

# The effects of High Frequency Percussive and Oscillatory Ventilation on Adult Patient Populations

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# Objectives

- Examine the Berlin Definition of Acute Respiratory Distress Syndrome
- Define High Frequency Percussive and Oscillatory Ventilation
- Briefly explain the Physiological changes within the lungs in Acute Respiratory Distress Syndrome.
- Compare the use of Conventional Ventilation and HFPV/ HFOV in ARDS patients
- Briefly overview types of common HFPV and HFOV devices
- Overview the mortality of Patients on Conventional vs. HFPV/HFOV

# Berlin Definition of Acute Respiratory Distress Syndrome

## PaO<sub>2</sub>/ FiO<sub>2</sub> ratio

- >200 Mild
- >100 Moderate
- <100 Severe

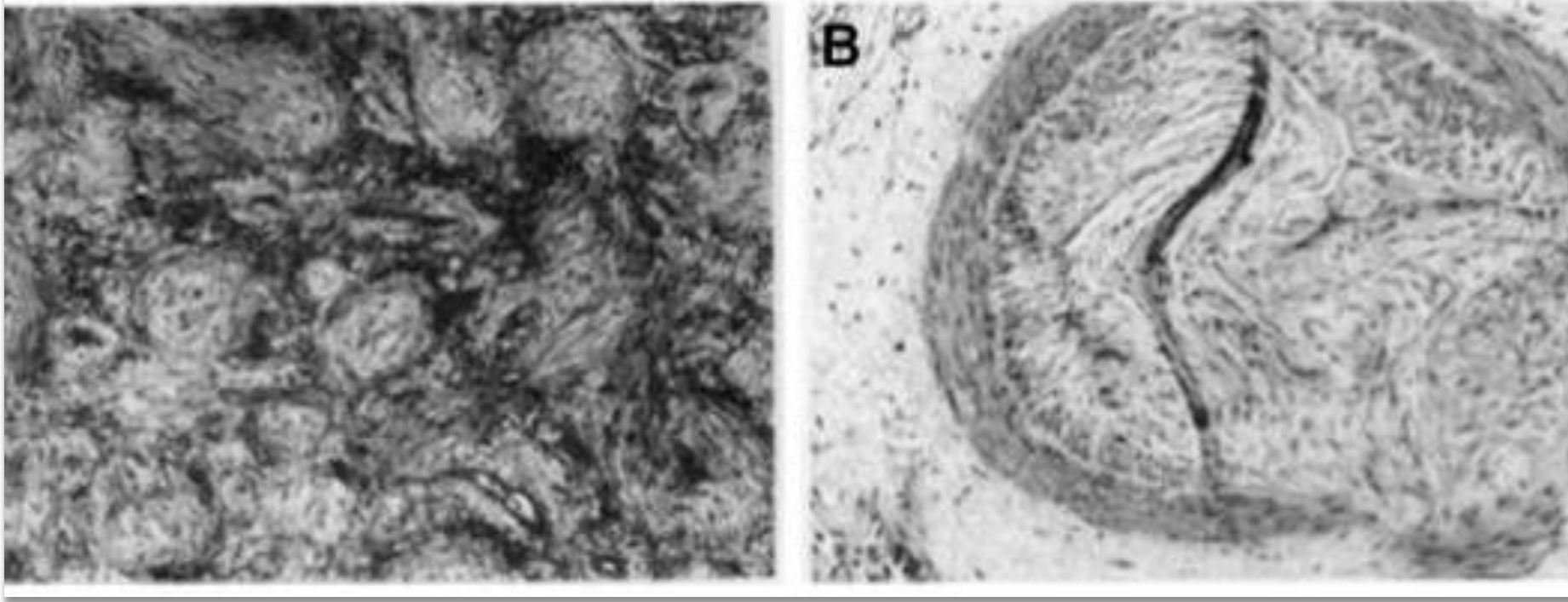
These are categories of shunting or perfusion in excess of ventilation.

