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Acute Respiratory Distress Syndrome (ARDS)

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Abstract

It is a syndrome characterized by increased alveolo-capillary membrane permeability, diffuse alveolar damage, alveolar edema due to accumulation of protein-rich fluid. ARDS has an acute onset. Typically it develops within 24-48 hours and lasts for days or even weeks. Ventilation with low tidal volumes, plato pressures <30 cm H20, adjust PEEP to keep Pa02 above 55 mmHg, Sa02 88% to maintain oxygenation, pH 7.25 to keep Fi02 60% or less, (even 7.20), it does not interfere with the high values of PaC02, increase the number of respiration if necessary to decrease PaC02, High PEEP application, sedation and, if necessary, neuromuscular paralysis decrease mortality. ARDS net and open lung systems are applied for mechanical ventilation. ARDS is the most vulnerable pathological process due to ventilator lung damage due to its low lung compliance and heterogeneous nature. Therefore, alveolar recruitment should be provided with PEEP by keeping the peak alveolar pressure below 30 cm H2O.Peak alveolar pressure should be at a level that does not overdistate. Overdistension causes hemodynamic depression, impaired gas exchange in the lungs, alveolar surfactant loss. Cyclical opening and closing of unstable lung units should be prevented by providing recruitment with PEEP. Opening and closing of the alveoli causes increased cytokine release and causes biotrauma. It can also cause rupture of the alveoli by creating shear-stress between the collapsed and opened areas. Apart from mechanical ventilation, inhaled nitric oxide and partial liquid ventilation can also be applied.

Keywords: ARDS; LUNG; Ventilation

1994 American-European Consensus Report [1]

a. Acute onset

b. PaO2 / FiO2 ≤ 200 mmHg (regardless of PEEP level)

c. Bilateral infiltration on lung radiography

d. PCWP ≤ 18 mmHg or absence of clinical signs of left atrial hypertension

Berlin Criteria in the Diagnosis of Ards [2]

1. Timing: ARDS developing within 7 days

2. Lung X-Ray: Unexplained bilateral infiltrations with effusion, collapsed lung or lung nodule. If edema risk factor cannot be determined, additional evaluations such as echocardiography

Oxygenation

1. Light: 200 <PaO2 / FiO2, <300 + PEEP or CPAP≥5 cmH2O

2. Medium: 100 <PaO2 / FiO2 <200 + PEEP ≥5 cmH2O

3. Heavy: PaO2 / FiO2 ≤100 + PEEP ≥5 cmH2O

Non-Mechanical Ventilation Treatments

1. **Inhaled nitric oxide [3]**: It consists of L-arginine, NADPH and oxygen by activation of nitric oxide synthetase. It is rapidly distributed to ventilated areas and improves the perfusion rate of ventilation by pulmonary vasodilation. Since it has no effect on long-term results in ARDS, it has no place in standard treatment, but it can be used as a rescuer in cases with no response.

2. Pron position: fixes oxygenation, no effect on survival

3. Negative fluid balance: improves oxygenation indexes, increases day without ventilator and day

without intensive care but no effect on survival

4. **Partial liquid ventilation (PLV) [4]**: Conventional gas ventilation is performed after the lungs are filled with carrier fluid.

The Carrier is a Liquid Perfluorocarbon

a. carries acceptable oxygen (63ml / dl)

b. carbon dioxide carrying capacity is very high (210 ml / dl)

c. low surface tension (18 dynes / cm) high density 1.92 gr / ml)

d. Since the evaporation pressure is high (11 mmHg), the first 24% (90% hourly) evaporates from the lungs.

e. colorless, odorless, insoluble in water, biologically inert, chemically

Stable.

f. For the effect to continue, the lungs must be filled every 3 hours.

g. has anti-inflammatory effect

h. Compressions and debris due to their insolubility in water and high density mobilizes from central to central

PLV is also called liquid PEEP because it makes alveolar recruitment. Since the density is high, the gravity that needs to be advertised is distributed from thedepen; thus, the improved V / P ratio causes an improvement in oxygenation. ARDS is the most vulnerable pathological process due to ventilator lung damage due to its low lung compliance and heterogeneous nature. For this reason, alveolar recruitment should be provided with PEEP by keeping the peak alveolar pressure below 30 cm H2O. Peak alveolar pressure should be at a level that does not overdistate. Overdistension causes hemodynamic depression, impaired gas exchange in the lungs, alveolar surfactant loss. Cyclical opening and closing of unstable lung units should be prevented by providing recruitment with PEEP. Opening and closing of the alveoli causes increased cytokine release, causing biotrauma. It can also cause rupture of the alveoli by creating shear stress between the collapsed and opened areas.

