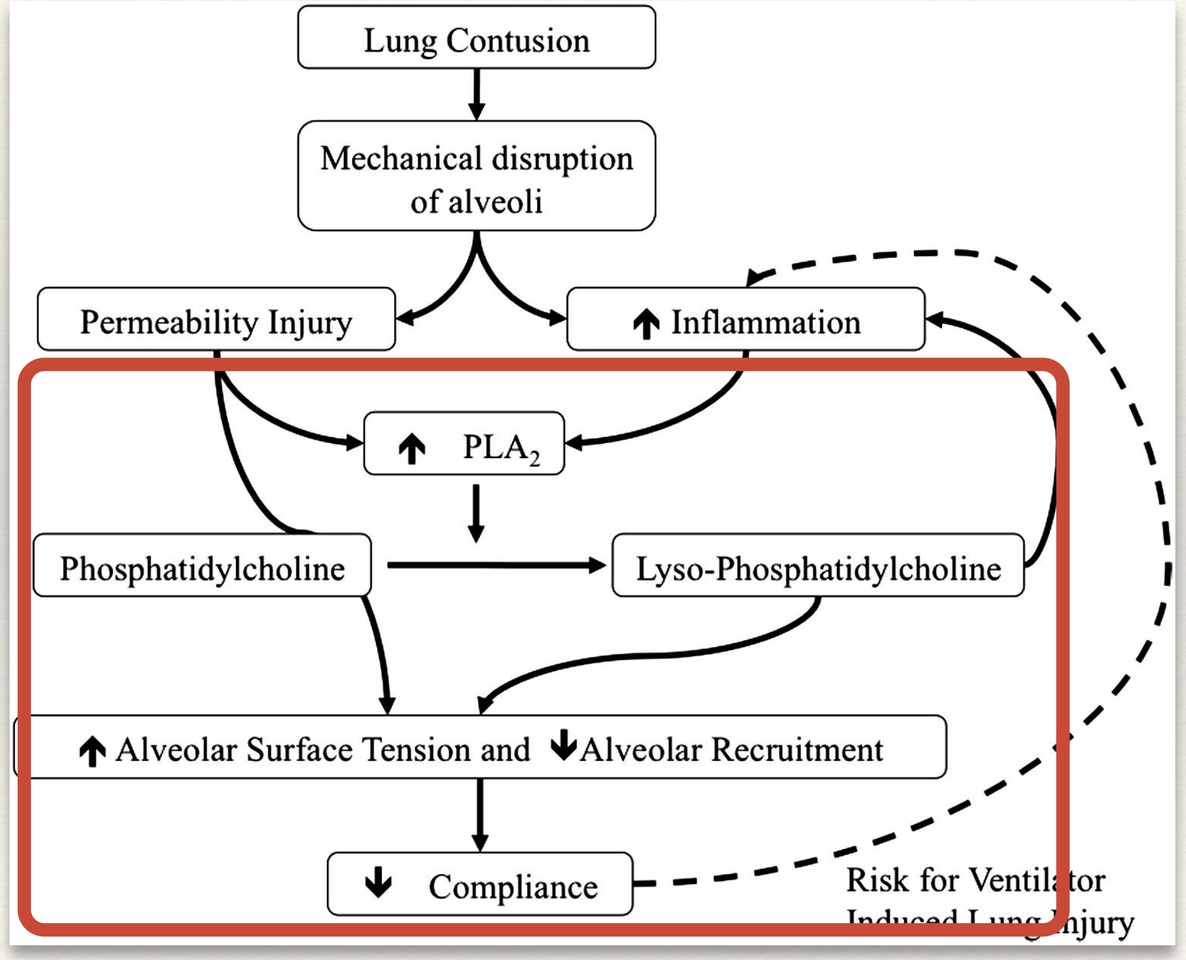
Alveolar collapse

Traumatic damage to the lung parenchyma

Inflammatory response

Increased capillary permeability

Pathophysiology



Inflammation + permeability injury

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Infiltration of neutrophils and monocytes

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Alveoli are full of protein, RBC and inflammatory cells