## Lung Compliance

- A Dynamic compliance of 40 cmH<sub>2</sub>O or less
- Increased Peak End Expiratory Pressures of >10 cmH<sub>2</sub>O

## Radiographic Findings

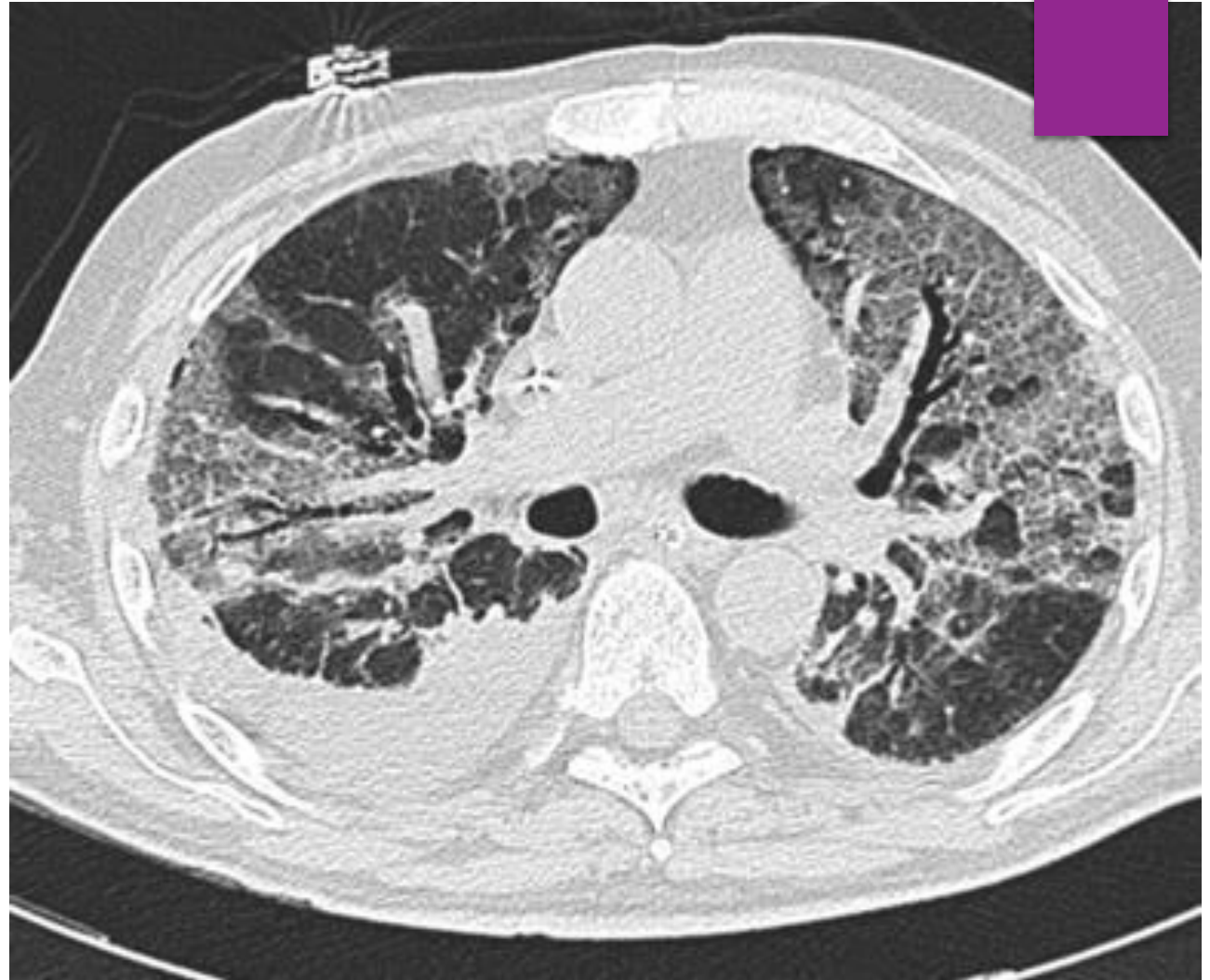
- Severity of the opacities and infiltrates.
- Presents itself as Bilateral diffuse Pulmonary edema.



