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Should APRV be used for patients with ARDS?

Pro: APRV should be used for ARDS

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Conflicts of Interest

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- I have no real or perceived conflict of interest that relates to this presentation. Any use of brand names is not in any way meant to be an endorsement of a specific product, but to merely illustrate a point of emphasis.

Let's jump right in!

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Should Airway Pressure Release Ventilation Be the Primary Mode in ARDS?

Eduardo Mireles-Cabodevila MD and Robert M Kacmarek RRT PhD FAARC

RESPIRATORY CARE • JUNE 2016 VOL 61 NO 6

The benefit in lung injury…

- APRV (due to inverse I-E ratio) has higher mean airway pressure (MAP)→ when compared to conventional "lung-protective" MV settings
  - Higher mean airway pressure = higher PaO_2
  - Higher I-time (T_{high}) leads to lower $PaCO_2$ (due to decrease in deadspace)
- Lower peak pressure for a given oxygenation goal

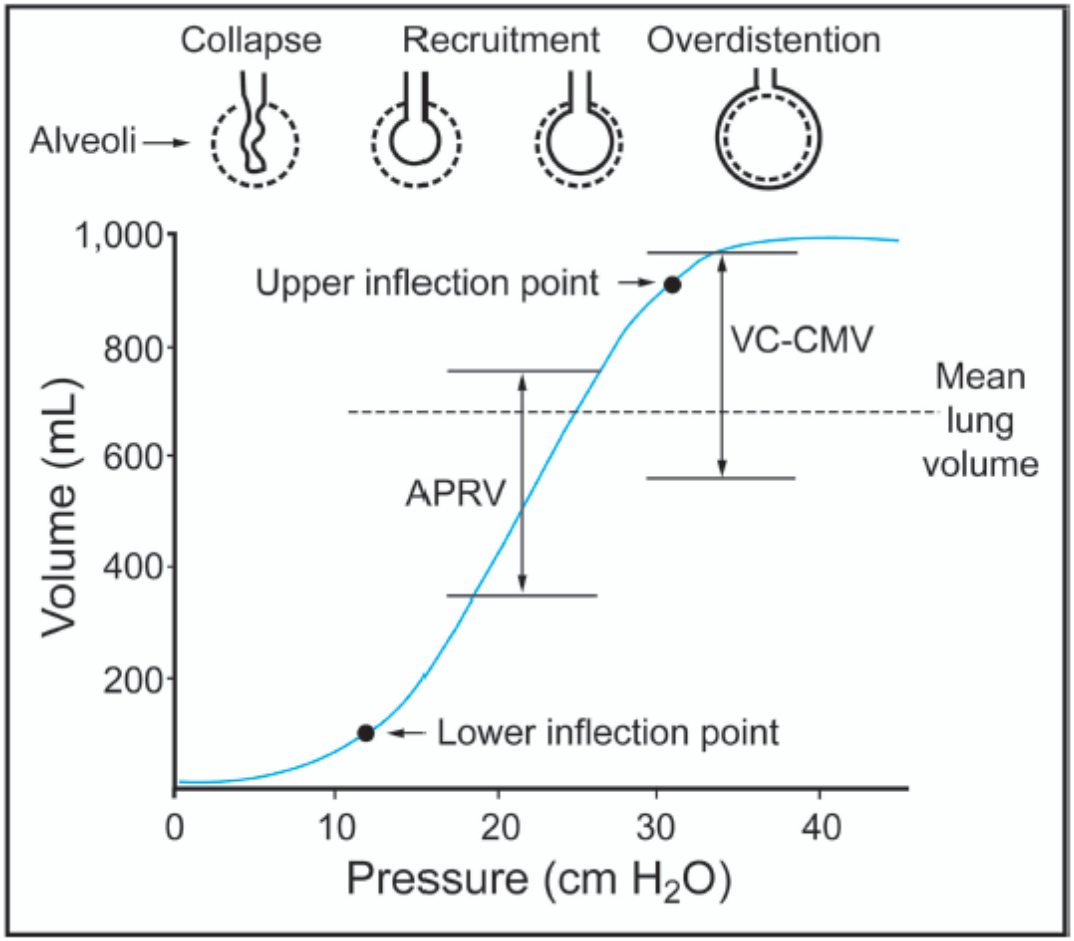
- Lower peak pressure may translate to a lower peak transpulmonary pressure
  - In passive conditions

- **<u>Bottom line</u>:** APRV can optimize gas exchange while reducing risk of lung injury

Crit Care Med 1991;19(10):1234-1241.

