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Non-invasive ventilation in chronic hypercapnic COPD. Introduction.

Non-invasive ventilation (NIV) is widely accepted for the treatment of chronic respiratory failure arising from various aetiologies such as neuromuscular diseases, thoracic restrictive disorders, obesity hypoventilation syndrome and chronic obstructive pulmonary disease (COPD). Due to the conflicting results of previous studies, however, the treatment of chronic hypercapnic COPD using home mechanical ventilation has been an ongoing matter of debate for the last decade.

Chronic hypercapnic respiratory failure arises from an imbalance in the load imposed on the respiratory pump and its capacity. Several diseases known to cause chronic hypercapnic respiratory failure include neuromuscular disorders, thoracic restrictive disorders, obesity hypoventilation syndrome and COPD. Long-term NIV as used for home mechanical ventilation has become a widely accepted treatment option for the majority of patients with such diseases, where NIV is initiated mainly in hospital, whilst long-term treatment is primarily provided at home during the night. Beside relieving the symptoms of chronic hypercapnic respiratory failure, there is increasing evidence that NIV is able to improve health-related quality of life (HRQOL) and long-term survival in most treated patients. Therefore, NIV should be offered routinely for the treatment of chronic hypercapnic respiratory failure to patients with neuromuscular disorders and thoracic restrictive diseases, as it has been reported to improve survival in this patient cohort.

Nevertheless, the use of NIV to treat chronic hypercapnic COPD is still a matter of debate. Although, HRQOL is reported to be improved by long-term NIV in COPD patients, its impact...
on survival still needs to be assessed in light of the contradictory results published in the past \[12-15\]. There is increasing evidence that it is the NIV technique that mainly impacts outcome parameters other than survival \[16,17\]. Higher inspiratory pressures are suggested to be more effective than lower inspiratory pressures in terms of carbon dioxide reduction and improvements in lung function parameters, HRQOL, exercise capacity and NIV compliance \[18\]. The NIV technique of using higher inspiratory pressures was introduced as “high-intensity non-invasive positive pressure ventilation”\[18\]. Nevertheless, the influence of this technique on long-term survival still needs to be addressed.

There is some evidence that home mechanical ventilation might be beneficial in chronic hypercapnic COPD patients after recovery from acute exacerbation \[19,20\]. However, it still needs to be assessed whether long-term NIV applied after acute hypercapnic exacerbation in these patients results in improved survival or a reduction in exacerbation frequency. Several on-going multicentre randomised controlled trials in Europe are addressing the remaining unanswered questions as to whether home mechanical ventilation applied in chronic hypercapnic COPD is capable of improving long-term survival and reducing exacerbation frequency.

In COPD patients, pulmonary rehabilitation has been shown to improve important physiological and clinical parameters such as exercise tolerance and dyspnoea, but also HRQOL \[21,22\]. Chronic hypercapnia is not an exclusion criterion per se for pulmonary rehabilitation of patients with COPD. Therefore, several trials investigated the use of night-time NIV, in addition to pulmonary rehabilitation, to treat nocturnal hypoventilation \[23-25\]. Here, NIV was shown to augment the benefits of pulmonary rehabilitation by improving HRQOL, functional status and gas exchange \[23-25\]. Only a few studies investigated the application of NIV during exercise in stable hypercapnic COPD patients. Although the administration of NIV during exertion in COPD patients cannot be routinely recommended, it has been shown that NIV is capable of improving oxygenation, exercise capacity and dyspnoea during exertion \[26\]. As a result, NIV applied during exertion and rehabilitation has emerged as a new potential indication for NIV in chronic hypercapnic COPD patients.

The points discussed clearly illustrate the broad spectrum of NIV indications for chronic hypercapnic COPD including treatment of night-time hypoventilation, persistent hypercapnia after acute exacerbation, in rehabilitation settings and, in some cases, during physical activity.
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BACKGROUND: Sleep hypoventilation has been proposed as a cause of progressive hypercapnic respiratory failure and death in patients with severe chronic obstructive pulmonary disease (COPD). A study was undertaken to determine the effects of nocturnal non-invasive bi-level pressure support ventilation (NIV) on survival, lung function and quality of life in patients with severe hypercapnic COPD.