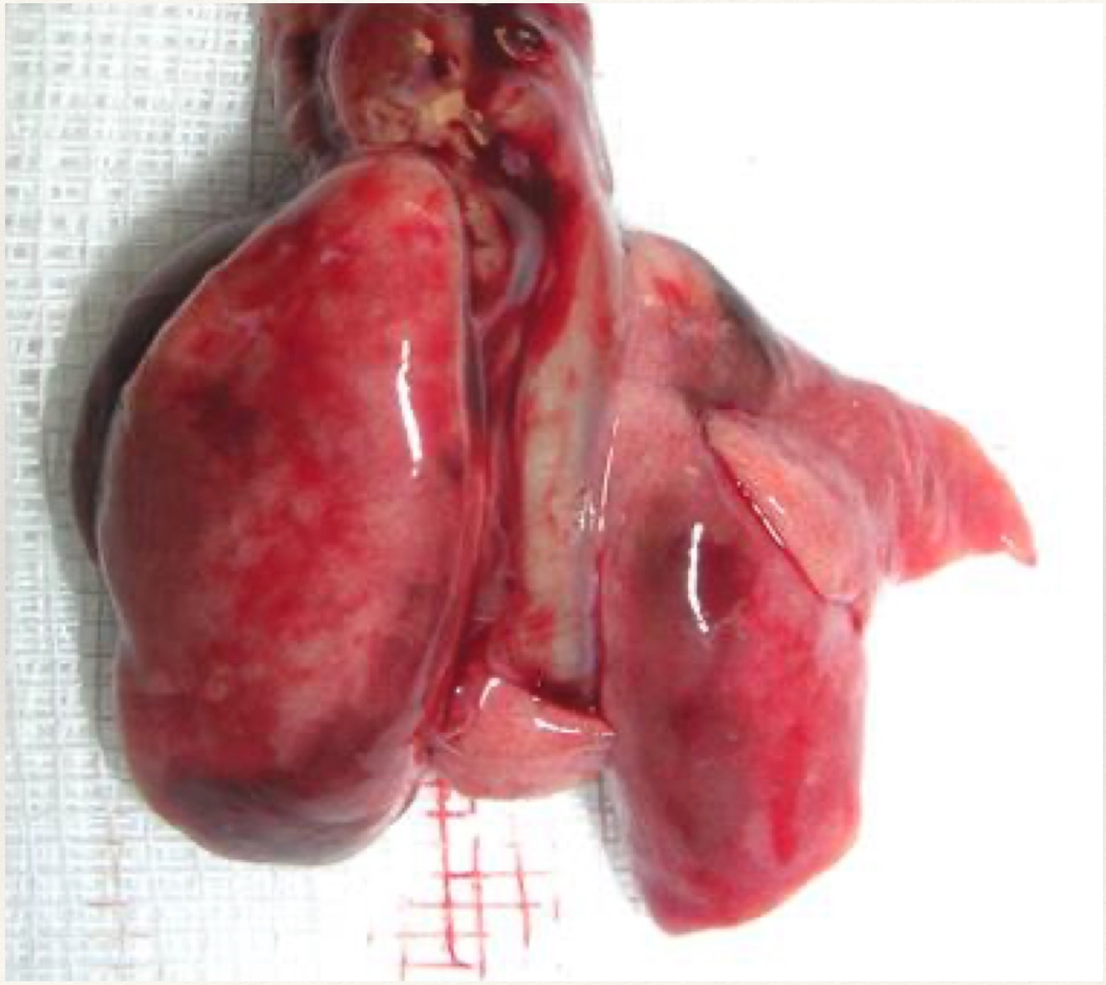
↓

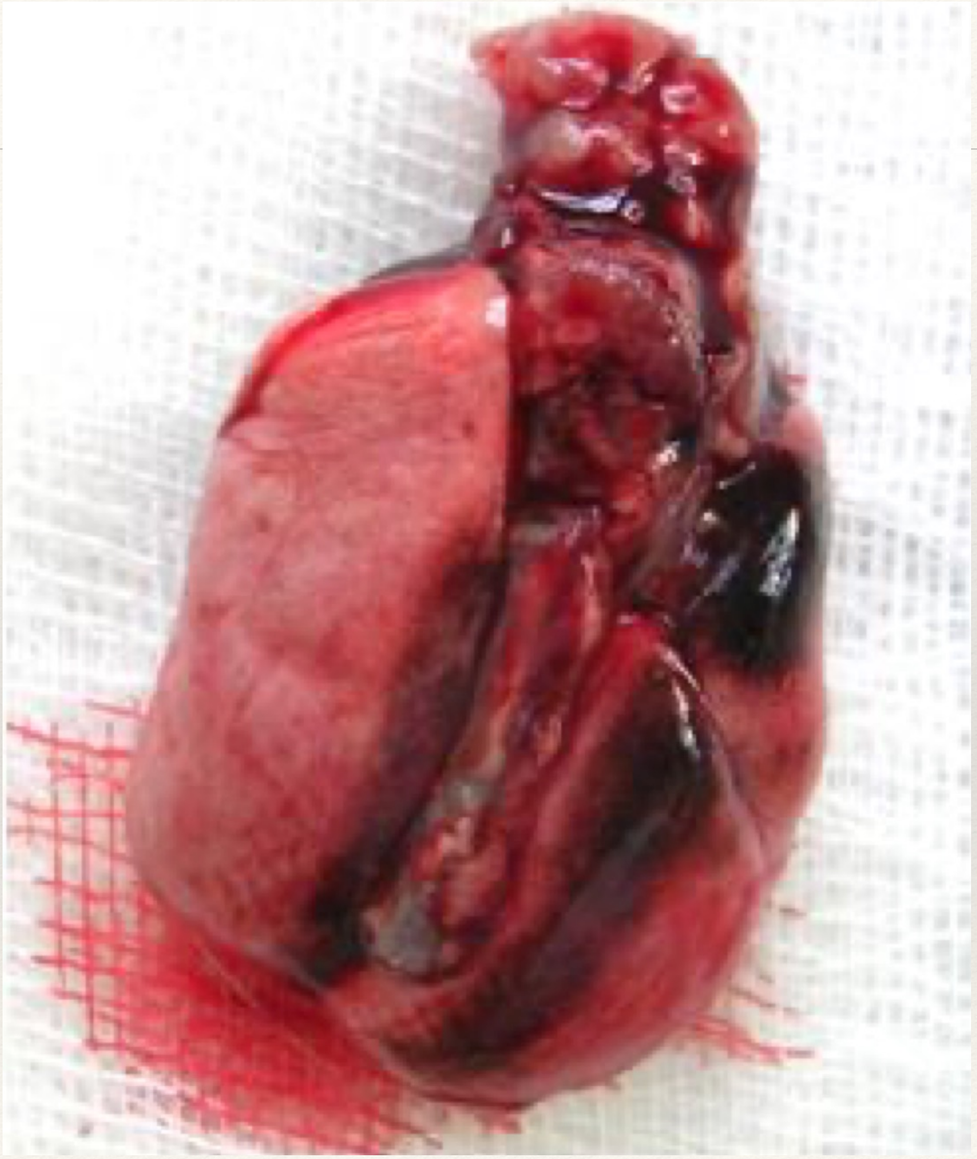
Normal architecture is lost

↓

Decrease in compliance

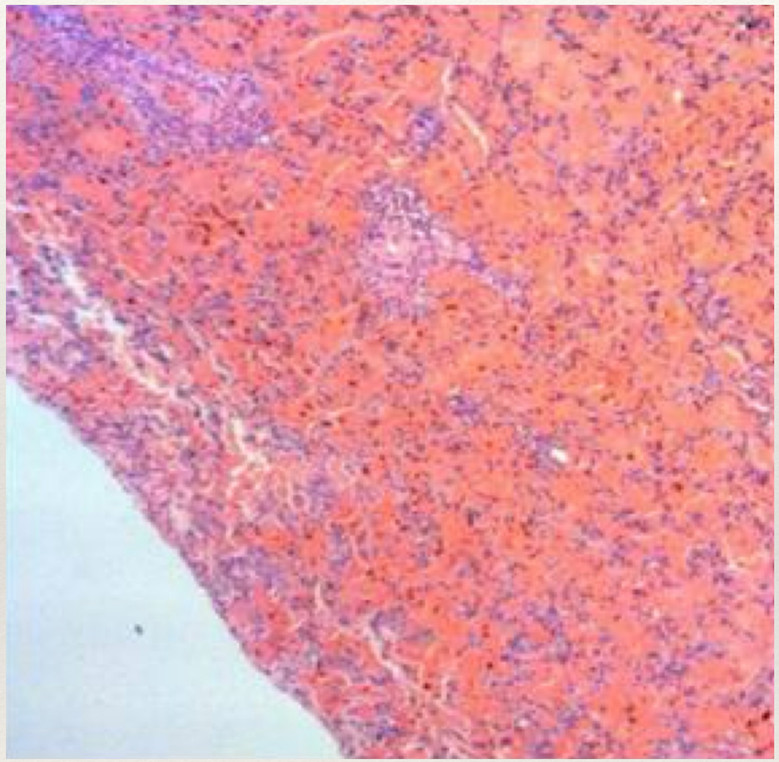
Pathophysiology



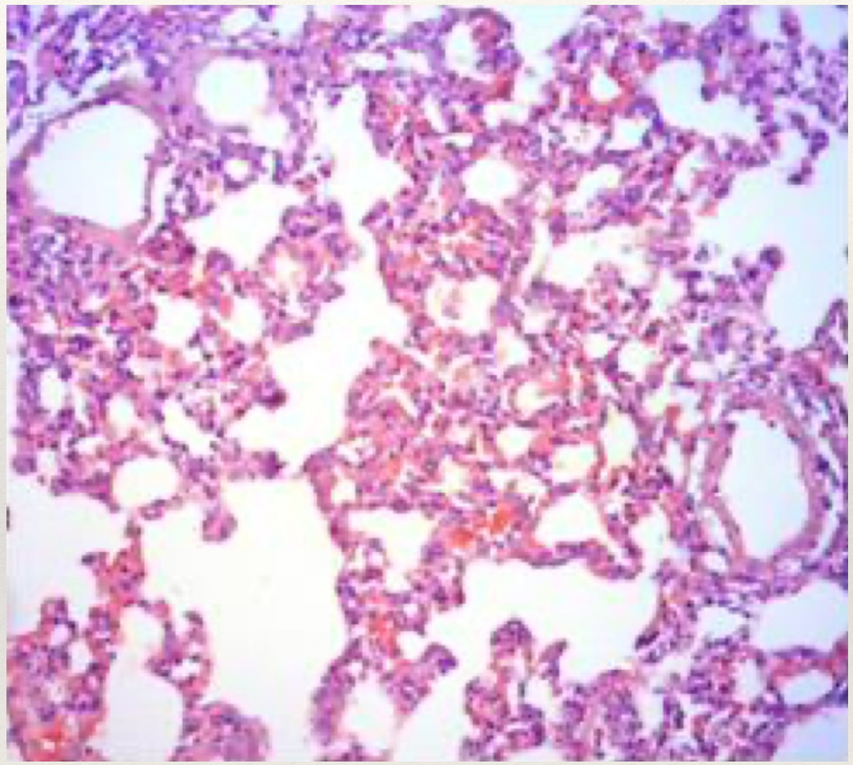


Novak of et al 2014

