Chapter 80
Approach to Patient-Ventilator Asynchrony in the ICU

80.1 Introduction

Ventilator asynchrony is a prevalent challenge in critical care medicine, with an incidence ranging from 10% to 85%. This mismatch between a patient's respiratory efforts and the ventilator's delivered breaths is associated with poor clinical outcomes, including prolonged ICU stays, increased mortality rates, and respiratory muscle dysfunction. Both patient-related factors—such as respiratory drive variations due to sepsis or acute respiratory distress syndrome (ARDS)—and ventilator-related factors like trigger sensitivity and flow settings contribute to asynchrony. Early recognition and management are crucial to optimize patient comfort, improve ventilator efficiency, and enhance clinical outcomes [1, 2] [Ref: Algorithm 80.1].

80.2 Identify Symptoms of Asynchrony

- Overview: Recognize signs of ventilator asynchrony, such as increased respiratory distress, tachypnea, hemodynamic instability, or visible discordance between patient effort and ventilator cycling.
- Rationale: Early detection prevents escalation of respiratory insufficiency and associated complications.
- Action: Confirm clinical suspicion by initiating waveform analysis for real-time detection and classification of asynchrony types [3].

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80.3 Proceed to Waveform Analysis and Monitoring

- Waveform Evaluation: Continuously monitor flow-time, pressure-time, and volume-time waveforms to identify patterns indicative of asynchrony.
- Importance: Waveform analysis is the cornerstone for diagnosing specific types of asynchrony. Advanced tools like esophageal pressure monitoring and diaphragmatic electromyography can be employed to confirm asynchrony when waveform analysis is inconclusive [4].
- Clinical Note: Incorporate esophageal manometry or diaphragm electrical activity monitoring to enhance detection accuracy.

80.4 Types of Asynchrony and Specific Interventions

80.4.1 Check Triggering Asynchronies

Ineffective Efforts

- Definition: Occurs when the ventilator fails to deliver a breath despite the patient's inspiratory effort, making it the most common type of asynchrony, especially in patients with auto-PEEP.
- Cause: Auto-PEEP, inadequate trigger sensitivity, or high respiratory drive.
- Intervention:
- Adjust trigger sensitivity to ensure the ventilator detects patient efforts.
- Reduce auto-PEEP by optimizing expiratory time or titrating ventilatory settings.
- Consider adjusting positive end-expiratory pressure (PEEP) levels to counterbalance auto-PEEP [5].

Auto-Triggering

- Definition: The ventilator delivers breaths without any patient effort.
- Cause: Circuit leaks, excessive trigger sensitivity, or inappropriate flow settings.
- Intervention:
- Evaluate and correct circuit leaks.
- Adjust trigger sensitivity to prevent false triggering.
- Modify flow trigger settings to align with patient needs [6].

80.4.2 Flow Asynchrony

- Definition: A mismatch between the ventilator's inspiratory flow rate and the patient's demand.
- Diagnosis: Inspect flow-time waveforms for abnormalities such as rapid deceleration or prolonged inspiratory phases.
- Management:
- Increase Flow: Adjust the inspiratory flow rate or switch to pressure-support ventilation to better match the patient's effort.
- Reduce Flow: Decrease tidal volumes or inspiratory pressures in patients demonstrating excessive flow demands.

80.4.3 Cycling Asynchrony

Premature Cycling

- Definition: The ventilator terminates inspiration before the patient completes their inspiratory effort.
- Management: Decrease the cycling-off percentage to extend the inspiratory time, allowing for complete breath delivery.

Delayed Cycling

- Definition: The ventilator continues delivering inspiration after the patient has finished their inspiratory effort.
- Management: Increase the cycling-off percentage to shorten the inspiratory time, preventing overdistension [7].

80.4.4 Double Triggering and Reverse Triggering

- Definition: Double triggering occurs when two consecutive breaths are triggered by a single patient effort; reverse triggering is when patient effort follows ventilator-delivered breaths. Both can contribute to lung injury due to excessive tidal volumes.
- Management:
- Adjust Tidal Volume: In ARDS patients, synchronize tidal volume adjustments to mitigate lung injury risks.
- Modify Inspiratory Time:
- For double triggering, increase inspiratory time to align with patient effort.
- For reverse triggering, reduce inspiratory time to prevent patient-ventilator mismatch.

80.5 Advanced Ventilatory Strategies

80.5.1 Optimize Ventilation Mode

- Switch to Proportional Modes: Utilize advanced modes like neurally adjusted ventilatory assist (NAVA) and proportional assist ventilation (PAV). These modes synchronize ventilator support with the patient's neural respiratory drive, reducing asynchrony.
- Advantages: Improved patient comfort, reduced work of breathing, and enhanced synchrony.
- Limitations: Limited widespread adoption due to complexity, equipment requirements, and the need for specialized training.

80.6 Address Patient Factors

- Underlying Issues: Identify and manage conditions contributing to respiratory drive mismatch, such as pain, anxiety, fever, or sepsis.
- Sedation Management: Avoid over-sedation to prevent respiratory muscle dysfunction. Use minimal sedation unless severe asynchrony necessitates controlled ventilation.

