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Non-invasive ventilation: When does it fail?

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Noninvasive ventilation in hypercapnic acute respiratory failure due to chronic obstructive pulmonary disease vs. other conditions: Effectiveness and predictors of failure

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Aim of the study

The aim of this study was to determine the effectiveness and risk factors of noninvasive ventilation (NIV) in hypercapnic acute respiratory failure (ARF) due to chronic obstructive pulmonary disease (COPD) versus other common pulmonary causes of ARF.

Methods

Study population

One hundred and eleven patients with hypercapnic ARF treated with NIV were included in this study. Fourty three had COPD exacerbations and 68 patients other conditions including 37 with pneumonia, 11 with neuro-musculoskeletal disorders, 9 with pulmonary edema, 5 with bronchiectasis, 3 with sepsis and 3 with asthma. Baseline main characteristics of the two groups were similar for age (72 years vs. 67 years), gender (male/female 35/8 vs. 39/29), vital signs and arterial blood gases (ABGs).

Protocol and treatment

In this study, NIV was delivered via Bi-Level Positive Airway Pressure (BiPAP) in the spontaneous/timed mode, starting an inspiratory positive airway pressure (IPAP) of 18 cmH_2O and an expiratory positive airway pressure (EPAP) of 4 cmH_2O; adjusting settings based upon continuous pulse oximetry and ABGs. Initially, oronasal masks where used for patient comfort, and after 24 hours nasal masks if the patient had not tolerated the first one. The duration of NIV was of 6 hours and endotracheal intubation (ETI) was performed when a patient had indications for NIV failure including: respiratory arrest, psychomotor agitation requiring sedation, systolic blood pressure < 70 mmHg, pH <7.26 after 1 hour of NIV and based on clinical judgment.

The risks for NIV failure (need for ETI) were measured as well as other predictors such as the Acute Physiology and Chronic Health Evaluation (APACHE) II score, presence of pneumonia, tachycardia or hypercapnia. Multivariate analysis was used to identify dependent and independent predictors for NIV failure.

Results

In both groups, the BiPAP settings were adjusted similarly. Both groups showed improved vital signs and ABGs after 1 hour of initiation of therapy. The failure rate in the COPD group was 19% vs. 47% in the non-COPD group (p=0.002). The mortality was 12% for the COPD group vs. 35% in the non-COPD (p=0.006), and the length of hospitalization was also lower in the COPD patients. The predictors for NIV failure reported included worsening ABGs (95%), worsening clinical status (90%), drowsiness (78%) and mask intolerance (5%).

In the COPD patient group, a high APACHE II score was the only variable associated with NIV failure (OR

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5.38 per 5 points, 95% CI 1.61-18.38, p=0.007). In the non-COPD group the independent predictors identified where the presence of pneumonia (65% of failures in this group), high APACHE II scores, rapid heart rate and a high $PaCO_2$ one hour after NIV. The failure of NIV was an independent predictor of ICU mortality (COPD 43% vs. 0% in the non-COPD group), as well as in-hospital mortality (55% vs. 10 % respectively) and longer ICU length of stay (median 7 vs. 3 days; p<0.001).

Conclusion

The authors conclude that NIV is more effective in patients with ARF due to COPD than the non-COPD conditions, particularly pneumonia. A high APACHE II score was a predictive variable in both groups for ETI. NIV failure was also an independent predictor of mortality.

Commentary

Non-invasive ventilation is a common form of ventilatory support via the patient's upper airway using a mask [1,2]. Although initially used in patients with neuromuscular disease NIV is accepted as the standard in hypercapnic and hypoxemic acute respiratory failure caused by COPD, restrictive lung disease from chest wall deformity, neuromuscular disease, pulmonary edema, ARF in cancer patients, and asthma [3-9].

The study by Phua and coworkers is important to critical care practitioners and consistent with previous NIV success rate reports [6-8]. This trial, compared to previous studies, compares NIV in different lung conditions attempting to predict success and failure rates.

NIV has several advantages in modern acute care medicine and for patients with chronic respiratory and neuromuscular disorders. Plant and colleagues, in a clinical study demonstrated that NIV is highly cost-effective in both reducing the costs and decreasing in-hospital mortality in patients with COPD and ARF in the United Kingdom [10]. When properly applied, NIV reduces the need for ETI and its associated complications.

NIV application for a variety of clinical conditions continues to evolve as the patient-ventilator interfaces are becoming widely used. New interesting devices are emerging, like a closed Helmet system described by Pelosi and associates [13]. Utilizing simpler devices and interfaces will allow clinicians to widely use NIV. However, clinicians must be aware of predictors of failure of NIV and their consequences.

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