A Comprehensive Approach: Acute Severe Bronchial Asthma Requiring NIV and Mechanical Ventilation

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Objectives

Present	- Present a clinical case of acute severe asthma requiring mechanical ventilation.
Discuss	- Discuss key ventilation strategies in asthma management.
Compare	- Compare nebulization methods in mechanically ventilated patients.

Case Description

Patient Information:

32-year-old female with a history of asthma presents to the ED with severe shortness of breath and wheezing, unable to complete sentences.

Not improving with her inhalers.

MH: Poor adherence to inhaled corticosteroids.

Recent upper respiratory tract infection.

Symptoms progressively worsened over the last 24 hours.

What are the immediate assessments for acute severe asthma???

Initial Vitals

- HR 120 bpm, RR 30/min, BP 130/80 mmHg, SpO2 88% on room air.

- On examination: accessory muscle use, bilateral wheezing, inability to speak in full sentences,

- ABG

What initial treatments should be started?

Initial treatment

- High-flow oxygen to maintain SpO2 > 92%.
- Continuous nebulization with salbutamol and ipratropium bromide.
- IV hydrocortisone 100 mg stat.
- IV Magnesium Sulphate
(2gm IV over 20 minutes)
- Close monitoring of vitals and response.

Progression of Symptoms

2 Hours Later:

- Patient shows no improvement despite aggressive therapy.
- Persistent tachypnea (RR 33), Respiratory acidosis.

Initiating Non-Invasive Ventilation (NIV)

Indications??

Persistent respiratory distress

Fatigue??

$PaCO_2$ > 45 mmHg

Goal??

* *Reverse acidosis*
* *Improve oxygenation*
* *Reduce work of breathing*

Monitoring??

* *Improvement in HACOR score,*
* *ABG,*
* *Clinical status.*

Initiating Non-Invasive Ventilation (NIV)

NIV Parameters:

- *Mode: BiPAP,*
- *IPAP: 12-16 cmH_2O,*
- *EPAP: 4-6 cmH_2O,*
- *FiO_2: Maintain SpO_2* **> 92%.**

Introduction to HACOR Score

HACOR SCORE

Variables	Category (j)	Assigned points
Heart rate, beats/min	≤120	0
	≥121	1
pH	≥7.35	0
	7.30–7.34	2
	7.25–7.29	3
	<7.25	4
GCS	15	0
	13–14	2
	11–12	5
	≤10	10
PaO_2/FiO_2	≥201	0
	176–200	2
	151–175	3
	126–150	4
	101–125	5
	≤100	6
Respiratory rate, breaths/min	≤30	0
	31–35	1
	36–40	2
	41–45	3
	≥46	4

