Noninvasive positive-pressure ventilation (NPPV) is the delivery of mechanical ventilatory support without an invasive nasotracheal or endotracheal tube, using a tight-fitting face or nasal mask. Continuous positive airway pressure (CPAP) is occasionally included in discussions of NPPV, although CPAP does not directly increase tidal volume or minute ventilation. In contrast, bilevel positive airway pressure (BiPAP) provides supplemental inspiratory tidal volume.

Both modes are useful in the hospital under a number of circumstances. CPAP or BiPAP sometimes can help stave off intubation for acutely ill patients with respiratory failure from exacerbations of acute pulmonary edema or chronic obstructive pulmonary disease (COPD). Physicians also frequently extubate patients to BiPAP to reduce the risk of reintubation.

**How CPAP Works**

A CPAP machine forces a continuous column of compressed air at a fixed designated pressure against the face and nose of the patient, who is wearing a mask or nasal cap. When the patient’s glottis opens to inhale, the pressure is transmitted throughout the airway, helping to open it. There is no inspiratory flow of air from the CPAP machine; whatever additional tidal volume the patient pulls in is from the additional airway volume recruited by the pressure.

When the patient exhales, pressure from the deflating lungs and chest wall pushes air out against the continuous pressure, until the two pressures are equal. The air pressure in the airway at the end of exhalation is equal to the external air pressure of the machine, and this helps “splint” the airway open, allowing better oxygenation and airway recruitment. If the CPAP is set too high for the patient, exhalation becomes very uncomfortable, since the patient has to push against the pressure to exhale. This can increase the work of breathing for fragile COPD patients or weak critically ill patients. Most ICU patients tolerate pressures of 5 to 8 cm H₂O. Patients with obstructive sleep apnea may require up to 20 cm H₂O to keep their airways open (see Figure below).

**Technoogy Traps**

<table>
<thead>
<tr>
<th>CPAP 5 cm H₂O</th>
<th>BiPAP 10/5 cm H₂O</th>
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<tr>
<td>Spontaneous respirations</td>
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<td>ATM = atmospheric pressure; BiPAP = bilevel positive airway pressure; CPAP = continuous positive airway pressure; EPAP = expiratory positive airway pressure; Ex = exhalation; In = inhalation; IPAP = inspiratory positive airway pressure.</td>
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**NPPV: General Indications for Use**

- Patient cooperation (an essential component that excludes agitated, belligerent or comatose patients),
- Dyspnea (moderate to severe, but short of respiratory failure),
- Tachypnea (>24 breaths/min),
- Increased work of breathing (accessory muscle use, pursed-lips breathing),
- Hypercapnic respiratory acidosis (pH range, 7.10 to 7.35), and
- Hypoxemia (PaO₂/FIO₂ <200 mm Hg, best in rapidly reversible causes of hypoxemia).

**How BiPAP Works**

BiPAP has two levels of continuous airway pressure. When the machine senses the patient’s inspiratory flow starting to increase, it increases the inspiratory pressure (IPAP) applied, so that air flow is enhanced and the patient’s own inspiratory tidal volume is augmented. When the machine senses flow is slowing or stopped, it reduces the applied airway pressure so the patient has less work upon exhaling, but maintains a continuous positive expiratory pressure (EPAP). This allows the patient to receive higher inspiratory pressure, but not have to work against higher expiratory pressure. In addition, the machine can be set to deliver a fixed respiratory rate. Air flow is generated until the airway pressure as sensed by the machine reaches a set target inspiratory pressure. The tidal volume received by the patient depends upon airway resistance, lung and chest wall compliance, patient synchrony with machine, and the absence of air leakage around the mask. BiPAP can only augment the patient’s respiration; it should not be used as a primary form of ventilation. As one might expect, BiPAP machines are much more expensive than CPAP machines ($10,000 vs. $3,000).