# 155. Advances in long-term noninvasive positive pressure ventilation

**1430**

**Respiratory mechanical and cardio-vascular changes during non invasive ventilation in stable COPD patients with chronic hypercapnic respiratory failure: High intensity ventilation vs low intensity ventilation**

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In a subgroup of stable COPD patients with chronic hypercapnic respiratory failure (HRF) the use of conventional NPPV (Li-NPPV), can improve pulmonary function, gas exchange, and health related quality of life. High-intensity positive pressure ventilation (Hi-NPPV) with higher IPAP (28 cmH20) and respiratory rate (20/min) were recently adopted in order to achieve maximal PaCO2 reduction and has been shown to better improve diurnal blood gas during spontaneous breathing (SB), compared to Li-NPPV. NPPV can provoke alterations in intrapleural pressure and lung volume, which influence the cardio-vascular performance. Our study evaluates the respiratory mechanical (RM) and cardio-vascular (CV) effects of Li-NPPV and HI-NPPV, in 15 stable COPD patients with HRF. We measured the RM and blood gas parameters, in addition non-invasive measurement of CV parameters was performed. The data were reported as mean ±SD, and where compared with repeated measures ANOVA. Significant (sgn) increases were observed in pleural pressure, decrease in tans-diaphragmatic pressure and minute diaphragmatic pressure-time product (SB: 323±149; Li-NPPV: 132±139; Hi-NPPV: 40±69 cmH2O·s/min). The PaCO2 showed a sgn. decrease and the pH a sign. increase during either modalities of NPPV. Significant reduction were detected in arterial blood pressure, stroke volume, cardiac output (SB: 5.5±1.14; NPPV: 4,7±0.98; Hi-NPPV: 4.00±0.96 l/min) and oxygen transport. The long-term effects of this RM and CV changes are uncertain, accordingly further long-term studies are needed to determine its effect on survival.

**1431**

**Lobar airway resistance and tissue stiffness in hypercapnic COPD patients eligible for NIV treatment**

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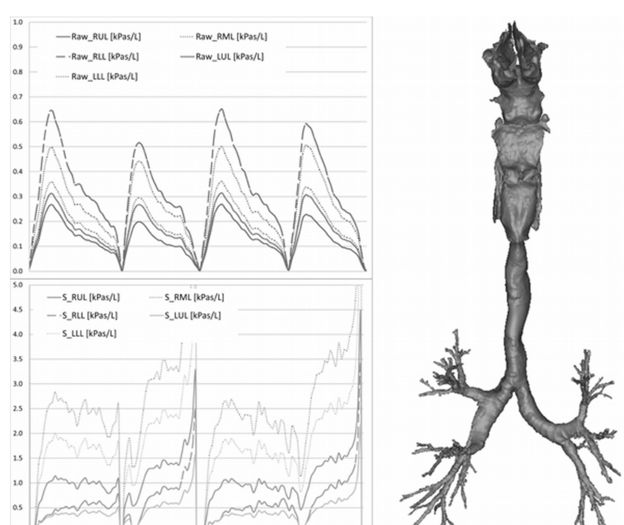
**Introduction:** The internal airflow redistribution under non-invasive ventilation (NIV) is dependent on lobar airway resistance (Raw) and tissue stiffness (S). This study aims to calculate lobar R and S using functional imaging (FI) updated with computational fluid dynamics (CFD).

**Methods:** 20 persistent hypercapnic COPD GOLD III patients, eligible for NIV treatment, undergo a low dose CT scan at FRC and TLC. From these scans airway tree and lobar expansion (=internal flow distribution) are obtained. Also a simultaneous respiratory flow and esophageal pressure (peso) measurement is performed. CFD calculations using the 3D model, measured flow rates and internal



distribution, provide lobar Raw and pressure. The difference in lobar pressure and peso, together with lobar inflow, provide lobar S.

**Results:** Results show that the lobar Raw profile has a similar shape as the flow profile. The lobar S profile is constant during expiration. During inspiration lobar S does increase exponentially near the end of the inspiration. Furthermore it can be seen that both Raw and S do vary significantly between the different lobes.

**Conclusions:** Lobar Raw and S can be obtained through FI updated with CFD, by taking a CT scan and a simultaneous flow and peso measurement. Information on these lobar properties can be used to predict the outcome non-invasive ventilation.