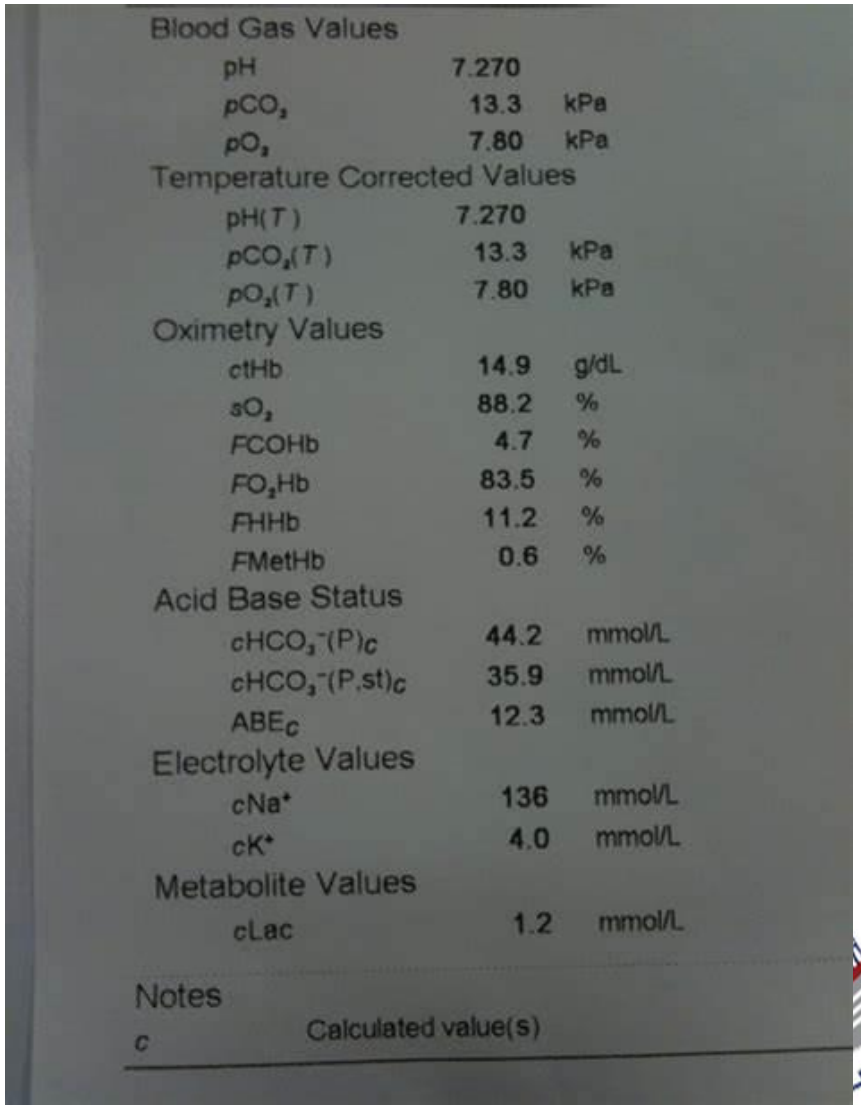
1.HACOR is a potentially useful bedside tool for the prediction of NIV failure.

2. A HACOR score >5 at 1hour of NIV highlights patients with a >80% risk of NIV failure regardless of diagnosis, age, and disease severity.

NIV Failure and Decision for Intubation

Signs of NIV Failure:

- Persistent or worsening acidosis (pH < 7.30..PCO2 70).
- No improvement in HACOR score.
- Exhaustion
- Altered mental status.



Blood Gas Values		
pH	7.270	
pCO_2	13.3	kPa
pO_2	7.80	kPa
Temperature Corrected Values		
pH(T)	7.270	
$pCO_2(T)$	13.3	kPa
$pO_2(T)$	7.80	kPa
Oximetry Values		
ctHb	14.9	g/dL
sO_2	88.2	%
FCOHb	4.7	%
FO_2Hb	83.5	%
FHHb	11.2	%
FMetHb	0.6	%
Acid Base Status		
$cHCO_3^-(P)_c$	44.2	mmol/L
$cHCO_3^-(P,st)_c$	35.9	mmol/L
ABE_c	12.3	mmol/L
Electrolyte Values		
cNa^+	136	mmol/L
cK^+	4.0	mmol/L
Metabolite Values		
cLac	1.2	mmol/L

Notes

c Calculated value(s)

Transition to Mechanical Ventilation

Preparation:

* Preoxygenation

* Rapid sequence induction. (with ketamine and rocuronium)

Post-intubation:

Initiated mechanical ventilation.

Ventilation Strategies

Goals:

Prevent dynamic hyperinflation

Allow permissive hypercapnia.

Initial Settings:

Mode: VCV,

LOW tidal Volume: 6-8 mL/kg – Ideal body weight,

RR: 8-12,

I:E Ratio: 1:3 or 1:4, Prolong Exp Time??

PEEP: 5 cmH_2O,

FiO_2: 100% initially.

Plateau Pressure: Keep <30 cmH_2O.

Nebulization in Mechanical Ventilation

- **Challenges??**

1. Efficient drug delivery
2. Minimizing circuit disconnection.

- **Methods??**

1. MDI using spacer
2. Jet Nebulizer
3. VMN

Which type of nebulizer do you use in your practice and why?