Mechanical Ventilation in ARDS

With hypoxemia, respiratory work has increased. Oxygenation should be corrected by using high PEEP and FiO2 initially and by reducing respiratory work.

Generally, CPAP and NIV are not recommended.

There are 2 types of approach:

Open-Lung Approach

a. PC ventilation is applied

b. Low plateau pressure is targeted by monitoring the Vt.

c. Recruitment maneuvers and high PEEP are used to provide maximal alveolar recruitment.

ARDS Net Approach

a. Low Vt is provided by monitoring plateau pressure.

b. PEEP is titrated according to FiO2.

Open-Lung Approach [5]

A specific pressure is targeted with PCV

a. 4-8 ml / kg Vt is provided, which keeps the peak alveolar pressure between 25-30 cm H2O. In this case permissive hypercapnia may occur, the number of breaths can be up to 35 / min.

b. Recruitment maneuver is performed before PEEP can be adjusted. 10-20 cm H2O PEEP is applied for alveolar recurrence.

c. PEEP is set more than necessary at the start and is reduced to a minimal level that ensures alveolar recurrence

d. FiO2 is adjusted before PEEP titration to achieve values above target PaO2 and SaO2. High alveolar pressures are worse than high FiO2 values.

e. If PEEP and alveolar recruitment does not work, Pron position is applied.

MOD: Assist-control, early and recovery phases PS

Volume / Pressure: Pressure control

Frequency: It can be as much as 35 / min; Avoid otoPEEP

Vt: 4-8 ml / kg or plateau pressure <30 cm H2O

Inspirium Time:

- if the patient is triggering it must be synchronized

- use short end-inspiratory pause in passive ventilation (0.1-0.3 sec)

PEEP: 10-20 cm H2O

FiO2: based on target PaO2 and SaO2

Pmean: smallest value for target SpO2 (usually 20-25 cm H2O)

Open-Lung Algorithm (Figure 1)

Gas exchange and pressure targets in OPEN-LUNG approach

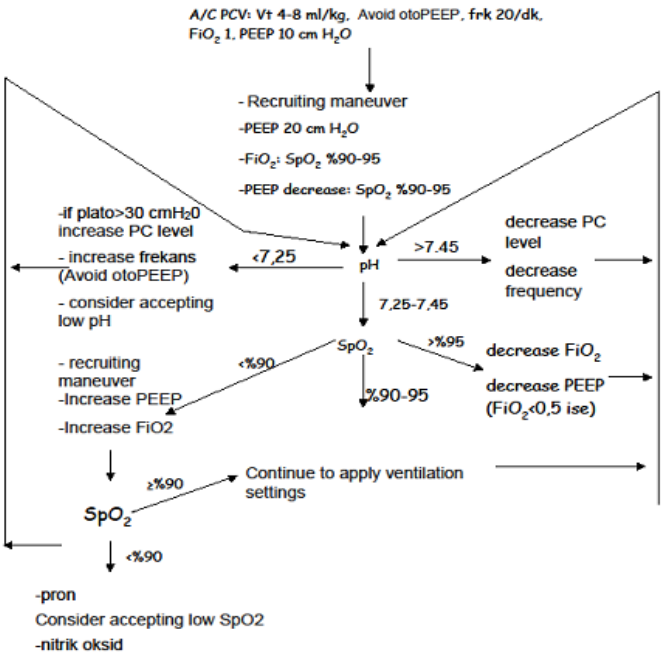

Figure 1: Open-Lung Algorithm.

i. **PaO2:** ALI…> 70 mmHg

Moderate ARDS…. > 60 mmHg

Serious ARDS… ..> 50 mmHg

ii. **PaCO2:** 40 mmHg possible Permissive to avoid high alveolar pressures hypercapnia

iii. **PEEP:** Alveolar recruitment is provided when necessary (10-20)

iv. **Pplato:** <30 cm H20 the value that ensures normal chest compliance

Oxygenation management in OPEN-LUNG approach

Initial settings

FiO2… .. 1

PEEP …… 10 cm H2O

Recruiting maneuver

Increase to PEEP 20

Decrease FiO2 until SpO2 is 90-95%

Reduce PEEP until SpO2 is 90-95%

Next settings

a. Apply PEEP to provide alveolar recurrence.