METHOD: A multicentre, open-label, randomised controlled trial of NIV plus long-term oxygen therapy (LTOT) versus LTOT alone was performed in four Australian University Hospital sleep/respiratory medicine departments in patients with severe stable smoking-related COPD (forced expiratory volume in 1 s (FEV1.0) <1.5 litres or <50% predicted and ratio of FEV1.0 to forced vital capacity (FVC) <60% with awake arterial carbon dioxide tension (PaCO₂) >46 mm Hg and on LTOT for at least 3 months) and age <80 years. Patients with sleep apnoea (apnoea-hypopnoea index >20/h) or morbid obesity (body mass index >40) were excluded. Outcome measures were survival, spirometry, arterial blood gases, polysomnography, general and disease-specific quality of life and mood.

RESULTS: 144 patients were randomised (72 to NIV + LTOT and 72 to LTOT alone). NIV improved sleep quality and sleep-related hypercapnia acutely, and patients complied well with therapy (mean (SD) nightly use 4.5 (3.2) h). Compared with LTOT alone, NIV (mean follow-up 2.21 years, range 0.01–5.59) showed an improvement in survival with the adjusted but not the unadjusted Cox model (adjusted hazard ratio (HR) 0.63, 95% CI 0.40 to 0.99, p = 0.045; unadjusted HR 0.82, 95% CI 0.53 to 1.25, p = NS). FEV1.0 and PaCO₂ measured at 6 and 12 months were not different between groups. Patients assigned to NIV + LTOT had reduced general and mental health and vigour.

CONCLUSIONS: Nocturnal NIV in stable oxygen-dependent patients with hypercapnic COPD may improve survival, but this appears to be at the cost of worsening quality of life.

PMID: 19213769
[PubMed – indexed for MEDLINE]

**RATIONALE:** The conventional approach of low-intensity non-invasive positive pressure ventilation (NPPV) produces only minimal physiological and clinical benefits in patients with stable hypercapnic chronic obstructive pulmonary disease (COPD).

**OBJECTIVES:** To determine whether the novel approach of high-intensity NPPV is superior to low-intensity NPPV in controlling nocturnal hypoventilation.

**METHODS:** A randomised controlled crossover trial comparing 6 weeks of high-intensity NPPV (using controlled ventilation with mean inspiratory pressures of 28.6±1.9 mbar) with low-intensity NPPV (using assisted ventilation with mean inspiratory pressures of 14.6±0.8 mbar) was performed in 17 patients with severe stable hypercapnic COPD.

**RESULTS:** Two patients refused low-intensity NPPV and two patients dropped out while on low-intensity NPPV. Thirteen patients (mean forced expiratory volume in 1 s (FEV₁) 0.76±0.29 l) completed the trial. High-intensity NPPV produced higher pneumotachographically-measured expiratory volumes, with a mean treatment effect of 96 ml (95% CI 23 to 169) (p=0.015). This resulted in a mean treatment effect on nocturnal arterial carbon dioxide tension (PaCO₂) of −9.2 mm Hg (95% CI −13.7 to −4.6) (p=0.001) in favour of high-intensity NPPV. Daily use of NPPV was increased in high-intensity NPPV compared with low-intensity NPPV, with a mean difference of 3.6 h/day (95% CI 0.6 to 6.7) (p=0.024). In addition, compared with baseline, only high-intensity NPPV resulted in significant improvements in exercise-related dyspnoea, daytime PaCO₂, FEV₁, vital capacity and the Severe Respiratory Insufficiency Questionnaire Summary Score.

**CONCLUSIONS:** High-intensity NPPV is better tolerated by patients with severe chronic hypercapnic COPD and has been shown to be superior to the conventional and widely-used form of low-intensity NPPV in controlling nocturnal hypoventilation. High-intensity NPPV therefore offers a new promising therapeutic option for these patients.

**PMID:** 20388753

[PubMed – indexed for MEDLINE]
Abstract. Physiological changes during low- and high-intensity noninvasive ventilation.