80.7 Outcome Correlation and Quality Metrics

- Asynchrony Index (AI): Calculate the AI, defined as the number of asynchronous events divided by the total number of breaths (patient-triggered and ventilator-triggered), multiplied by 100%.
- Clinical Significance: An AI greater than 10% is linked with higher mortality and longer durations of mechanical ventilation.
- Quality Improvement: Routine calculation of AI can be part of quality improvement initiatives to enhance patient outcomes.
- Training: Implement structured training programs for healthcare providers to improve detection accuracy of asynchrony, as automation in this area remains underdeveloped.

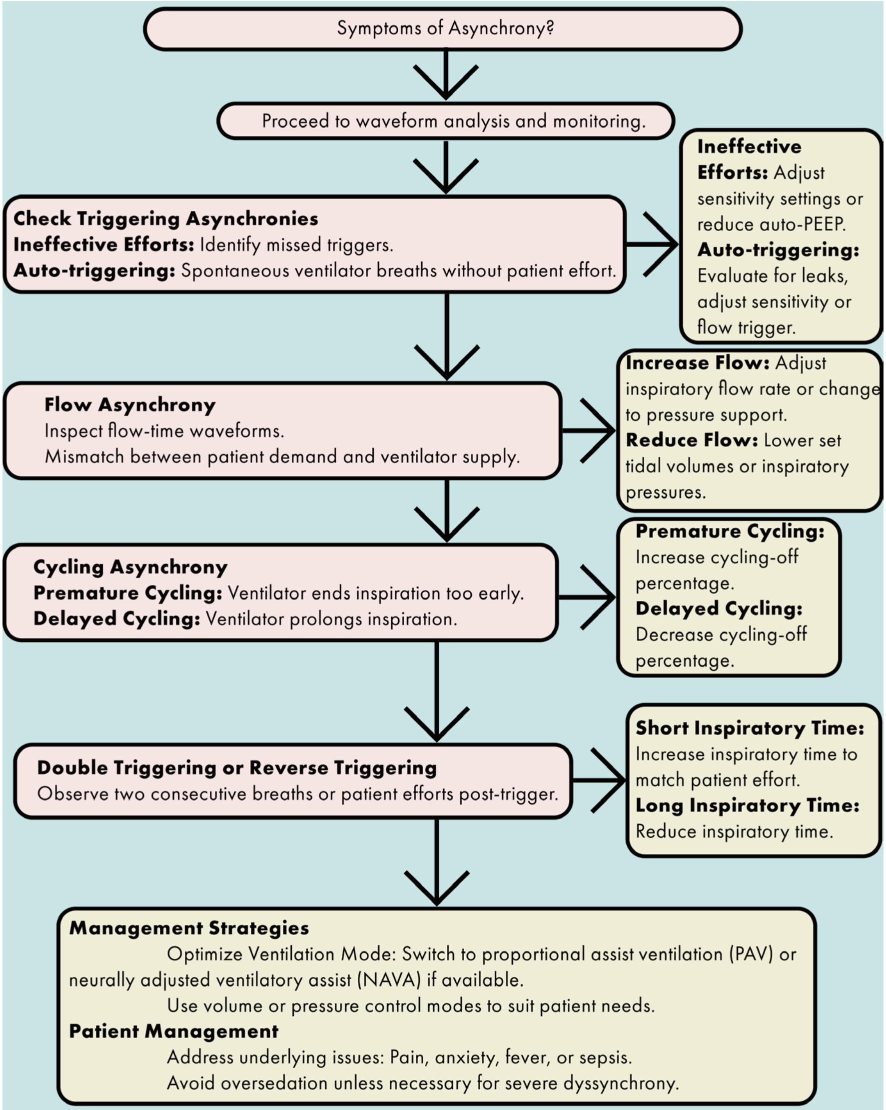
80.8 Research and Emerging Trends

- Machine Learning Algorithms: Ongoing developments in machine learning offer promise for automated detection of asynchrony and predictive analytics for intervention planning.
- Personalized Ventilatory Settings: Encourage the inclusion of personalized ventilatory settings as part of future precision medicine approaches to optimize patient outcomes.
- Future Directions: Research into user-friendly interfaces and integration of advanced monitoring tools could facilitate wider adoption of advanced ventilatory modes.

80.9 Conclusion

Ventilator asynchrony is a multifactorial issue that significantly impacts patient outcomes in critical care settings. A systematic approach involving careful waveform analysis, precise adjustments to ventilator settings, and addressing underlying patient factors is essential for achieving optimal synchronization. Advanced ventilatory strategies, such as NAVA and PAV, offer promising solutions but require further integration into clinical practice. Monitoring tools like the Asynchrony Index and developments in machine learning hold potential for improving detection and management. Clinicians must remain vigilant and adaptive, as patient conditions and ventilator dynamics continuously evolve during ICU management. Implementing structured training and embracing emerging technologies will be pivotal in enhancing patient care and outcomes.

Algorithm 80.1: Approach to patient-ventilator asynchrony in the ICU



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