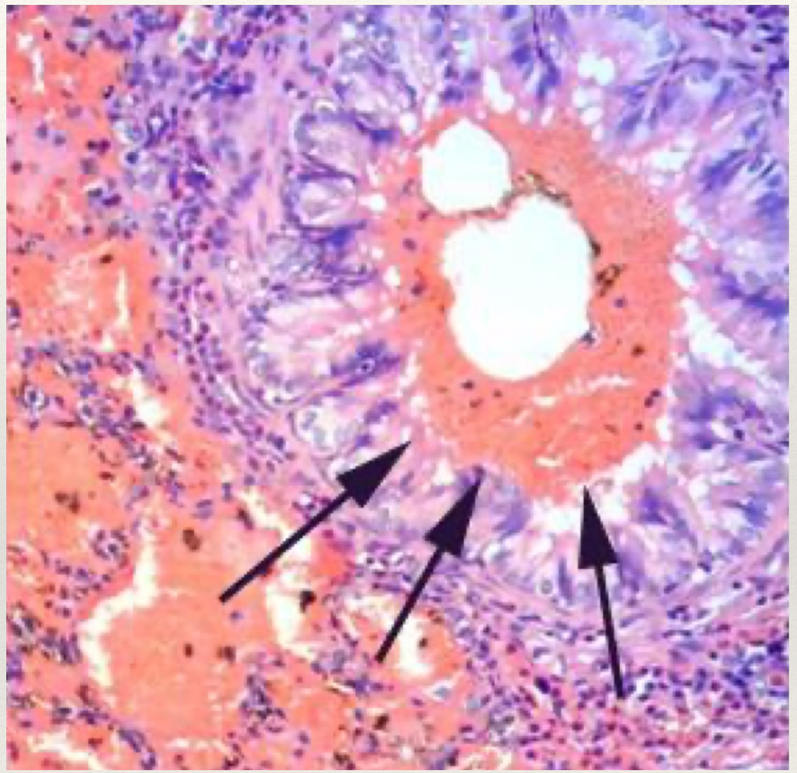
Pathophysiology



Hemorrhage



Alveolar destruction



Damaged bronchioles

Novak et al 2014

Pathophysiology

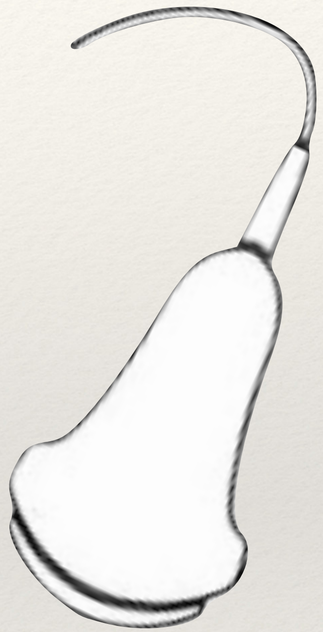
- Healing:
  - 48 - 72h: healing has started
  - 7-10 days: lungs are healed with little scarring

Physical examination findings

- Tachypnea / dyspnea
- Auscultation:
  - Normal, increased breath sounds, crackles or wheezes
  - Usually **asymmetric** and might be **unilateral**
  - It can be challenging when concurrent condition is present