In a physiological randomised cross-over study performed in stable hypercapnic chronic obstructive disease patients, we assessed the short-term effects of two settings of noninvasive ventilation. One setting was aimed at maximally reducing arterial carbon dioxide tension (P<sub>a</sub>CO<sub>2</sub>) (high-intensity (Hi) noninvasive positive pressure ventilation (NPPV)): mean ± SD 27.6 ± 2.1 cmH<sub>2</sub>O of inspiratory positive airway pressure, 4 ± 0 cmH<sub>2</sub>O of expiratory positive airway pressure and respiratory rate of 22 breaths • min<sup>−1</sup>. The other was performed according to the usual parameters used in earlier studies (low-intensity (Li)-NPPV): 17.7 ± 1.6 cmH<sub>2</sub>O of inspiratory positive airway pressure, 4 ± 0 cmH<sub>2</sub>O of expiratory positive airway pressure and respiratory rate of 12 breaths • min<sup>−1</sup>. Both modes of ventilation significantly improved gas exchange compared with spontaneous breathing (SB), but to a greater extent using Hi-NPPV (P<sub>a</sub>CO<sub>2</sub>) 59.3 ± 7.5, 55.2 ± 6.9 and 49.4 ± 7.8 mmHg for SB, Li-NPPV and Hi-NPPV, respectively). Similarly, Hi-NPPV induced a greater reduction in the pressure-time product of the diaphragm per minute from 323 ± 149 cmH<sub>2</sub>O • s • min<sup>−1</sup> during SB to 132 ± 139 cmH<sub>2</sub>O • s • min<sup>−1</sup> during Li-NPPV and 40 ± 69 cmH<sub>2</sub>O • s • min<sup>−1</sup> during Hi-NPPV, while in nine out of 15 patients, it completely abolished SB activity. Hi-NPPV also induced a marked reduction in cardiac output (CO) measured noninvasively with a Finometer PRO (Finapres Medical Systems BV, Amsterdam, the Netherlands) compared with Li-NPPV. We conclude that while Hi-NPPV is more effective than Li-NPPV in improving gas exchange and in reducing inspiratory effort, it induces a marked reduction in CO, which needs to be considered when Hi-NPPV is applied to patients with pre-existing cardiac disease.

PMID: 21885393
[PubMed – in process]


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INTRODUCTION: Noninvasive ventilation (NIV) is a well-established treatment for acute-on-chronic respiratory failure in hypercapnic COPD patients. Less is known about the effects of a long-term treatment with NIV in hypercapnic COPD patients and about the factors that may predict response in terms of improved oxygenation and lowered CO₂ retention.

METHODS: In this study, we randomized 15 patients to a routine pharmacological treatment (n = 5, age 66 [standard deviation ± 6] years, FEV₁ 30.5 [±5.1] %pred, PaO₂ 65 [±6] mmHg, PaCO₂ 52.4 [±6.0] mmHg) or to a routine treatment and NIV (using the Synchrony BiPAP device [Respironics, Inc, Murrieville, PA]) (n = 10, age 65 [±7] years, FEV₁ 29.5 [±9.0] %pred, PaO₂ 59 [±13] mmHg, PaCO₂ 55.4 [±7.7] mmHg) for 6 months. We looked at arterial blood gases, lung function parameters and performed a low-dose computed tomography of the thorax, which was later used for segmentation (providing lobe and airway volumes, iVlobe and iVaw) and post-processing with computer methods (providing airway resistance, iRaw) giving overall a functional image of the separate airways and lobes.

RESULTS: In both groups there was a nonsignificant change in FEV₁ (NIV group 29.5 [9.0] to 38.5 [14.6] %pred, control group 30.5 [5.1] to 36.8 [8.7] mmHg). PaCO₂ dropped significantly only in the NIV group (NIV: 55.4 [7.7] → 44.5 [4.7], P = 0.0076; control: 52.4 [6.0] → 47.6 [8.2], NS). Patients actively treated with NIV developed a more inhomogeneous redistribution of mass flow than control patients. Subsequent analysis indicated that in NIV-treated patients that improve their blood gases, mass flow was also redistributed towards areas with higher vessel density and less emphysema, indicating that flow was redistributed towards areas with better perfusion. There was a highly significant correlation between the % increase in mass flow towards lobes with a blood vessel density of >9% and the increase in PaO₂. Improved ventilation-perfusion match and recruitment of previously occluded small airways can explain the improvement in blood gases.

CONCLUSION: We can conclude that in hypercapnic COPD patients treated with long-term NIV over 6 months, a mass flow redistribution occurs, providing a better ventilation-perfusion match and hence better blood gases and lung function. Control patients improve homogeneously in iVaw and iRaw, without improvement in gas exchange since there is no improved ventilation/perfusion ratio or increased alveolar ventilation. These differences in response can be detected through functional imaging, which gives a more detailed report on regional lung volumes and resistances than classical lung function tests do. Possibly only patients with localized small airway disease are good candidates for long-term NIV treatment. To confirm this and to see if better arterial blood gases also lead to better health related quality of life and longer survival, we have to study a larger population.