Less risk of lung injury…

- Vt is generated by pressure difference from PEEP to inspiratory pressure (P_{low} to P_{high})
- Achieving equivalent mean lung volumes in conventional MV vs. APRV requires higher PEEP
  - Same tidal volume has higher end-inspiratory volume→ which may cause overdistension



Respir Care 2016 61(6):761-773

Auto-PEEP is better than your PEEP!

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- APRV uses short release times to generate PEEP
- In animal models (rats), PEEP generated by a short T_{low} leads to more gas in the alveoli vs. conventional PEEP, where gas is more in the conducting airways

J Am Coll Surg. 2014 Nov;219(5):968-76

Spontaneous breathing…

- APRV allows for spontaneous breathing
  - Allows diaphragm to stay active
    - Improve gas exchange
  - Less sedation/less paralyzation
  - Spontaneous breathing *may* be more comfortable

Decreased Work of Breathing…

- APRV leads to:
  - Alveolar recruitment
  - Improve functional residual capacity
  - Reduced elastic work of breathing

Early application of airway pressure release ventilation may reduce mortality in high-risk trauma patients: A systematic review of observational trauma ARDS literature

Penny L. Andrews, RN, BSN, Joseph R. Shiber, MD, Ewa Jaruga-Killeen, PhD, Shreyas Roy, MD, CM, Benjamin Sadowitz, MD, Robert V. O'Toole, Louis A. Gatto, PhD, Gary F. Nieman, BA, Thomas Scalea, MD, *and* **Nader M. Habashi, MD,** *Baltimore, Maryland*

(*J Trauma Acute Care Surg*. 2013;75: 635–641

CONCLUSION

Our results suggest that early application of APRV in high-risk trauma patients can significantly reduce ARDS incidence and mortality. These findings warrant further research because this is a potential breakthrough from treatment of an established syndrome to prevention before ARDS develops.

Characteristics and outcomes of patients treated with airway pressure release ventilation for acute respiratory distress syndrome: A retrospective observational study☆

Jolene Lim, MBBS (Hon) [a,1], Edward Litton, MB, ChB, MSs, FCICM [b,c,*], Hayley Robinson, BMedSci (Hon), MBBS (Hon) [d], Mike Das Gupta [e,2]

Journal of Critical Care 34 (2016) 154–159

Conclusions: In patients with ARDS-related refractory hypoxaemia treated with APRV, an early and sustained improvement in oxygenation, low incidence of clinically significant barotrauma and progression to ECMO was observed. The safety and efficacy of APRV requires further consideration.

To conclude…

- APRV can:
  - Decrease peak airway pressure
  - Improve alveolar recruitment
  - Increase ventilation in dependent lung zones
  - Improve oxygenation

- ARDS mortality still high ~35-46%
- This despite:
  - Low tidal volumes (ARDSnet)
    - Supportive since 2000
  - Prone Position
    - Newer data that is supportive
  - HFOV
    - Poor data
  - ECMO
    - Emerging data
  - iNO/inhaled agents
    - Poor data

- APRV is on most ventilators, may offer benefit

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IDENTIFYING THE OPTIMAL MECHANICAL BREATH PROFILE:

AN ANIMAL CASE STUDY IN VENTILATION APPROACHES TO THE ARDS LUNG MODEL, A CONSENSUS BY THE INDIVENT WORK GROUP

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Background

ARDS continues to be associated with high mortality since early recognition and institution of lung protective ventilation remains a significant challenge in the ICU. Recent literature suggests that mechanical ventilation (MV) should be individualized. Identifying the optimal mechanical breath profile (MBp) could theoretically decrease the incidence of ARDS. Our Individualized Mechanical Ventilation (IndiVent) Work Group convened to discuss current concepts and trends in ARDS mechanical ventilation (MV) management.

