

# Mechanical Ventilation: Bilevel Ventilation (Respiratory Therapy)

## ALERT

**Patients must be free of heavy sedation and neuromuscular paralysis to benefit from bilevel ventilation.**

## OVERVIEW

Biphasic modes of ventilation use pressure-controlled, intermittent mandatory ventilation with unrestricted spontaneous breathing.<sup>2</sup> Bilevel ventilation is a mode of biphasic ventilation that allows the patient to breathe spontaneously together with delivered ventilator breaths. The patient's breaths can occur anytime during the inspiratory or expiratory phase of the breathing cycle.<sup>3</sup> This ventilation method increases patient comfort and synchrony with the ventilator.

Bilevel ventilation is a good mode of ventilation for use with patients with acute respiratory distress syndrome (ARDS). In ARDS, bilateral infiltrates can develop when the alveoli collapse, making bilevel ventilation necessary for alveoli recruitment. The goals of ARDS treatment are to limit lung damage by preventing the overdistension of stiff lungs, limit lung collapse, open the alveoli, and improve lung oxygenation. Bilevel ventilation can help achieve these goals.

The ventilator settings in this mode include inspiratory time (T high) and (T low), respiratory rate, and fraction of inspired oxygen (FIO<sub>2</sub>).<sup>3</sup> Two levels of pressure are also set: the inspiratory pressure limit (P high) and the positive end-expiratory pressure (PEEP) low (P low).<sup>1,3</sup> The difference between the two levels determines the tidal volume (V<sub>T</sub>) and can be adjusted to deliver a V<sub>T</sub> of 6 to 8 ml/kg in accordance with ARDS Network guidelines.<sup>3</sup>

## EDUCATION

- Provide developmentally and culturally appropriate education based on the desire for knowledge, readiness to learn, and overall neurologic and psychosocial state.
- Discuss the reasons for initiating bilevel ventilation.
- Explain the procedure.
- Discuss the differences between bilevel ventilation and conventional ventilation.
- Encourage questions and answer them as they arise.

## ASSESSMENT AND PREPARATION

### Assessment

1. Perform hand hygiene before patient contact.
2. Introduce yourself to the patient.
3. Verify the correct patient using two identifiers.
4. Assess the patient's level of consciousness and ability to understand and participate in decisions. Include the patient as much as possible in all decisions.
5. Assess the patient for indications for bilevel use (e.g., ARDS, protection against ventilator-induced lung disease, acute lung injury).
6. Assess the patient's cardiovascular and respiratory systems.

### Preparation

1. Gather all needed equipment, including the ventilator, circuit, humidification device, and suction device.

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2. Before initiating mechanical ventilation, check the system microprocessor or ventilation system. Perform a short self-test as appropriate.
  - a. Verify compliance of the heat-moisture exchanger, humidifier, and filters (if needed).
  - b. Document the completed ventilation system test. Include pass or fail, date, and initials or signature and credentials of the respiratory therapist (RT).
3. Verify the authorized practitioner's order for the initiation of mechanical ventilation.

### PROCEDURE

1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers.
3. Explain the procedure to the patient and ensure that the patient agrees to treatment.
4. Collaborating with the practitioner, adjust the ventilator to the bilevel mode and enter the prescribed settings.

**Settings may be brand specific, and the terms for the individual settings may differ.**

5. Adjust the P high setting for the higher pressure level. Usually, this is the conventional ventilation plateau pressure, but P high should be no higher than 30 cm H<sub>2</sub>O.<sup>2</sup>
6. Adjust the P low setting for the lower pressure setting.
7. Adjust the T high setting for the time at the higher pressure.
8. Adjust the T low setting for the time at the lower pressure.
9. Adjust the inspiratory rise time (%).
10. Adjust the trigger flow or trigger pressure.
11. Adjust the pressure support level above P high.
12. Adjust the pressure support level above PEEP.
13. Adjust the FIO<sub>2</sub> as prescribed.
14. Remove gloves and perform hand hygiene.
15. Document the procedure in the patient's record.

### MONITORING AND CARE

1. Check the ventilator settings.
2. Ensure that all ventilator alarms are on, set appropriately for the patient's individual ventilator settings and not silenced.
3. If the ventilator has a freeze screen, freeze the patient's ventilator flow-time curve screen to monitor pressure release and expiratory flow values.