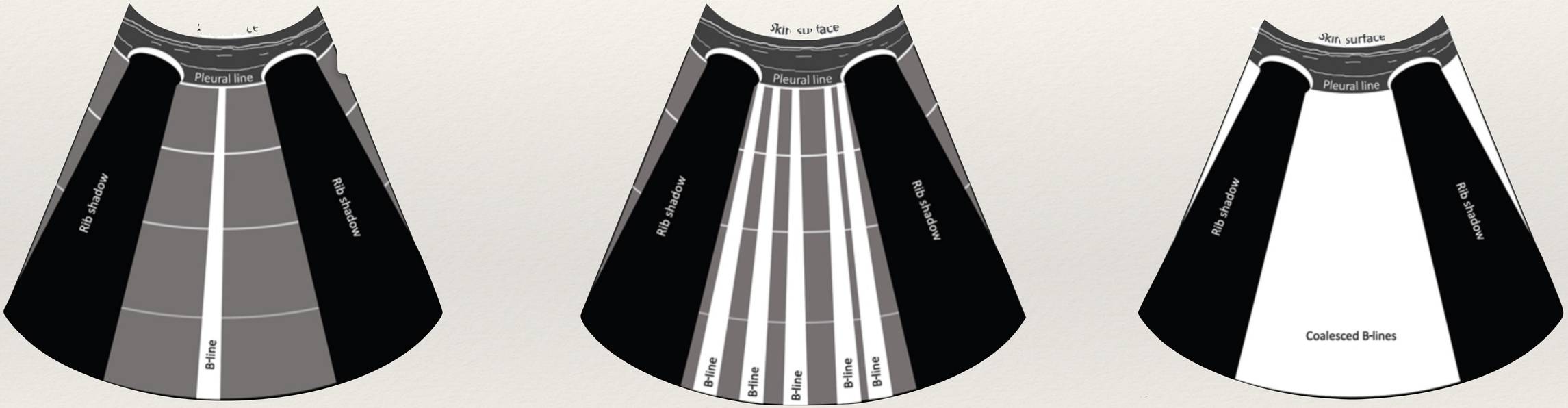
Imaging

- Ultrasound
  - POCUS techniques:
    - Minimal handling and restraining
    - Safer position in unstable patients
    - Can be operator- and machine-dependent



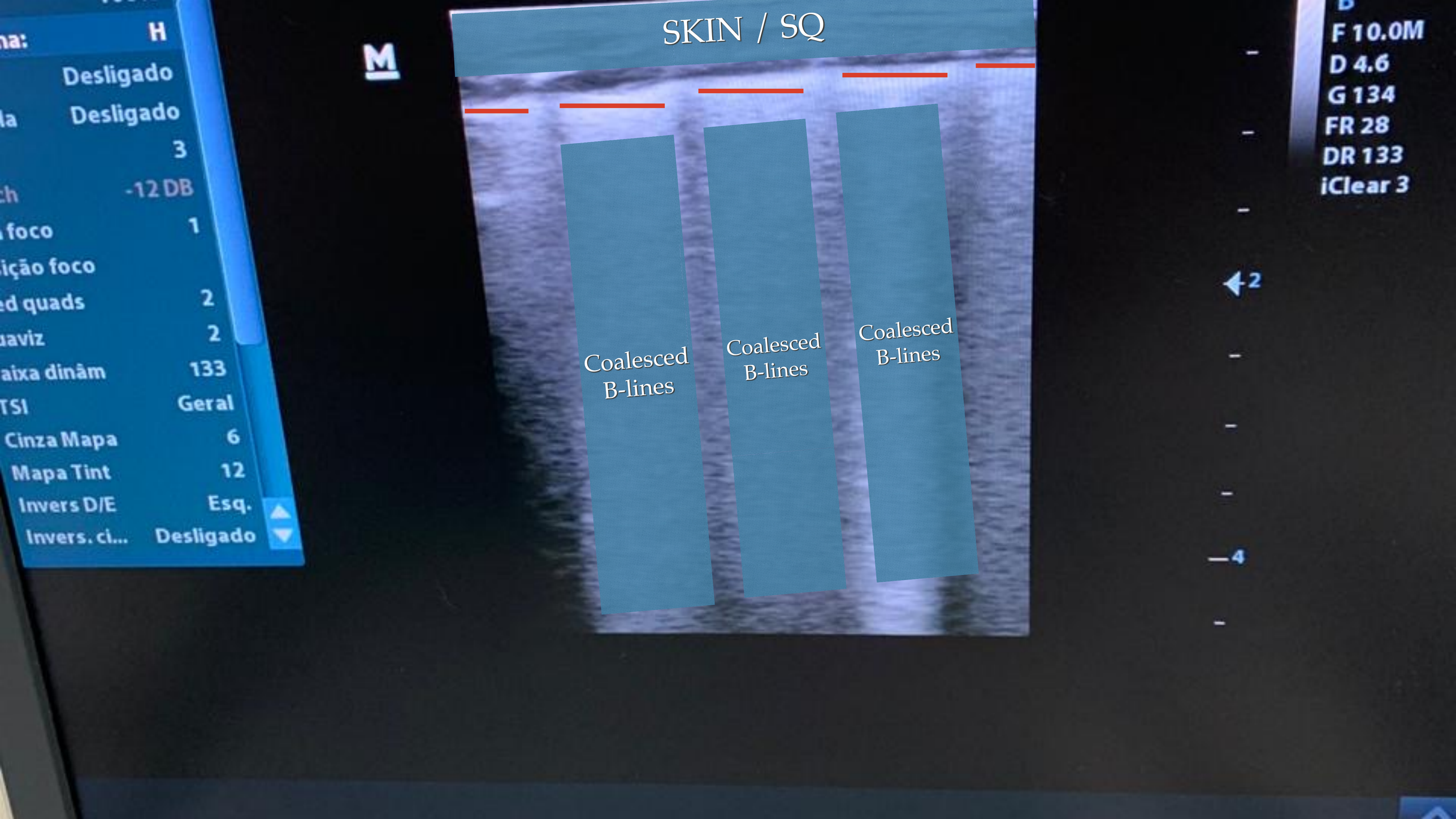
Imaging

"White lung"