Histologic findings of hematoxylin-eosin staining at open-lung biopsy in a patient with acute respiratory distress syndrome. The photomicrograph shows myxoid fibrosis, fibroblastic and inflammatory cell infiltration of the interstitium, and scattered collapsed alveoli (A) and subintimal deposition of loose myxoid collagen in an arteriole (B). American College of Chest Physicians and adapted from Meduri GU et al. Chest 1994; 105:1516–27

# Damage to Lung Parenchyma due to ARDS

► Typical computed tomography features of acute respiratory distress syndrome showing: non-homogeneous distribution, a ventro-dorsal gradient of density, more dense consolidation in the dependent regions, widespread ground-glass opacities associated with thickening of interlobular septa (crazy paving), and pleural effusion

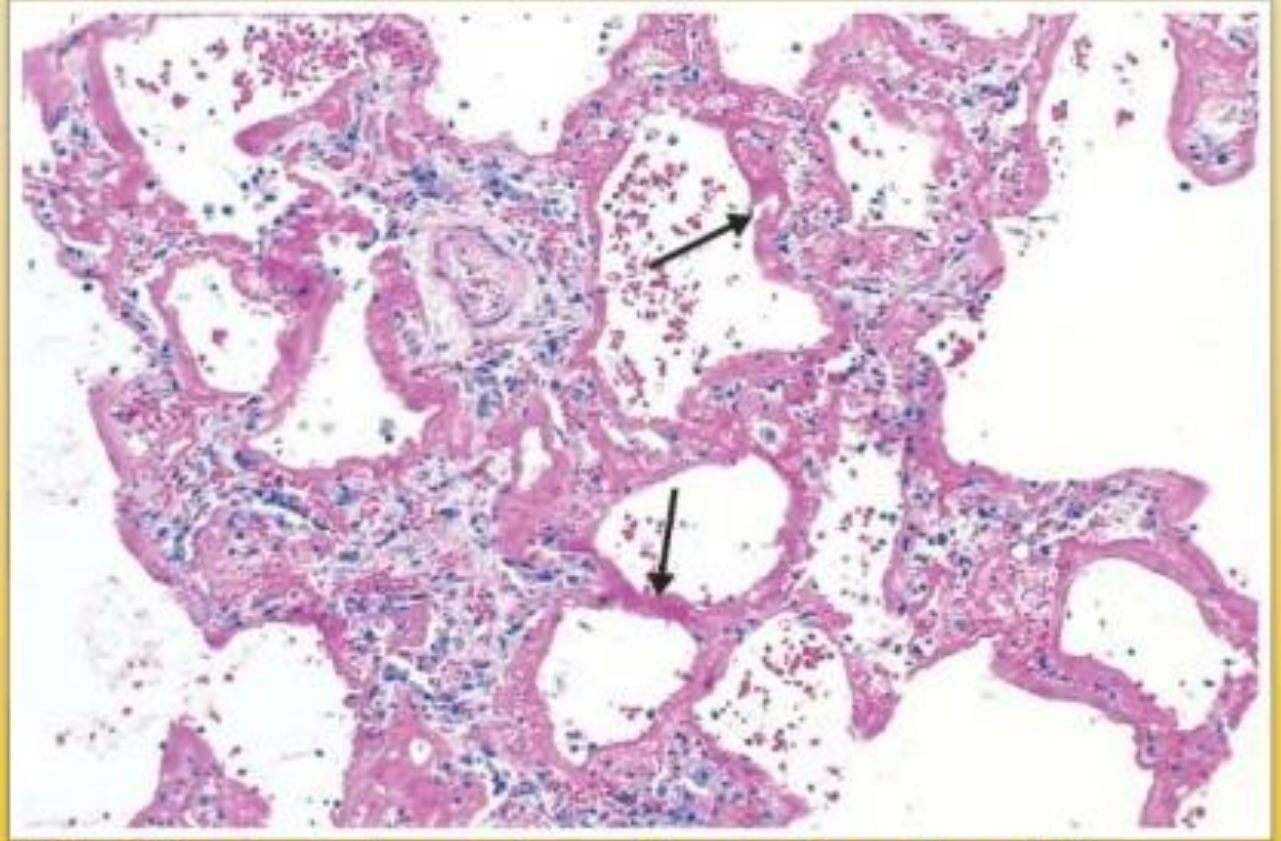


Maurizio Zompatori, Federica Ciccicarese, Luca Fasano  
European Respiratory Review 2014 23: 519-530; DOI:  
10.1183/09059180.00001314



# Alveolar damage in ARDS

## HISTOLOGY :



**Fig. : Diffuse alveolar damage. Some of the alveoli are collapsed; others are distended, and many are lined by hyaline membranes (arrows).**

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What is High  
Frequency Percussive  
Ventilation?