Rationale: Freezing the screen makes determining these values easier.

4. Continuously monitor the patient's oxygen saturation and exhaled carbon dioxide.
5. Observe the patient for signs and symptoms of pain. If pain is suspected, report it to the authorized practitioner.

### EXPECTED OUTCOMES

- Decreased work of breathing
- Decreased respiratory rate
- Decreased metabolic demand

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- Decreased barotrauma
- Decreased circulatory compromise
- Better ventilation/perfusion (V/Q) matching
- Increased oxygenation
- Improved lung compliance

### UNEXPECTED OUTCOMES

- Altered volumes with alteration in lung compliance and resistance
- Increased work of breathing
- Increased barotrauma
- Decreased oxygenation
- Inadequate V/Q matching

### DOCUMENTATION

- Ventilator system tests
- Ventilator checks
- Ventilator settings
  - P high
  - P low
  - T high
  - T low
  - FIO<sub>2</sub>
  - Pressure support
  - Plateau pressure
  - Circuit temperature
  - Inspiratory rise time (%)
- Secretions from suctioning
- Education
- Unexpected outcomes and related interventions

### REFERENCES

1. Cairo, J.M. (2020). Chapter 5: Selecting the ventilator and the mode. In *Pilbeam's mechanical ventilation: Physiological and clinical applications* (7th ed., pp. 58-79). St. Louis: Elsevier.
2. Cairo, J.M. (2020). Chapter 23: Special techniques in ventilatory support. In J.M. Cairo (Ed.), *Pilbeam's mechanical ventilation: Physiological and clinical applications* (7th ed., pp. 475-502). St. Louis: Elsevier.
3. Gallagher, J.J. (2018). Alternative modes of mechanical ventilation. *AACN Advanced Critical Care*, 29(4), 396-404. doi:10.4037/aacnacc2018372

### ADDITIONAL READINGS

West, M.A. and others. (2019). APRV: A Comparison of APRV/BiLevel, PC-APRV, BiLevel and BiVent. *Respiratory Care*, 64(Suppl. 10), 3239222.

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## Supplies

- Air flowmeter
- Gloves
- Humidification and suction device
- Oxygen flowmeter
- Ventilator that supports bilevel modes
- Ventilator circuit
- Manual resuscitation bag
- Stethoscope

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Published: April 2020

## Mechanical Ventilation: Bilevel Ventilation (Respiratory Therapy)

1. Performed hand hygiene before patient contact.
2. Introduced self to the patient.
3. Verified the correct patient using two identifiers.
4. Assessed the patient's level of consciousness and ability to understand and participate in decisions. Included the patient as much as possible in all decisions.
5. Assessed the patient for indications for bilevel use.
6. Assessed the patient's cardiovascular and respiratory systems.
7. Gathered all needed equipment, including the ventilator, circuit, humidification device, and suction device.
8. Before initiating mechanical ventilation, checked the system microprocessor or ventilation system. Performed a short self-test as appropriate.
  - a. Verified compliance of the heat-moisture exchanger, humidifier, and filters (if needed).
  - b. Documented the completed ventilation system test. Included pass or fail, date, and initials or signature and credentials of the RT.
9. Verified the authorized practitioner's order for the initiation of mechanical ventilation.
10. Performed hand hygiene and donned gloves.
11. Explained the procedure to the patient and ensured that the patient agreed to treatment.
12. Collaborating with the practitioner, adjusted the ventilator to the bilevel mode and entered the prescribed settings.
13. Adjusted P high for the higher pressure level.
14. Adjusted P low for the lower pressure setting.
15. Adjusted T high for the time at the higher pressure.
16. Adjusted T low for the time at the lower pressure.
17. Adjusted the inspiratory rise time (%).
18. Adjusted the trigger flow or trigger pressure.
19. Adjusted the pressure support level above P high.
20. Adjusted the pressure support level above PEEP.
21. Adjusted the FIO<sub>2</sub> as prescribed.
22. Continuously monitored the patient's oxygen saturation and exhaled carbon dioxide.
23. Observed the patient for signs and symptoms of pain. If pain was suspected, reported it to the authorized practitioner.
24. Removed gloves and performed hand hygiene.
25. Documented the procedure in the patient's record.