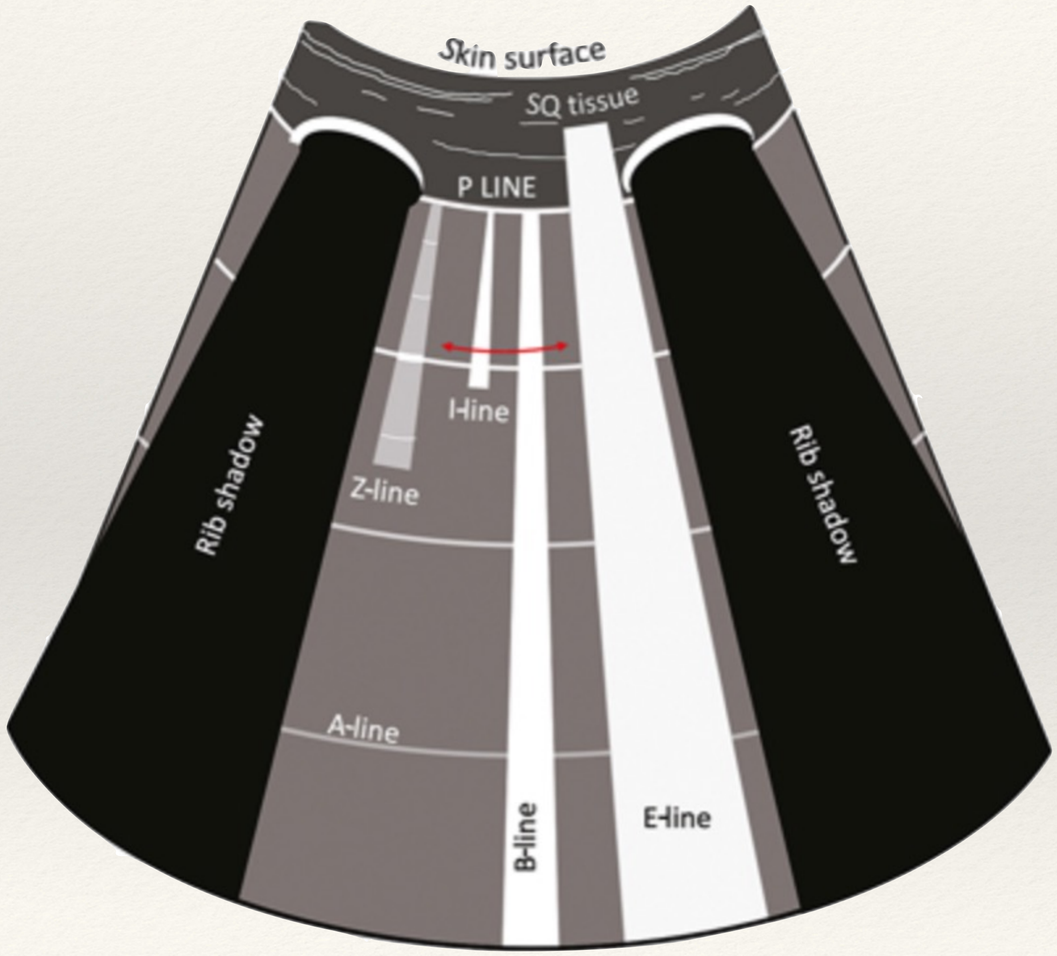


Less aeration

Silverstein & Hopper. 2022


SKIN / SQ
Coalesced B-lines
Coalesced B-lines
Coalesced B-lines
F 10.0M
D 4.6
G 134
FR 28
DR 133
iClear 3
Desligado
Desligado
3
-12 DB
1
2
2
133
Geral
6
12
Esq.
Desligado

