RECENT APPROACHES IN MANAGEMENT OF ADULT RESPIRATORY DISTRESS SYNDROME / ACUTE LUNG INJURY

An Essay
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الطرق الحديثة فى معالجة متلازمة الضيق التنفسي الحاد والإصابة الحادة للرئة

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Summary

Acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) are both defined by the acute onset of bilateral infiltrates consistent with pulmonary edema, but without evidence of elevated left atrial pressure. The severity of the hypoxemia distinguishes ARDS from ALI, being in ARDS an arterial oxygen tension to fraction of inspired oxygen ratio (PaO_2/FiO_2) of 201 to 300 mmHg, while in ALI PaO_2/FiO_2 of $\leq$200 mmHg

The initial courses of ALI and ARDS are characterized by pulmonary abnormalities that typically develop within 48 hours of the inciting event and rapidly worsen. These include dyspnea, tachypnea, and hypoxemia. Physical examination usually reveals tachycardia, cyanosis, tachypnea, and diffuse rales, while arterial blood gases usually detect an acute respiratory alkalosis, hypoxemia, and an elevated alveolar-arterial oxygen gradient. The initial chest radiograph typically has bilateral, fluffy alveolar infiltrates with prominent air bronchograms. Mechanical ventilation is almost universally required.

Following the initial period, most patients with ALI and ARDS exhibit better oxygenation and decreasing alveolar infiltrates on the chest radiograph. However, some have persistent interstitial infiltrates and ventilator-dependence.

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List of Abbreviation

AECC	American-European Consensus Committee
ALI	Acute lung injury
APC	Activated protein C
APRV	Airway pressure release ventilation
ARDS	Acute respiratory distress syndrome
AT	Antithrombin
AT II	Angiotensin II
$AVCO_2R$	Arteriovenous carbon dioxide removal
BAL	Bronchoalveolar lavage
BIPAP	Biphasic positive airway pressure
BMI	Body Mass Index
BNP	Brain Natriuretic Peptide
BOOP	Bronchitis Oblitrans with Organizing Pneumonia
BVV	Biological Variable Ventilation
Ca2+	Calcium
C-GMP	Cyclic guanosine monophosphate
CHF	Congestive heart failure
CO_2	Carbon dioxide
COP	Cryptogenic organizing pneumonia
CPAP	Continous positive airway pressure
CT	Computed tomography
CVCs	Central venous catheters
CVP	Central venous pressure
DAD	Diffuse alveolar damage
DVT	Deep Venous Thrombosis
EC	Endothelial cell
$ECCO_2R$	Extracorporeal CO_2 removal

ECMO	Extra corporeal membrane oxygenation
EELV	End Expiratory Lung Volume
ET-1	Endothelin-1
$ETCO_2$	End tidal CO_2
ETT	Endotracheal tube
FACTT	Fluid and Catheter Treatment Trial
FDA	Food and Drug Administration
F_iO_2	Fraction of inspired Oxygen Concentration
FRC	Functional residual capacity
GRV	Gastric Residual Volume
HFOV	High-frequency oscillation ventilation
HFPPV	High-frequency positive pressure ventilation
HFPV	High-frequency percussive ventilation
HFV	High-Frequency Ventilation
I: E ratio	Inspiration: expiration ratio
IAEP	Idiopathic Acute Esinophilic Pneumonia
IBW	Ideal body weight
ICAM-1	Intercellular adhesion molecule-1
ICP	Intra cranial pressure
ICU	Intensive care unit
IGF-1	Insulin like growth factor -1
IL	Interleukins
IRV	Inverse ratio ventilation
KGF	Keratinocyte growth factor
KGFR	Keratinocyte growth factor receptor
LIP	The lower inflection point
LIPS	Lung Injury Prediction Score
LIS	Lung Injury Score
MAP	Mean arterial blood pressure

MODS	Multi-organ Dysfunction Syndrome
MOF	Multi-organ failure
NAC	N-acetylcysteine
$NaHCO_3$	Sodioum bicarbonate
NIH	National Institute Of Health
NIV	Non-invasive ventilation
NO	Nitric oxide
OLB	Open lung biopsy
P_aCO_2	Partial Pressure of Carbon Dioxide in Arterial blood
PaCO2	Partial pressure of Carbon Dioxide in arterial blood
PACs	Pulmonary artery catheters
PAF	Platelet activating factor
PAI	Plasminogen activator inhibitor
P_aO_2	Partial pressure of Oxygen in arterial blood
PAOP	Pulmonary artery occlusion pressure
PCV	Pressure Controled Ventilation
PCWP	Pulmonary capillary wedge pressure
PE	Pulmonary Embolism
PEEP	Positive end-expiratory pressure
PGI_2	Prostacyclin
Plt	Platelet
PLV	Partial liquid ventilation
PMNs	Polmorph nuclear granulocytes
PMP	Polymethylpentane
Pplat	Plateau pressure
PS	Pressure support
PV	Pressure–volume
RBC	Red blood cell
RM	Recruitment Maneuver

