TABLE 323-2 CHARACTERISTICS OF THE MOST COMMONLY USED FORMS OF MECHANICAL VENTILATION

Ventilatory Mode	Variables Set by User (Independent)	Variables Monitored by User (Dependent)	Trigger Cycle Limit	Advantages	Disadvantages
ACMV (assist-control ventilation)	Tidal volume Ventilator rate F_{IO_2} PEEP level Pressure limit	Peak, mean, and plateau airway pressures VE ABG I/E ratio	Patient effort Timer Pressure limit	Patient control Guaranteed ventilation	Potential hyperventilation Barotrauma and volume trauma Every effective breath generates a ventilator volume
IMV (intermittent mandatory ventilation)	Tidal volume Mandatory ventilator rate F_{IO_2} PEEP level Pressure limit Spontaneous breaths between assisted breaths	Peak, mean, and plateau airway pressures VE ABG I/E ratio	Patient effort Timer Pressure limit	Patient control Comfort from spontaneous breaths Guaranteed ventilation	Potential dysynchrony Potential hypoventilation
PSV (pressure-support ventilation)	Inspiratory pressure level F_{IO_2} PEEP Pressure limit	Tidal volume Respiratory rate VE ABG	Pressure limit Inspiratory flow	Patient control Comfort Assures synchrony	No timer backup Potential hypoventilation
NIV (noninvasive ventilation)	Inspiratory and expiratory pressure level F_{IO_2}	Tidal volume Respiratory rate VE ABG	Pressure limit Inspiratory flow	Patient control	Mask interface may cause discomfort and facial bruising Leaks are common Hypoventilation

Abbreviations: ABG, arterial blood gases; F_{IO_2}, fraction of inspired oxygen; PEEP, positive end-expiratory pressure; I/E, inspiratory to expiratory time ratio; VE, minute ventilation.

use in patients with tachypnea because they may attempt to exhale during the ventilator-programmed inspiratory cycle. Consequently, the airway pressure may exceed the inspiratory pressure limit, the ventilator-assisted breath will be aborted, and minute volume may drop below that programmed by the operator. In this setting, if the tachypnea represents a response to respiratory or metabolic acidosis, a change in ACMV will increase minute ventilation and help normalize the pH while the underlying process is further evaluated and treated.

Pressure-Support Ventilation (PSV) This form of ventilation is patient-triggered, flow-cycled, and pressure-limited. It provides graded assistance and differs from the other two modes in that the operator sets the pressure level (rather than the volume) to augment every spontaneous respiratory effort. The level of pressure is adjusted by observing the patient's respiratory frequency. During PSV, the inspiration is terminated when inspiratory airflow falls below a certain level; in most ventilators, this flow rate cannot be adjusted by the operator. With PSV, patients receive ventilator assistance only when the ventilator detects an inspiratory effort. PSV is often used in combination with SIMV to ensure volume-cycled backup for patients whose respiratory drive is depressed. PSV is well tolerated by most patients who are being weaned from MV; PSV parameters can be set to provide full ventilatory support and can be withdrawn to load the respiratory muscles gradually.

Other Modes of Ventilation There are other modes of ventilation, each with its own acronym and each with specific modifications of the manner and duration in which pressure is applied to the airway and lungs and of the interaction between the mechanical assistance provided by the ventilator and the patient's respiratory effort. Although their use in acute respiratory failure is limited, the following modes have been used with varying levels of enthusiasm and adoption.

PRESSURE-CONTROL VENTILATION (PCV) This form of ventilation is time-triggered, time-cycled, and pressure-limited. A specified pressure is imposed at the airway opening throughout inspiration. Since the inspiratory pressure is specified by the operator, tidal volume and inspiratory flow rate are *dependent*, rather than *independent*, variables and are not operator-specified. PCV is the preferred mode of ventilation for patients in whom it is desirable to regulate peak airway pressures, such as those with preexisting barotrauma, and for post–thoracic surgery patients, in whom the shear forces across a fresh suture line should be limited. When PCV is used, minute ventilation is altered through changes in rate or in the pressure-control value, with consequent changes in tidal volume.

INVERSE-RATIO VENTILATION (IRV) This mode is a variant of PCV that incorporates the use of a prolonged inspiratory time with the appropriate shortening of the expiratory time. IRV has been used in patients with severe hypoxemic respiratory failure. This approach increases mean distending pressures without increasing peak airway pressures. It is thought to work in conjunction with PEEP to open collapsed alveoli and improve oxygenation. However, no clinical-trial data have shown that IRV improves outcomes.

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) CPAP is not a true support mode of ventilation because all ventilation occurs through the patient's spontaneous efforts. The ventilator provides fresh gas to the breathing circuit with each inspiration and sets the circuit to a constant, operator-specified pressure. CPAP is used to assess extubation potential in patients who have been effectively weaned and who require little ventilatory support and in patients with intact respiratory system function who require an endotracheal tube for airway protection.

Nonconventional Ventilatory Strategies Several nonconventional strategies have been evaluated for their ability to improve oxygenation and reduce mortality rates in patients with advanced hypoxemic respiratory failure. These strategies include high-frequency oscillatory ventilation (HFOV), airway pressure release ventilation (APRV), extracorporeal membrane oxygenation (ECMO), and partial liquid ventilation (PLV) using perfluorocarbons. Although case reports and small uncontrolled cohort studies have shown benefit, randomized controlled trials have failed to demonstrate consistent improvements in outcome with most