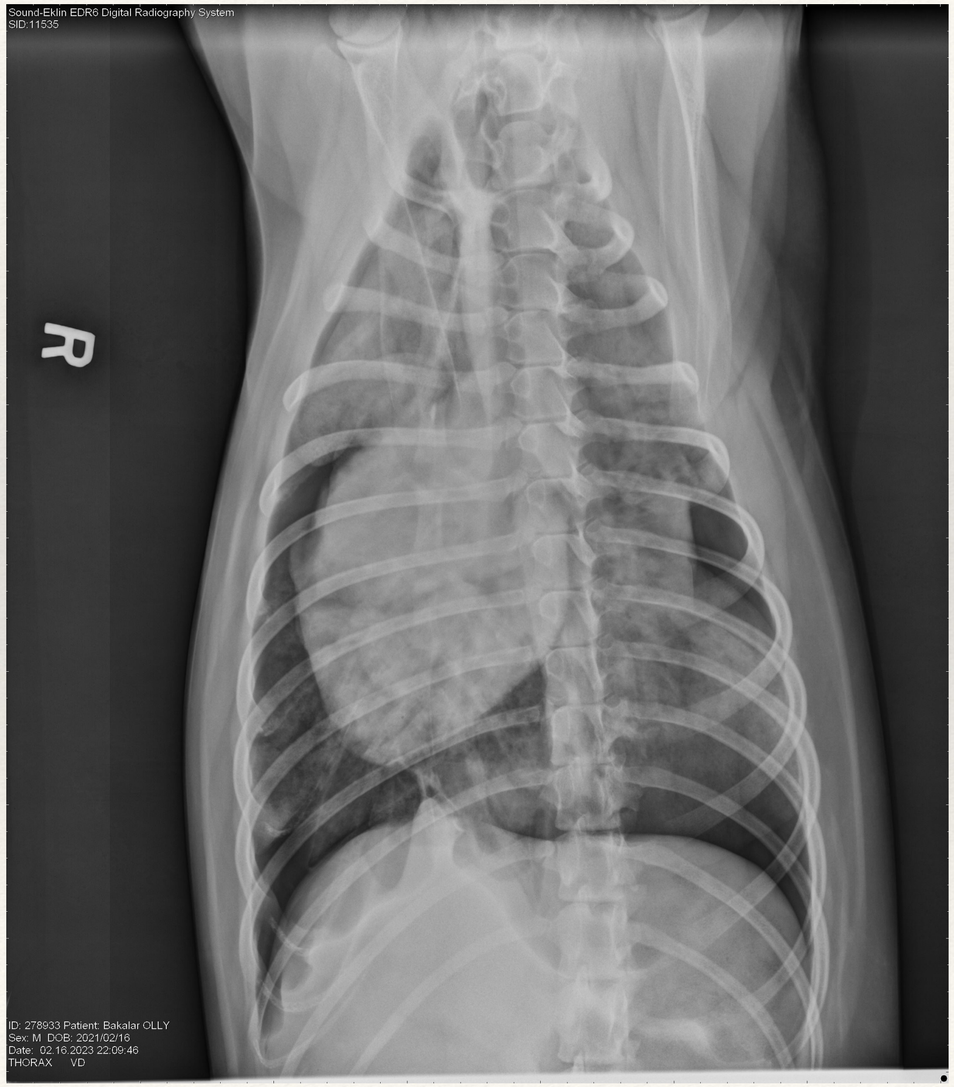
Imaging



- B-line vs others
  - Z-line and I-line: no clinical importance
  - E-line: SQ emphysema

Silverstein & Hopper. 2022

Imaging



- Radiographs:
  - Patchy or diffuse areas
  - Alveolar lung infiltrate
  - Can be generalized or localized
  - May lag 12-24h

Imaging

- CT scan:
  - Gold standard in human medicine
  - Veterinary medicine
    - Lack of availability
    - Need sedation +/- anesthesia