Comparison of Nebulizers

Nebulizer type	Mechanism of action	Types	Advantages	Disadvantages
Jet [68]	Pressurized gas forms a jet passing through a tube creating a low-pressure zone (Venturi effect) that draws liquid formulation into the jet stream (Bernoulli effect)	• With a corrugated tube • With a collection bag	• Cheap • Easy to use	• Inefficient • Difficult to clean
	Droplet size > 5 µm	• Breath-enhanced jet nebulizers	• Effective in delivering drugs that cannot be delivered with pMDIs and DPIs	• Need compressed gas and additional tubing
		• Breath-actuated jet nebulizers	• Breath-enhanced and breath-actuated options	

Jet nebulizers

Comparison of Nebulizers

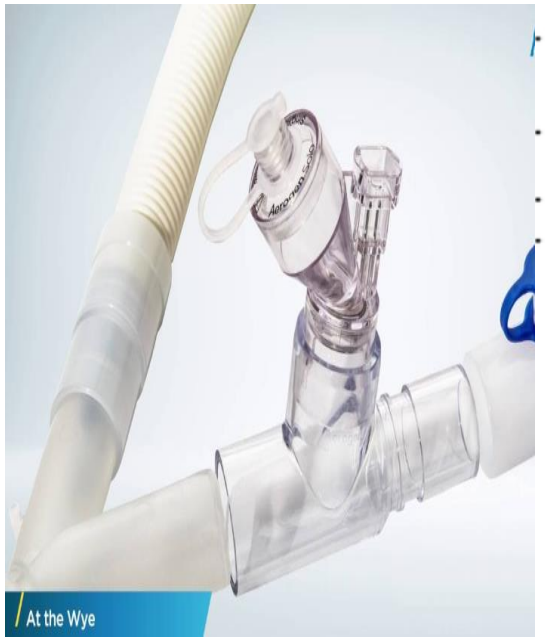
Jltrasonic 70, 131]	Piezoelectric crystal converts an electrical signal into high-frequency vibrations in the liquid, forming an aerosol using cavitation and capillary mechanisms Drug output alpha vibration amplitude Particle size alpha vibration frequency Droplet size variable, may be less than 5 µm	• Small volume (e.g. for medications) • Large volume (e.g. for hypertonic saline used for sputum induction)	• Easy to use • More efficient than jet nebulizers • Shorter nebulization time (better for large volumes)	• Large residual volume • Unable to nebulize viscous solutions • Degradation of heat-sensitive materials—so inappropriate for proteins • Aerosol temperature 10–14 °C higher than that in jet nebulizer • Large device size