PMID: 22135493
[PubMed – indexed for MEDLINE]
Abstract. Long-term non-invasive ventilation in COPD after acute-on-chronic respiratory failure.

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BACKGROUND: COPD patients who remain hypercapnic after acute respiratory failure requiring mechanical ventilation have a poor prognosis. Long-term nocturnal non-invasive ventilation (NIV) may be beneficial for these patients. We hypothesized that stable patients on long-term NIV would experience clinical worsening after withdrawal of NIV.

METHODS: We included 26 consecutive COPD patients (63 ± 6 years, 58% male, FEV₁ 31 ± 14% predicted) who remained hypercapnic after acute respiratory failure requiring mechanical ventilation. After a six month run-in period, during which all patients received NIV, they were randomised to either continue (ventilation group, n = 13) or to stop NIV (withdrawal group, n = 13). The primary endpoint was time to clinical worsening defined as an escalation of mechanical ventilation.

RESULTS: All patients remained stable during the run-in period. After randomisation the withdrawal group had a higher probability of clinical worsening compared to the ventilation group (p = 0.0018). After 12 months, ten patients (77%) in the withdrawal group, but only two patients (15%) in the ventilation group, experienced clinical worsening (p = 0.0048). Six-minute walking distance increased in the ventilation group.

CONCLUSION: COPD patients who remain hypercapnic after acute respiratory failure requiring mechanical ventilation may benefit from long-term NIV.

PMID: 21111590
[PubMed – indexed for MEDLINE]
Abstract. Long-term non-invasive ventilation to manage persistent ventilatory failure after COPD exacerbation.

BACKGROUND AND OBJECTIVE: Patients with ventilatory failure at discharge from hospital following an exacerbation of COPD (ECOPD) have increased work of breathing and reduced inspiratory muscle strength compared with those with a normal arterial carbon dioxide tension (PaCO₂). They also have a significantly worse prognosis. Long-term non-invasive positive pressure ventilation (NIPPV) may offer a treatment strategy but benefits have not been established.

METHODS: We examined the outcomes of 35 patients, with a PaCO₂ >7.5 kPa and normal pH, following hospital admission with an ECOPD. Patients were initiated on long-term NIPPV. Our aims were to establish if NIPPV was tolerated and to describe the effects on ventilatory parameters.

RESULTS: Daytime arterial blood gases and nocturnal ventilatory parameters improved significantly on NIPPV. Diurnal PaO₂, self-ventilating, rose from (mean (SD)) 7.3 (1.8) to 8.1 (0.9) kPa (P = 0.005) and PaCO₂ fell from 8.8 (1.3) to 7.3 (0.8) kPa (P < 0.001). Mean overnight oxygen saturations increased from 82% (7%) to 89% (2%) (P < 0.001) and mean overnight transcutaneous carbon dioxide fell from 7.6 (1.3) to 5.6 (1.7) kPa (P < 0.001). Similar changes were seen in a group of stable COPD patients, who initiated NIPPV without a preceding exacerbation, suggesting improvements were not solely due to recovery from exacerbation. Acceptance (89%) and compliance (8.4 (3.5) h/day) with domiciliary treatment were good. Median survival was 28.6 months (95% CI: 10.9–46.8).

CONCLUSIONS: NIPPV was well tolerated in this group and appears to improve ventilation. Our preliminary data support further investigation of NIPPV in patients who remain hypercapnic after hospital admission with ECOPD.

PMID: 20546195 [PubMed – indexed for MEDLINE]
Abstract. Nocturnal non-invasive ventilation in addition to rehabilitation in hypercapnic patients with COPD.


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**BACKGROUND:** Long-term non-invasive positive pressure ventilation (NIPPV) might improve the outcomes of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease (COPD) with chronic respiratory failure. A study was undertaken to investigate whether nocturnal NIPPV in addition to pulmonary rehabilitation improves health-related quality of life, functional status and gas exchange compared with pulmonary rehabilitation alone in patients with COPD with chronic hypercapnic respiratory failure.

**METHODS:** 72 patients with COPD were randomly assigned to nocturnal NIPPV in addition to rehabilitation (n = 37) or rehabilitation alone (n = 35). Outcome measures were assessed before and after the 3-month intervention period.