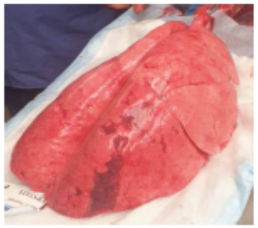
Methods

Our group consisted of 14 respiratory care professionals from the US and Canada. Over two days, the group discussed concepts related to the optimal MBp and conducted an animal case study in ARDS. Three Yorkshire pigs, instilled with Tween for induction of ARDS, were used as a case study for three approaches to MV management (ARDSnet with High PEEP, ARDSnet with recruitment maneuvers, and Airway Pressure Release Ventilation). Teams discussed how the strategy was used to protect the lung, advantages and disadvantages, and questions related to its use. Perceived barriers to the implementation of lung protective ventilation and the concept of preventing ARDS with a personalized MBp were deliberated. The work group developed consensus statements and responses to key questions for optimizing the MBp, ARDS prevention and MV management.

Discussion

Consensus statements coalesced into three broad concepts:

1) **Preemptive protective ventilation should be implemented early**
   Patients at risk for developing ARDS should be prospectively identified and known protective MV strategies instituted earlier.
2) **Macroventilation is not the same as microventilation**
   Conventionally monitored parameters are not necessarily reflective of processes taking place at the alveolar level.
3) **The MBp for each patient should be individualized.**
   The specific components of a MBp, customized to be protective for each individual patient, may prevent ARDS onset but are not yet fully elucidated.



Conclusion

The development of more reflective and clinically feasible monitoring tools is warranted. An early preventive approach to ARDS management deserves much more consideration.

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A QUEST TO FINDING THE OPTIMAL MECHANICAL BREATH PROFILE FOR THE MANAGEMENT OF ARDS: A PILOT ANIMAL STUDY

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Background

Although ARDS mortality has been reduced significantly since 1967, there has been no further decrease in mortality since 1998, and remains >40%. Early application of low volume ventilation and open lung approach have been promoted as the best strategies to manage ARDS. Identification of the optimal mechanical breath profile (MBp) to obtain lung protection has proven more difficult than anticipated. The purpose of this animal study was to evaluate three different approaches to optimize mechanical ventilation after induction of lung injury.

Methods

Three Yorkshire pigs were anesthetized, surgically instrumented and placed on mechanical ventilation with a tidal volume (Vt) of 10mL/kg, PEEP of 5cmH_2O, and FiO_2 1.0. Following lung injury by Tween instillation they were separated into 3 groups: ARDSnet low tidal volume and High PEEP (LVt/High PEEP), LVt plus recruitment maneuvers (LVt+RM), and airway pressure release ventilation (APRV). A group of 14 clinicians (LVt/High PEEP=5; LVt+RM= 5; APRV=4) from different centers in the US and Canada were responsible for the ventilator management of each animal for 5h. Ventilator changes during the study were made after reaching consensus. ABGs were obtained at baseline, after lung injury, and every hour. Driving pressures (Driving P), Vt, lung compliance (Cst), mean arterial pressure (MAP), and P/F ratios were recorded every hour. Necropsy was performed after 5h of MV. The lungs were extracted and re-inflated with 25 cm H_2O pressure to appreciate gross changes. No statistical comparisons were made between variables as limited extrapolation of results can be achieved from a single subject on each group.

Results

After injury, P/F ratio decreased (LVt/High PEEP=168; LVt+RM=174; APRV=84). Table 1 shows the mean values (SD) for variables recorded during the 5h of MV post lung injury. On the gross anatomy, all lungs showed areas of atelectasis that uniformly resolved upon re-expansion.

	Pplat	Driving P	PEEP	Cstat	Vt (ml/kg)	MAP	FiO_2	pH	PCO_2	PO_2	PF
LVt/High PEEP	20±5	11±1	9±4	22.3±2.9	6.0±0.0	97.2±3.5	0.30±0.04	7.36±0.05	55±3	112±27	374±106
LVt+RM	34±2	17±2	16±1	11.0±0.2	5.2±0.0	85.2±35.9	0.39±0.04	7.26±0.04	60±6	101±31	330±231
APRV	33±3	15±1	18±2	21.3±5.9	10.4±1.18	62.6±4.8	0.21±0.00	7.38±0.01	37±3	127±22	602±104

Conclusion

The MBp used by teams varied considerably; reflecting the current approach to ventilate patients with ARDS. The application of different MBp resulted in acceptable pulmonary mechanics, hemodynamic, and gas exchange. Even under similar circumstances and using different approaches to MV, identifying the optimal MBp has to be individualized. Future study should extend the duration of lung protective ventilation MBp strategies to determine if there is a difference in clinically important markers of lung injury progression.

- Most data is animal data
- More human clinical trials are needed

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Questions?

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Thank you!

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