Ultrasonic nebulizers

Comparison of Nebulizers

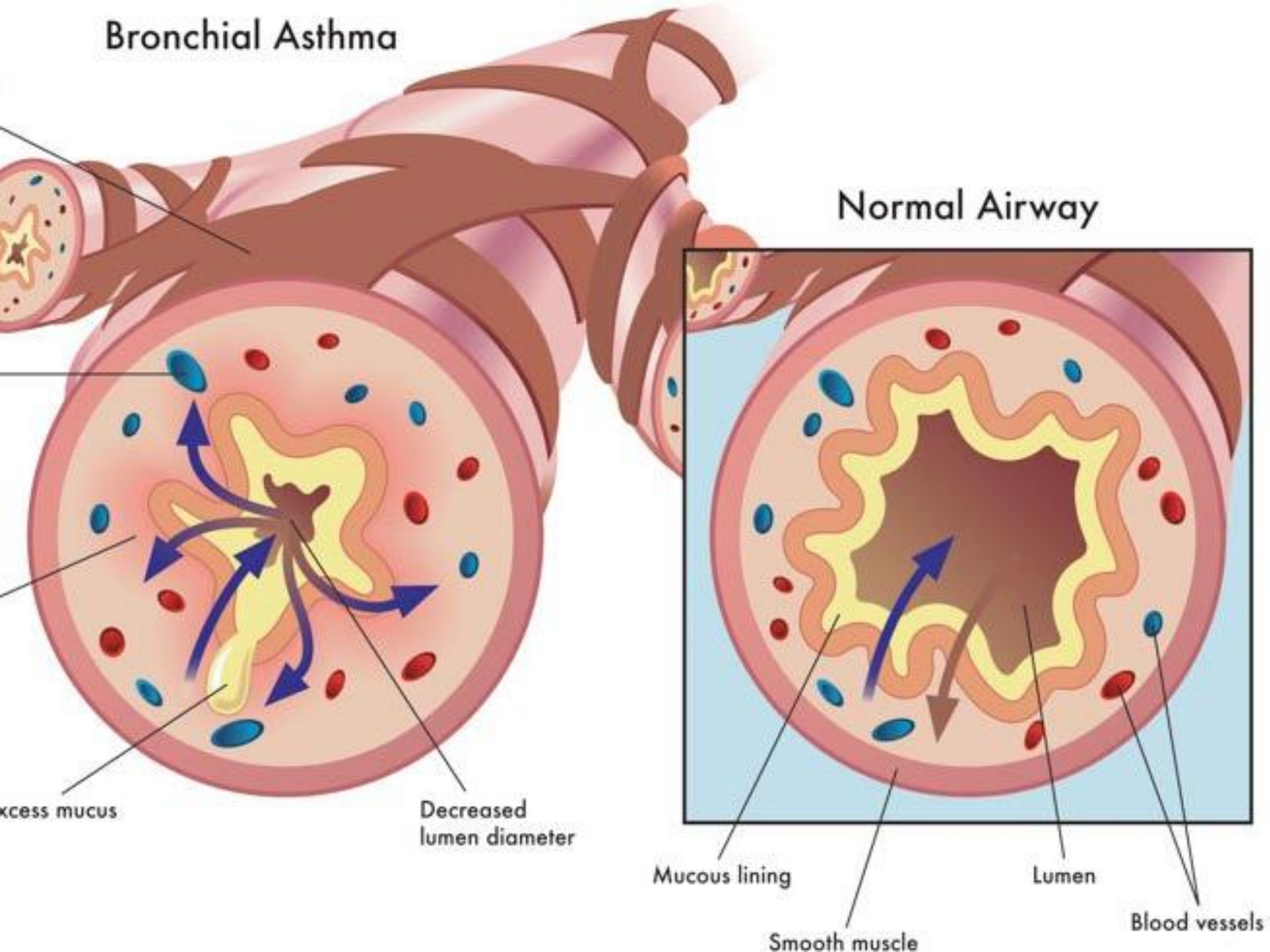
/ibrating mesh 19, 70]	Aerosol is produced by forcing the liquid using the micropumping action through the vibrating mesh containing funnel-shaped holes Droplet size < 5 µm	• Active (e.g. Aeroneb®; Aerogen, Galway, Ireland)	• Silent operation, portable	• More expensive
		• Passive (e.g. Microair NE-U22®; Omron, Bannockburn, IL, USA)	• Short treatment time • Minimal residual volume	• Cleaning can be difficult • Drug dose needs to be adjusted in transition from jet nebulizers
			• Self-contained power source	• Inability to use to aerosolize viscous liquids
			• Optimize particle size for specific drugs • More output efficiency than other nebulizers • Two to three times higher drug deposition compared with jet nebulizers • Aerosol temperature usually unchanged • Unchanged osmolality • Easy to use	• Inability to aerosolize drugs that crystallize on drying