b. Give as much FiO2 as needed

c. Evaluate the pron position

d. evaluate plateau pressure regularly

ARDS Net Approach [6]

In this approach, Vt is restricted using VC ventilation in the acute phase. Target Vt is 6 ml / kg and varies between 4-8 mg / kg. Target plateau pressure is 25-30 cmH2O. PEEP is determined based on PaO2 and FiO2 based on the FiO2 / PEEP relationship. The target pH is 7.30-7.45 and for this purpose, the frequency can be increased up to 35 / min.

ARDS Net Approach Protocol

Initial Settings

a. Calculating the predicted body weight

a. male: 50 + 2.3 (height (inch) - 60) kg

b. female: 45.5 + 2.3 (height (inch) - 60) kg

b. Mode: volume assist / control

c. Vt: 8 ml / kg

d. Vt is reduced to 7 ml / kg in 1-2 hours and to 6 ml / kg in the following 1-2 hours. to. Frequency is increased to provide minute ventilation to baseline (max 35 / min)

Following Vt Settings

a. Target plateau pressure <30 cm H2O

b. Evaluate the inspiratory plateau pressure at least every 4 hours or with 0.5 s pause every PEEP and Vt change:

I. If Pplato> 30; Reduce Vt to 5 ml with 1 ml / kg pieces and to 4 ml / kg if necessary

II. If Pplato <25 and Vt <6 ml / kg Pplato> 25 or Vt is increased by 1 ml / kg pieces until Vt = 6 ml / kg

III. If the respiratory rate increases or severe dyspnea occurs and Pplato is still <30 Vt can be increased to 7-8 ml / kg (not mandatory)

Arterial Oxygenation

a. Purpose: PaO2 = 55-80 mmHg, SpO2 = 88-95%

b. The FiO2 / PEEP combination is used for this purpose:

FiO2 / PEEP .... 0.3-0.4 / 5, 0.4-0.5 / 8, 0.5-0.7 / 10, 0.7 / 12-14, 0.8-0.9 / 14, 0.9 / 16-18, 1 / 18-24

Respiratory rate and arterial pH

a. Target pH: 7.30-7.45

b. Acidosis management:

i. Frequency is increased until pH <7.30 or PaCO2

<25 mmHg (max 35)

ii. If the frequency is 35 and pH <7.30, sodium bicarbonate can be given (not mandatory)

iii. If pH <7.15, the frequency is increased to 35, and if pH <7.15, bicarbonate is given, Vt is increased by 1 ml / kg pieces until the pH> 7.15 (target plateau pressure surmountable)

c. Alkalosis management (pH> 7.45): the mandatory frequency is reduced until the patient frequency is higher than the set frequency (min set 6 / min)

d. I / E ratio: target 1 / 1- 1/3. Flowu and pattern are adjusted according to the purpose

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Maneuvering Types

i. Sustained Inflation: Ventilator CPAP or sponton mode (mandatory breath = 0) 30-40 cm H2O CPAP is applied for 40 seconds. In order to reach the lowest possible intrapulmonary shunt ratio, it has been suggested to increase the CPAP value up to 50. This method has not been widely accepted.

ii. PCV with high PEEP value: 10-12 mandatory frequency and 20 cmH2O PEEP pressure controlled ventilation is applied, PEEP is increased until PIP is at least 40 cmH2O and this PEEP value is maintained for 40-60 seconds. Then, pressure-controlled ventilation is continued by decreasing the PEEP value to protect it from the degree.

iii. PCV with increased PEEP: PEEP is increased by 5 cmH2O pieces, each lasting 2-5 minutes. Example: PC level 20, baseline PEEP 20, PIP 35, mandatory frequency 10, I / E 1/1 ……. PEEP is increased by keeping other parameters constant.

iv. Sigh (Sigh):

a. three consecutive 45 cm H2O plateau pressures per minute

b. Increasing the PEEP value of 2 breaths every 30 seconds from 10 to 16 cmH2O (Vt constant)

c. Increasing the value of PEEP by reducting Vt as with steps in a few minutes

vt; ..2 ..4 .... 8 6 0.

PEEP; 10 15 ..... .20 ....30 ..... 25 ...

v. APRV, HFOV

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