RNS	Reactive Nitrogen Species
ROS	Reactive Oxygen Species
RR	Respiratory rate
SaO2	Haemoglobin Oxygen Saturation in arterial blood
SH	Thiol group
SIRS	Systemic Inflammatory Response Syndrome
SP	Surfactant protein
SpO2	Arterial O_2 saturation
TBLB	Transbronchial lung biopsy
TFPI	Tissue factor pathway inhibitor
TGI	Tracheal gas insufflations
TLV	Total Liquid Ventilation
TNF-α	Tumor necrosis factor α
TRIM	Timed rexpansion inspiratory manoeuver
TV	Tidal volume
TX	Thromboxane
UIP	The upper inflection point
V/Q ratio	Ventilation /perfusion ratio
VA	Venoarterial
VALI	Ventilator associated lung injury
Vd/Vt	Dead space ventilation
VEGF	Vascular Endothelial Growth Factor
VILI	Ventilator-induced lung injury
VSMC	Vascular Smooth Muscle Cells
VV	VenoVenous

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Introduction

Acute respiratory distress syndrome (ARDS) and acute lung injury (ALI) were first described in 1967, and are characterized by the abrupt onset of clinically significant hypoxaemia (when partial arterial pressure of oxygen [PaO2]/fractional concentration of oxygen in inspired air [FIO2] <300, the disorder is termed ALI and when PaO_2/FIO_2<200, the disorder is termed ARDS), with presence of bilateral diffuse pulmonary infiltrates on radiograph.These disorders affect patients of all ages and usually happen soon after an easily identified triggering event ***(Wheeler and Gordon, 2007).***

Acute lung injury and acute respiratory distress syndrome, the most severe stage of ALI, are associated with intra- and extra-pulmonary disorders, including infection, aspiration, trauma, and drug overdose. Mechanical ventilation is the cornerstone of supportive therapy ***(Delong et al., 2006).***

However, despite several important advances, including smaller tidal volumes and higher levels of positive end-expiratory pressure (PEEP), profound hypoxemia is difficult to overcome and mortality rates remain high ***(Zambon and Vincent, 2008).***

Population-based epidemiological study of ALI and ARDS in the United States using standardized definitions

showed an estimated incidence of ALI of 78.9 per 100,000 person-years. The incidence of ARDS was estimated as 58.7 per 100,000 person-years. The incidence of ALI increased dramatically with age, with an incidence of 306 per 100,000 Person/years for ages 75 through 84 years ***(Fishman and William, 2007).***

Pathophysiology in the early phase of acute lung injury show leakage of oedema fluid into the lung and inflammatory cellular infiltrates cause diffusion abnormalities and ventilation perfusion mismatch, which clinically manifest as hypoxaemia. Concurrently, cellular infiltration, diffuse atelectasis, and oedema fluid reduce thoracic compliance ***(Wheeler and Gordon, 2007).***

Management of patients with ALI and ARDS aims to maintain oxygenation, by using nontoxic FiO_2 (<0.7), PEEP, and mechanical ventilation, protective ventilatory strategy by adopting a low tidal volume, high PEEP with a limit (≤30 cm H_2O) on static end-inspiratory airway pressure (plateau pressure) to guard against barotrauma, enhance patient-ventilator synchrony and patient comfort by use of sedation, amnesia, opioid analgesia, and pharmacological paralysis, support or treat other organ system dysfunction or failure, general critical care (preventive and homeostatic measures) and adequate early nutritional support ***(Fishman and William, 2007).***

Aim of the Work

Our study aims at discussing the most important causes of ARDS, explaining how to diagnose, the pathopyisiology and presenting the new concepts of mechanical ventilation in ARDS and current controversies.

Definitions & Epidemiology

- **Definitions of ARDS**

Criteria for ARDS: the presence of severe dyspnea, tachypnea, cyanosis that is refractory to oxygen therapy, loss of lung compliance and diffuse alveolar infiltration on chest x-ray ***(Ashbaugh and Petty, 1967)***. A PaO_2/FiO_2 ratio lower than 150 to define the level of hypoxemia needed to classify patients as affected by ARDS ***(Bone et al., 1979)***.

In ***1979, National heart, Lung and Blood Institute*** revised the criteria and defined them more strictly as to select patients to be enrolled in a collaborative study. Two operative definitions to select patients with ARDS were designed: the first to enhance specificity (not including temporary conditions) - the fast entry criteria - included a PaO_2 lower than 50 mmHg for more than two hours with a FiO_2 equal to 1 and a PEEP level equal to or higher than 5 cm H_2O; the second, not to limit sensibility (including very severe cases) - the slow entry criteria - included a PaO_2 lower than 50 mmHg for more than twelve hours with a FiO_2 equal to 0.6, a PEEP level equal to or higher than 5 cm H_2O and a shunt fraction higher than 30% after 48 hours of maximal medical therapy ***(National heart, Lung and Blood Institute, 1979)***.