Mesh nebulizers

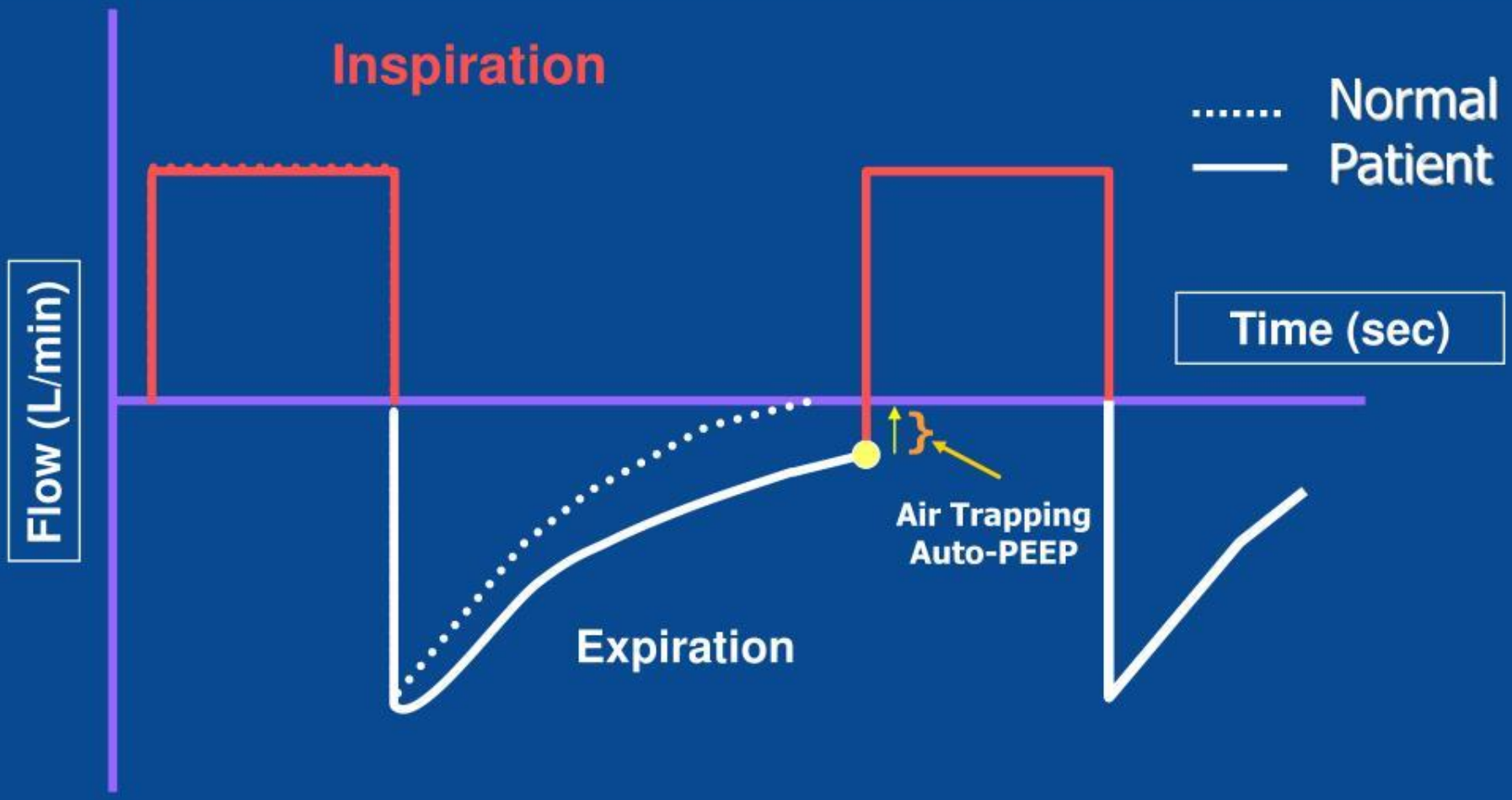


Complications

Key Risks	Barotrauma,
	Dynamic hyperinflation,
	VAP.
Prevention	Monitor plateau pressures,
	Optimize expiratory time,
	Avoid circuit disconnections.


Bronchial Asthma
Normal Airway
xcess mucus
Decreased
lumen diameter
Mucous lining
Smooth muscle
Lumen
Blood vessels

Air Trapping



ICU Management Post-Intubation

- Sedation and analgesia.
- Monitoring for barotrauma and ventilator-associated complications.

Weaning Criteria

- Resolution of acidosis
- Improved oxygenation
- Stable vitals
- Minimal ventilatory support.

Case Outcome

Patient extubated after 48 hours.

Transitioned to high-flow nasal oxygen and nebulization.

Discharged with follow-up plan and adherence counseling.

Key Takeaways

1. Early recognition and escalation in asthma management are critical.
2. The HACOR score aids in predicting NIV outcomes.
3. Individualized ventilation strategies improve outcomes.

***Tailored ventilation strategies minimize complications

4. Nebulizer selection depends on context and resource availability.

***Effective nebulization improves outcomes

Discussion

A. How would you balance oxygenation and ventilation in this case?

B. When would you consider ECMO for refractory cases?

C. Risks of permissive hypercapnia in severe asthma?

D. Preferred nebulization method for ventilated patients?

References

- BTS/SIGN Asthma Management Guidelines.
- ARDSNet Ventilation Protocol.
- Peer-reviewed articles on nebulization in mechanical ventilation.


thank
you