**RESULTS:** The Chronic Respiratory Questionnaire total score improved 15.1 points with NIPPV + rehabilitation compared with 8.7 points with rehabilitation alone. The difference of 7.5 points was not significant (p = 0.08). However, compared with rehabilitation alone, the difference in the fatigue domain was greater with NIPPV + rehabilitation (mean difference 3.3 points, p<0.01), as was the improvement in the Maugeri Respiratory Failure questionnaire total score (mean difference ~10%, p<0.03) and its cognition domain (mean difference ~22%, p<0.01). Furthermore, the addition of NIPPV improved daytime arterial carbon dioxide pressure (mean difference ~0.3 kPa; p<0.01) and daily step count (mean difference 1269 steps/day, p<0.01). This was accompanied by an increased daytime minute ventilation (mean difference 1.4 l; p<0.001).

**CONCLUSION:** Non-invasive ventilation augments the benefits of pulmonary rehabilitation in patients with COPD with chronic hypercapnic respiratory failure as it improves several measures of health-related quality of life, functional status and gas exchange.

PMID: 18710905

[PubMed – indexed for MEDLINE]
Abstract. Two-year home-based nocturnal noninvasive ventilation added to rehabilitation in chronic obstructive pulmonary disease patients: a randomized controlled trial.

BACKGROUND: The use of noninvasive intermittent positive pressure ventilation (NIPPV) in chronic obstructive pulmonary disease (COPD) patients with chronic hypercapnic respiratory failure remains controversial as long-term data are almost lacking. The aim was to compare the outcome of 2-year home-based nocturnal NIPPV in addition to rehabilitation (NIPPV + PR) with rehabilitation alone (PR) in COPD patients with chronic hypercapnic respiratory failure.

METHODS: Sixty-six patients could be analyzed for the two-year home-based follow-up period. Differences in change between the NIPPV + PR and PR group were assessed by a linear mixed effects model with a random effect on the intercept, and adjustment for baseline values. The primary outcome was health-related quality of life (HRQoL); secondary outcomes were mood state, dyspnea, gas exchange, functional status, pulmonary function, and exacerbation frequency.

RESULTS: Although the addition of NIPPV did not significantly improve the Chronic Respiratory Questionnaire compared to rehabilitation alone (mean difference in change between groups –1.3 points (95% CI: –9.7 to 7.4)), the addition of NIPPV did improve HRQoL assessed with the Maugeri Respiratory Failure questionnaire (–13.4% (–22.7 to –4.2; p = 0.005)), mood state (Hospital Anxiety and Depression scale –4.0 points (–7.8 to 0.0; p = 0.05)), dyspnea (Medical Research Council –0.4 points (–0.8 to –0.0; p = 0.05)), daytime arterial blood gases (PaCO₂ –0.4 kPa (–0.8 to –0.2; p = 0.01); PaO₂ 0.8 kPa (0.0 to 1.5; p = 0.03)), 6-minute walking distance (77.3 m (46.4 to 108.0; p < 0.001)), Groningen Activity and Restriction scale (–3.8 points (–7.4 to –0.4; p = 0.03)), and forced expiratory volume in 1 second (115 ml (19 to 211; p = 0.019)). Exacerbation frequency was not changed.

CONCLUSIONS: The addition of NIPPV to pulmonary rehabilitation for 2 years in severe COPD patients with chronic hypercapnic respiratory failure improves HRQoL, mood, dyspnea, gas exchange, exercise tolerance and lung function decline. The benefits increase further with time.

PMID: 21861914
[PubMed – indexed for MEDLINE]
Abstract. Noninvasive ventilation in pulmonary rehabilitation of COPD patients.

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Noninvasive positive pressure ventilation (NIPPV) has been shown to improve exercise tolerance and health-related quality of life in patients with advanced COPD. This study tested the feasibility of nocturnal NIPPV as an additional tool in a hospital-based pulmonary rehabilitation program. This prospective observational trial included forty COPD patients in GOLD stage IV. NIPPV was successfully introduced and accepted during sleep by all patients. All patients received pressure support ventilation for 7.9±0.5h per day with an inspiratory support of 17.5±4.4 cmH₂O, and an expiratory pressure of 4.5±0.9 cmH₂O. The outcome of pulmonary rehabilitation in patients receiving nocturnal NIPPV was compared with the results of forty matched control patients who underwent the same program. Rehabilitation with nocturnal NIPPV resulted in the 6-minute walk test and in the longest non-stop walk distance in improvements of 82 and 89 m, respectively, while patients without nocturnal ventilatory support improved by 50 and 51 m (p<0.04 and p<0.03 between groups, respectively). Further significant improvements were found for FEV₁, lung hyperinflation, and blood gases in the NIPPV treated, but not in the control subjects. Health-related quality of life, assessed by the SF-36 questionnaire, improved moderately or largely in patients receiving NIPPV in the categories role-physical, vitality, social function, and mental health. Control subjects improved moderately in vitality only. In conclusion, nocturnal NIPPV is feasible and enhances the effects of pulmonary rehabilitation in advanced stage COPD.

