

NON-INVASIVE POSITIVE PRESSURE VENTILATION: A BRIEF CLINICAL GUIDE

by David Wheeler RRT, NPS



Ventilatory support without establishment of an endotracheal airway is termed noninvasive ventilation. Noninvasive ventilation may be given with the use of devices that utilize intermittent negative extra-thoracic pressure. However, the overwhelming majority of noninvasive ventilation currently in use clinically utilizes a positive pressure ventilation device. Noninvasive Positive Pressure Ventilation (NPPV) is the delivery of positive-pressure ventilatory support to the upper airway via a nasal or full face mask.

The use of noninvasive ventilation has grown exponentially with the mounting evidence that NPPV has a role in the management of acute and chronic respiratory failure and may be clinically helpful for patients with congestive heart failure. NPPV preserves the normo-physiologic processes of swallowing, feeding, speech, cough, thermoregulation and humidification.

The primary clinical intention of noninvasive ventilation is to eliminate the need for intubation and prevent the opportunity for VAP, VILI and VALI. Current evidence demonstrates that NPPV therapy reduces the need for endotracheal intubation, shortens ICU and hospital lengths of stay, decreases the duration of mechanical ventilation and may reduce mortality in selected patients with acute respiratory failure. One might wonder at the lack of clinical utilization of this useful option. Current evidence suggests that the three primary reasons cited for not employing this valuable clinical adjunct are lack of physician knowledge, inadequate available equipment, and lack of therapist training.

NPPV via nasal or face mask has gained greater acceptance for the support of both chronic and acute ventilatory failure. The development of improved masks and ventilator technology made this mode of ventilation acceptable. Full facemasks were the initial mask chosen to treat patients with acute respiratory failure. Additionally, the full facemasks have a lower initial intolerance rate than nasal masks in the acute setting. Patient reports suggest that nasal masks have been rated as more comfortable by patients in stable condition who are experiencing chronic respiratory failure.

Anatomically, when NPPV is applied with a nasal mask the soft palate falls in opposition to the tongue whilst in face mask applications the soft palate closes the nasopharynx thus securing an acceptable airway to the trachea. Numerous types, sizes and designs of masks are currently utilized. Face masks that cover the entire face or just the nose and mouth; nasal masks, nasal pillows that fit into the nostrils and cushion type mechanisms that fit across the nares all have clinical utility.

Noninvasive positive-pressure ventilation can be given with a volume ventilator, pressure-controlled ventilator or a dedicated bi-level positive-airway-pressure ventilator. The type of ventilator becomes significant only when one is attempting to employ NPPV with antiquated control algorithms.

Volume-cycled noninvasive ventilation may improve outcomes in acute respiratory failure and has been used to control chronic respiratory failure. This clinical strategy requires significant patient education as the volume cycling is difficult to endure in the spontaneously breathing patient and compliance is problematic. Positive-pressure noninvasive ventilation, in which the ventilator delivers a set pressure for each breath, is commonly given with bi-level pressure/flow/time cycled devices or with standard pressure support or pressure control and PEEP. Managing NPPV with a nasal or face mask and a hospital grade mechanical ventilator permits the clinician greater accuracy with inspired oxygen concentrations and fully utilizes the ventilator monitoring and assessment capabilities.

Essentially NPPV utilizes either Pressure Control / Pressure Support with PEEP. The Pressure Support is typically well tolerated by patients and provides adequate inspiratory augmentation. Pressure Control is especially useful in cases where the patient demonstrates frequent apneas or requires a time cycled inspiratory phase. In the PCV mode one can set a fixed inspiratory time and also provide a backup respiratory rate. Bear in mind that in this time cycled pressure limited mode flow will be decelerating and subject to pressure gradients and resistance.

Bi-level ventilators provide continuous high-flow airway pressure that is essentially a combined PSV/PCV with PEEP method of NPPV. In the spontaneous mode, bi-level triggers and cycles similar to any standard PSV mode. The trigger mechanism responds to the patient's breathing efforts and compensates for air leaks in the system circuit. In control modes the NPPV system acts as a PCV system. The machine initiated breaths are time cycled pressure limited while the spontaneous breathe are essentially PSV breaths. The baseline pressure for both types of breath



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is PEEP and in many bi-level systems peak pressure in additive rather than cumulative. Biphase ventilation fluctuates in pre-set time intervals between two baseline pressures and permits spontaneous breathing throughout all intervals.