**ACCORDING TO SALIM ET AL. ,” HIGH-FREQUENCY PERCUSSIVE VENTILATION IS A TIME-CYCLED, PRESSURE-LIMITED MODE OF VENTILATION THAT DELIVERS SUBPHYSIOLOGIC TIDAL VOLUMES AT RATES THAT CAN EXCEED 500 BREATHS/MIN.”**

## What is High Frequency Oscillatory Ventilation?

- ▶ Defined by Birch et al. “High frequency oscillatory ventilation (HFOV) is a type of mechanical ventilation that uses a constant distending pressure (mean airway pressure [MAP]) with pressure variations oscillating around the MAP at very high rates (up to 900 cycles per minute).”



# CONVENTIONAL VENTILATION

- ▶ Conventional Ventilation has been noted by Ferguson et al. in The New England Journal of Medicine to promote, “Repetitive overstretching or collapse of lung units with each respiratory cycle can generate local and systemic inflammation, contributing to multiorgan failure and death.”
- ▶ Chiumello et al. believe that “Injury due to mechanical ventilation has been attributed to excessive pressure (barotrauma) or volume (volutrauma) applied to the lung parenchyma, to shear stresses occurring in the interface of open and closed lung regions (atelectrauma, and to cellular inflammatory response (biotrauma).”

# HIGH FREQUENCY VENTILATION

- ▶ Hurst et al. “High-frequency ventilation has been reported to cause less circulatory interference than conventional mechanical ventilation, reduce air leaks in bronchopleural fistulae, and create similar of improved gas exchange at lower airway pressures.”
- ▶ A study by Chan et al. also proved that the early implication of HFOV increases survival based on the patients in the study who were placed on conventional ventilation for longer durations prior to switching to high frequency oscillatory ventilation, which led to a 47% mortality rate. This method is a growing trend amongst hospital platforms to be more aggressive in fighting the early detection of ARDS.

## Popular Models

### The *Percussionaire* Servolator Percussionator (VDR)



“Critical Care.” Percussionaire, Percussionaire Corp., 2018, [percussionaire.com/critical-care/](https://percussionaire.com/critical-care/).

# 3100A Oscillator

<https://www.oxygen-care.com/product/sensormedics-3100a-hfov>



# Mortality in Patients using High Frequency Percussive or Oscillatory ventilation

## **“OSCILLATE”**

Tested 548 patients on both conventional and high frequency ventilation.

- Patients with refractory hypoxemia were placed on HFV and others were placed on conventional ventilation with low volumes and pressures.
- The trial was ultimately withdrawn because of its increase in mortality.
- Lengths of stay were comparable but there was no evidence that HFV was beneficial over CV.



# Mortality in Patients using High Frequency Percussive or Oscillatory ventilation

## “OSCAR”

- ▶ Trial tested 795 patients both on conventional and high frequency ventilation.
- ▶ The patients in the HF group had high rates of inpatient death then those in the control group by 0.06%.
- ▶ Later in this trial out of the patients that were discharged, 50% of the HFOV had died compared to the conventional group with 48%.

# Mortality in Patients using Conventional Ventilation

- A study conducted by Hurst et al., places HFV as comparable to conventional ventilation with no notable change in morbidity or mortality.
- Studies by Papazian et al. have begun to show that by applying high frequency percussive and oscillatory ventilation to patients in a prone position, we reduce inflammation and improve oxygenation, opposed to being in a supine position that exacerbates inflammation and has less effect on oxygenation.<sup>10</sup>

# Conclusion

- ▶ Creating a systematic way to ventilate a population of critically ill patients is always determinant on those patient's health; Patients are never the same and so all results are subject to that scrutiny. Advances and research are being created more frequently than they ever have and our understanding and treatment of this syndrome will only excel. For now, mortality in ARDS without any intervention is especially high, and the evidence varies on the topic of whether High Frequency Percussive and Oscillatory Ventilation will increase or decrease mortality rates in ARDS patient populations.



Thank You for Your Time

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