PMID: 19362809
[PubMed – indexed for MEDLINE]
Abstract. Noninvasive ventilation during walking in patients with severe COPD: a randomised cross-over trial.

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It was hypothesised that noninvasive positive-pressure ventilation (NPPV) applied during walking prevents exercise-induced hypoxaemia and improves exercise performance in severe chronic obstructive pulmonary disease (COPD) patients already receiving long-term NPPV. A total of 20 COPD patients (mean±sd age 65.1±8.7 yrs, forced expiratory volume in one second 27±8% predicted and total lung capacity 116±27% pred) reporting dyspnoea, even during mild exertion, underwent two 6-min walking tests with a rollator and supplemental oxygen (2.1±0.9 L.min⁻¹) in a randomised cross-over design: with and without pressure-limited NPPV as used at home (inspiratory:expiratory pressure 2.9±0.44:0.4±0.1 kPa (29±4:4±1 mbar), respiratory frequency 20±2 breaths. min⁻¹). The arterial oxygen tension significantly increased by 1.39±1.43 kPa (95% confidence interval (CI) 0.71–2.07 kPa) after walking with NPPV, but significantly decreased by 1.43±1.06 kPa (95% CI –1.92 to –0.94 kPa) without NPPV. Dyspnoea, as assessed by the Borg dyspnoea scale, significantly decreased from 6 (interquartile range (IQR) 4.5–10) to 4 (1.5–4.5) and walking distance significantly increased from 209 (IQR 178–279) to 252 (203–314) m when walking was NPPV-aided. In chronic hypercapnic chronic obstructive pulmonary disease, high-intensity noninvasive positive-pressure ventilation can also be administered during walking with unchanged ventilator settings compared with settings used at rest, thus resulting in improved oxygenation, decreased dyspnoea and increased walking distance. Therefore, noninvasive positive-pressure ventilation during walking could prevent hypoxia-induced complications and could, in future, play a role in palliative care.

PMID: 17331969
[PubMed – indexed for MEDLINE]
Abstract. Non-invasive ventilation during arm exercise and ground walking in patients with chronic hypercapnic respiratory failure.

BACKGROUND AND OBJECTIVE: People with chronic hypercapnic respiratory failure (HRF) often have a ventilatory limitation to exercise with difficulty performing activities of daily living. Although non-invasive ventilation (NIV) appears to reduce the ventilatory limitation and improve exercise performance in people with severe COPD, the effect of NIV during functional activities such as unsupported arm exercise (UAE) and ground walking in people with chronic HRF is unclear.

METHODS: Seventeen patients with chronic HRF (PaCO₂ 52.1 ± 5.3 mm Hg) performed a series of UAE tests, and 15 patients (PaCO₂ 51.7 ± 3.8 mm Hg) performed a series of endurance shuttle walk tests, with and without NIV in a randomized cross-over design.

RESULTS: NIV during UAE increased endurance time by a mean of 91 s (95% confidence interval (CI): 10–172, P = 0.031) and reduced dyspnoea by a mean of 2.3 on the Borg scale (95% CI: 1.0–3.7, P = 0.002) compared with exercise without NIV. There was a non-significant increase in walking endurance time with NIV during exercise (119 s, 95% CI: –17 to 254, P = 0.081); however, isotime dyspnoea was unchanged compared with walking without NIV (–1.0, 95% CI: –3.0 to 1.0, P = 0.29).

CONCLUSION: NIV during UAE increased endurance time and reduced dyspnoea compared with exercise without NIV in patients with chronic HRF. Investigation of the role of NIV as an adjunct to UAE training is warranted. In contrast, NIV during ground walking did not improve exercise capacity. However, the pressure support provided may have been inadequate as dyspnoea was not reduced.

PMID: 19210652
[PubMed – indexed for MEDLINE]