When utilizing many bi-pap type instruments supplemental oxygen is titrated in a side-stream fashion and diluted by an extremely high flow of air. This may cause fluctuations in inspired oxygen levels as the FiO₂ will vary inversely with the patient's minute ventilation. Most modern systems allow for greater control of oxygen levels. Several systems use a common inspiratory and expiratory line which may contribute to the re-breathing of exhaled gas and some level of iatrogenic hypercapnia. Maintaining PEEP levels of at least 4 cm.H₂O reduces potential re-breathing of carbon dioxide.

NPPV is of little clinical utility if the patient is anxious, uncooperative, or asynchronous with the ventilator. Patient education and patient "buy in" is critical for a successful outcome. Generally speaking it is best to initiate pressure ventilation at lower pressures and progressively increase both the peak and end-expiratory pressures. The informed clinician will palpate the sternocleidomastoid muscle to determine whether the work of breathing has decreased. Assessment of lower thoracic expansion, subjective dyspnea scales and blood gas values are also essential.

Additional assessments include; patients comfort, respiratory rate, oxyhemoglobin saturation, signs of ventilator-patient asynchrony, nasal-mask intolerance, disproportionate air leaks, gastric distention, drying of the eyes and skin breakdown. Gastric distention was once thought to be a primary side effect of NPPV however, is very rare with pressure levels lower than 25 cmH₂O Eye irritation and skin necrosis are reported to a greater degree and bear close watching. When a leak compensating NPPV system is used, it is not necessary to apply the mask so securely that it is airtight as the device can be loosened to patient comfort levels. The mask should fit without excessive pressure on the skin. The utilization of nasal pillows or nasal devices can reduce the dermal considerations.

The most common use of NPPV is nocturnal for management of chronic respiratory failure. NPPV is also useful in the long-term management of neuromuscular disease. NPPV significantly improves daytime arterial-blood gases, lung volumes and respiratory-muscle strength, reduces the number of hospitalizations for patients with respiratory insufficiency due to obstructive sleep apnea and severe kyphoscoliosis. NPPV has some utility as a maintenance treatment in patients with intrinsic lung disease and marked hypercapnia. Some limited application of NPPV has proved useful in improving the respiratory pattern and blood gases of stable COPD patients with hypercapnia.

NPPV has demonstrated efficacy in patients with acute respiratory failure due to a variety of causes. Inspiratory pressures of 12 to 20 cmH₂O with expiratory pressures of 0 to 6 cmH₂O have proven benefit. There is strong support for the use of NPPV in patients with severe exacerbations of COPD. Patients with COPD have evidenced a reduction in the need for intubation when utilizing NPPV with inspiratory pressure of 20 cmH₂O and expiratory pressure of 0 – 6 cmH₂O delivered by face mask. NPPV has been shown to significantly lower rates of complications, reduce the need for endotracheal intubation, shorten hospital stay and lower mortality.

NPPV in acute respiratory failure COPD may help because of the application of positive expiratory pressure, which can enhance

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exhalation in the presence of intrinsic PEEP and dynamic hyperinflation. Studies have demonstrated improvements in the work of breathing and arterial-blood gas values with the administration of NPPV to patients with COPD who had acute respiratory failure. NPPV is a prudent and valuable method of providing ventilatory support for many patients with acute respiratory failure. NPPV is safer and has fewer potential complications than conventional intubation and mechanical ventilation NPPV for acute respiratory failure appears to be effective in 50 to 80 percent of patients. The patients most likely to benefit from noninvasive ventilation are those with acute or chronic respiratory failure. Hemodynamic instability, deteriorating mental status or increasing respiratory rate are indicative of failure of the NPPV trial. Frequently patients are unable to tolerate or refuse to use the NPPV device. In general, NPPV probably is not indicated in patients who are unable to cooperate, who have impaired consciousness, significant secretions or sustained hemodynamic instability.

NPPV has been shown to be an effective therapy for acute pulmonary edema. When used appropriately NPPV improves oxygenation, reduces hypercapnia, decreases respiratory work and decreases the need for endotracheal intubation. The informed clinician will be mindful of the inherent hemodynamic instability in this patient population and be prudent when using NPPV treat acute pulmonary edema. One must begin with low pressures and titrate pressure levels commensurate with the patient's clinical response.

Nocturnal NPPV in patients with chronic congestive heart failure and sleep-related breathing disturbances reduces the frequency of apnea, improves nocturnal oxy-

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effecting access to sleep testing by patients by limiting the practice of sleep technology to the credentialed members of their own group while thousands of practitioners have been competently performing this job for decades. This would be unacceptable and may have ramifications it would be premature to discuss now.