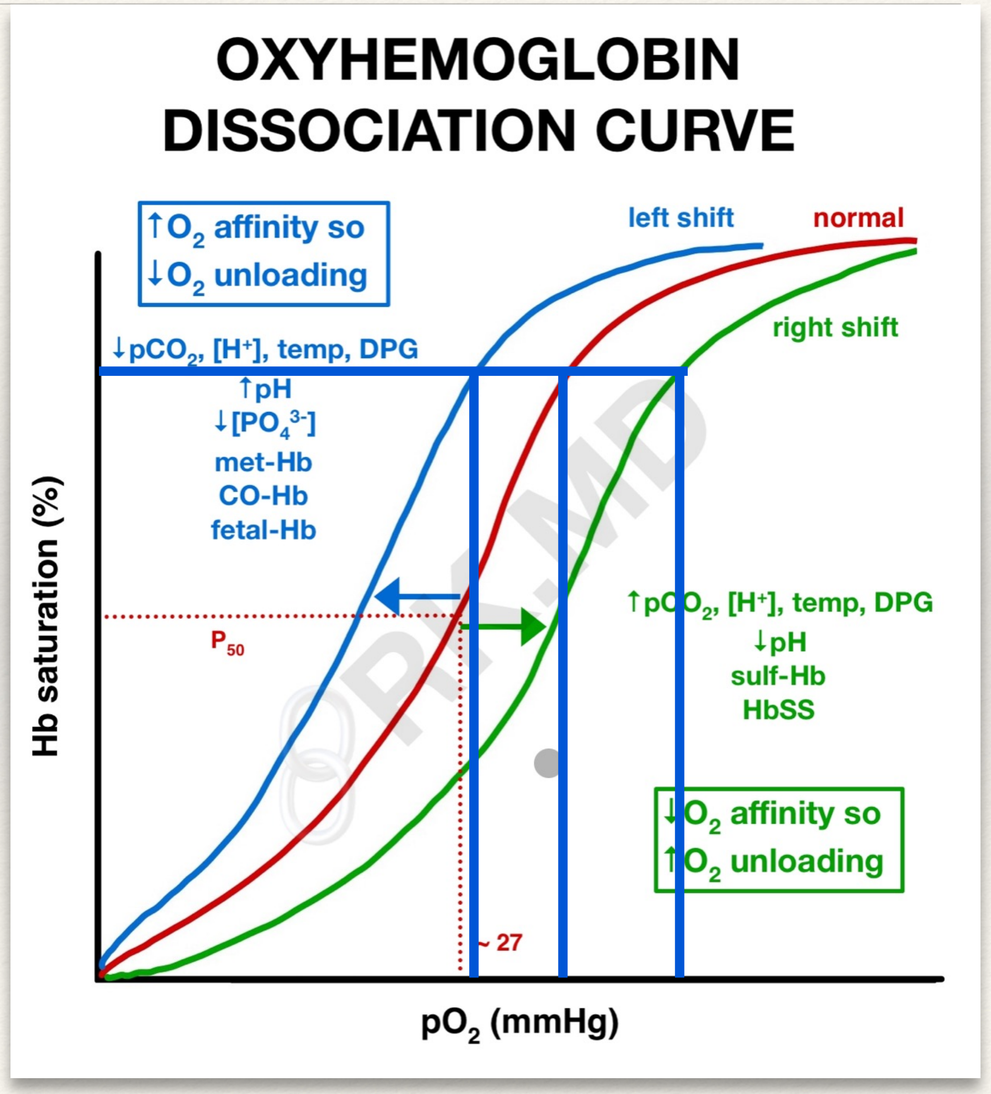
Blood gas analysis

- Most objective method for assessing and monitoring
  - Must be arterial
  - Hypoxemia +/- CO2 disorder
    - PaO2/FiO2 (P/F)

- PaO2/FiO2:
  - Normal: P/F > 300
  - Mild: 300 > P/F > 200
  - Moderate: 200 > P/F > 100
  - Severe: P/F < 100

Pulse oximetry

- It has some limitations
- Indication
  - Initial assessment
  - Arterial blood gas analysis is not possible
- Less accurate indicator of impaired oxygenation
- Does not provide information about ventilation
- Values
  - SpO2 < 95% = hypoxemia
  - SpO2 < 90%= severe hypoxemia



Management

- Initial approach
  - ABC
    - Airways
    - **Breathing**
    - Circulation

Management

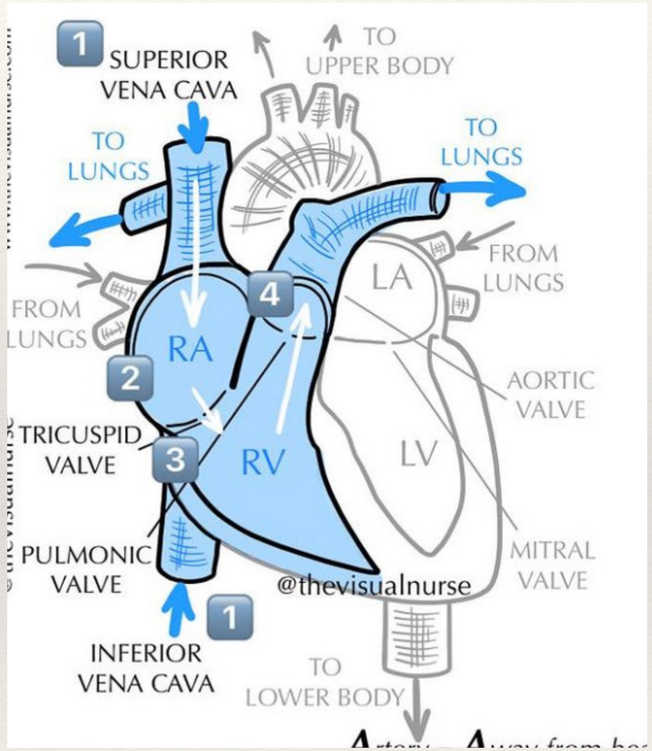
- Oxygen therapy and ventilation
  - Should be administered to all dyspneic patients
    - **Flow-by**
    - Nasal oxygen
    - **Oxygen cages**/hoods
    - In severe affected patients
      - High flow nasal oxygen
      - Mechanical ventilation

Oxygen cage

Mechanical ventilation

Management

- Fluid therapy
  - Many patients will have hypovolemic shock
    - Optimizing perfusion
    - Avoid overzealous administration
  - Increase in pulmonary capillary hydrostatic pressure
    - Increases fluid extravasation into the alveoli
  - Individualize the fluid therapy prescription
    - Avoid administering preset volumes and rates
  - Pulmonary contusion can increase right ventricle afterload



Management

- Fluid therapy
  - Evidence in veterinary medicine is scarce
    - No evidence of benefits of HTS over isotonic solutions
    - Synthetic colloids may worsen pulmonary edema

Management

- Analgesia
  - Thoracic injuries are painful
  - Consider:
    - Visceral vs somatic pain
    - Bolus vs CRI
    - Effect on cardiac and respiratory function
    - Systemic vs regional block

Management

- Antimicrobial therapy
  - 1% of dogs develop pneumonia after pulmonary contusion
  - Avoid to limit bacterial resistance
  - Ideally should be based culture and susceptibility tests

Prognosis

- Survival rates depends on:
  - Severity of pulmonary contusion
  - Coexisting thoracic and extrathoracic lesions

- Literature:
  - 82% of survival
  - If required mechanical ventilation = 30% survival

- If discharged = no residual long-term sequelae

CPR

- **Atropine!**
- Respiratory issues can lead to increased vagal tone
- If associated with pneumothorax
  - Open chest CPR is recommended!

Fadel - Pulmonary Contusion

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- A "URL" should appear. Click the URL and fill out the feedback form.

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"Learning without thinking is useless. Thinking without learning is dangerous."

–Confucius