The BRPT has responded to the stated intent of the NBRC to study the feasibility of establishing a sub-specialty credentialing exam by pointing out that while their organization has been engaged in this endeavor since 1978 and has considerable experience in this field, the NBRC does not. The BRPT has credentialed over 9000 sleep technologists since 1979. It is recognized by the National Commission for Certifying Agencies so has legitimate and equal status with the NBRC. The BRPT maintains close ties with both the physician/professional sleep medicine society (AASM) and technical association (APT). The BRPT consults with and utilizes input from the fields of respiratory therapy, adult and pediatric pulmonology, adult and pediatric neurology, electroneurodiagnostic technology (EMG & EEG), cardiology, (ECG), psychology, otorhinolaryngology and other medical specialties and subspecialties which are directly or peripherally involved with sleep disorders of one type or another. The NBRC's thrust is solely on the respiratory/cardiopulmonary side. The BRPT feels the field is too diverse to be placed under the aegis of an organization whose current thrust is just cardiopulmonary even if that thrust is to a far greater depth than any sleep tech would be required to perform. The BRPT has always and continues to accord dispensation to credentialed RTs to take the polysomnographic exam by allowing them to do so without benefit of any other pre-requisite other than 6 months experience working in a sleep lab; but, they value RTs as essentially equal members of the polysomnographic team. Their philosophy is not to exclude or restrain any properly trained individual from sitting the exam and, if they can pass it, be accorded the BRPT credential.

On the subject of dual credentialing that an NBRC sub-specialty exam would engender, the BRPT feels a second credential would directly compete with the BRPT credential. This could lead to candidates "shopping" both exams to see which is better for them. It would cause confusion among patients, physicians, hospitals, and the sleep medicine community at large. It would also complicate pathways to education. The respiratory curriculum is much longer and encompasses skill sets and training not required of a sleep technologist. This would make it much more expensive, would lower numbers of individuals available to work in either field, RT or sleep, and negatively impact patient diagnosis and care.

Sleep techs need a smattering of knowledge from several otherwise unrelated fields while RT has developed into a complex field all its own requiring in-depth knowledge and far more critical patient care responsibilities than that required of sleep technologists who are recording data and applying a few "respiratory procedures" on a trial basis. For example life threatening emergencies in sleep labs are extremely rare to almost non-existent whereas they are an everyday occurrence for the RT professional. Unstable patients are not, nor should they be, sent into a sleep lab for testing. They are hospitalized, RT administered PAP if required, and then sent as outpatients to the lab after they are stable and it is safe to do so. Third party payers categorize sleep testing as an outpatient procedure. But recognizing that cardiac arrests can occur anyplace, anytime, the BRPT requires sleep techs to have current BCLS training and certification in order to take the BRPT exam and maintain their credential. It remains to be seen what the NBRC survey will show and what action that organization takes on it. We will have to wait and see.

genation, improves symptoms of heart failure, improves the left ventricular ejection fraction and decreases sympathetic nervous activity. Nearly half of those with stable and optimally treated congestive heart failure have an apnea-hypopnea index of more than 26 episodes per hour with central apnea or obstructive apnea during sleep associated with oxygen desaturation. NPPV and CPAP are both safe and effective clinical applications for patients with congestive heart failure and sleep disturbances. Indeed, in patients with CHF, NPPV or CPAP may improve oxygenation by enhancing the opportunity for improved V/Q matching, enhancement of lung volumes and reducing the effects of hypoxic events by increasing oxygen stores.

Two to six hours a day of NPPV therapy can significantly reduce the effects of dyspnea. The mechanism of action is the topic of several theories attempting to explain why intermittent NPPV is effective. One theory holds that intermittent rest of chronically fatigued muscles improves respiratory-muscle function. Another theory says that intermittent NPPV improves lung compliance in patients with neuromuscular or chest-wall disease by recruiting atelectatic regions of the lung. A third theory holds that by preventing nocturnal hypoventilation NPPV prevents the blunting effect of the central ventilatory drive that occurs with hypercapnic states.

A significant population of the most severely ill patients may be able to avoid both the trauma and potential risks of endotracheal intubation and mechanical ventilation through greater utilization of NPPV. NPPV is an evidence based option that is an effective treatment for specific patients with acute respiratory failure and clinical signs of respiratory distress. NPPV can have a positive impact on the quality of life in selected patients with chronic respiratory and sleep conditions and appears to have some benefit for patients with acute cardiogenic pulmonary edema and congestive heart failure. Indeed, the widest clinical application seems to be in the population of patients with sleep-related breathing disorders. The complete and informed practitioner should expand their awareness of noninvasive ventilation devices and techniques. It is the responsibility of every caregiver to offer evidenced based therapeutic options for all of their patients. NPPV holds great promise for delivering more care with fewer traumas to our patients with severe respiratory insufficiency and CHF.

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