**1432**

**HOT HMV UK: An investigation into mechanisms of action of home mechanical ventilation (HMV) following acute hypercapnic exacerbations of COPD**

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**Introduction:** HMV in COPD remains controversial. Current data indicates improvements in arterial carbon dioxide ($PaCO_2$) are mediated by improved pulmonary mechanics and hypercapnic ventilatory response (HCVR). This hypothesis has yet to be tested in a controlled trial and no studies have investigated changes in neural respiratory drive (NRD) measured by parasternal EMG ($EMG_{para}$).

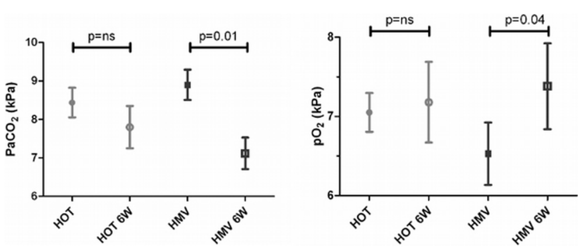
**Method:** Patients with persistent hypercapnia ($PaCO_2$ >7 kPa) 2-4 weeks after resolution of an acute exacerbation of COPD were randomised to home oxygen therapy (HOT) or HOT and HMV. Baseline studies included HCVR and $EMG_{para}$. Patients were re-studied at 6 weeks.

**Results:** 20 patients have been recruited and randomised.

Table 1

| | HOT (n=10) | HMV (n=10) |
|---|---|---|
| Age | 66±13 | 70±10 |
| $FEV_1$ | 0.71±0.37 | 0.56±0.16 |
| $PaCO_2$ | 8.3±0.9 | 8.2±0.7 |
| $PaO_2$ | 6.6±1.03 | 6.5±0.8 |

Follow up data is presented on 9 patients. Ventilator settings were IPAP 28±3, EPAP 5±1, RR 15±1. Significant improvement in both $PaO_2$ and $PaCO_2$ only occurred in the HMV group.




There was a significant between group difference in HCVR and NRD.

Table 2

| | HOT | HMV |
|---|---|---|
| ΔHCVR minute ventilation (l/min/kPa) | −3.1±1.9 | 0.8±2.4* |
| ΔHCVR $EMG_{para}$%max (%/kPa) | −2.0±4.2 | 7.8±7.8* |

*p<0.05.

**Conclusion:** These preliminary data suggest that the addition of HMV to HOT in this group is associated with improvements in gas exchange and this appears in part mediated by changes in HCVR and NRD suggesting "resetting" of central drive.

**1433**

**Polysomnography (PSG) under NIV in stable COPD to reduce patient-ventilator asynchrony (PVA) and morning breathlessness**

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**Introduction:** Patient-ventilator asynchrony (PVA) is frequent in COPD patients considered yet effectively treated by NIV.

**Objective:** To assess whether adjusting ventilator settings during polysomnography (PSG) might improve patient-ventilator synchronization, sleep quality and morning dyspnea ("deventilation dyspnea").

**Methods:** 8 consecutive severe COPD patients (61±8 yrs, $FEV_1$ 30.4±8.7% of predicted values) treated by home NIV underwent two consecutive sleep studies. Patient's usual ventilator settings were applied during the first night. During the second titration night ventilator settings were adjusted in order to reduce PVA by using on-line PSG including $TcPCO_2/SaO_2$ monitoring.

**Results:** During titration, pressure support was reduced in all cases from 13.6±1.8 to 10.3±1.7cm$H_2O$, p=.0005. This resulted in reduction of PVA index from 40.5%±31.0 to 6.7%±7.3 of time of recording, p=.009. Total sleep time, microarousal index and sleep efficiency were not significantly improved. NIV adjustments led to a marked decrease in morning "deventilation dyspnea" measured by a modified Borg scale (baseline 5.8±2.5; adjusted 2.3±1.6, p=.0059). Comfort of ventilation assessment using visual analog scales showed significant improvements in perceived PVA (p=.04), perception of leaks (p=.04) and overall quality of sleep (p=.01). Pressure support reduction had no effect on nocturnal $TcPO_2$.

**Conclusion:** This study confirms a high 40% rate of PVA in severe COPD under home ventilation usually undetected without PSG. Adjusting ventilator settings using online PSG resulted in: improvements in patient ventilator synchronization, patient comfort and decreased "deventilation dyspnea" without negative impact on nocturnal $TcPO_2$.

**1434**

**Impact of exhalation system and additional leak on oxygenation during noninvasive ventilation**

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**Objective:** Supplemental oxygen ($O_2$) when added to longterm noninvasive ventilation (NIV) is usually inserted into the ventilatory circuit next to the ventilator, but the impact of different exhalation systems and leaks on actual $FiO_2$ needs to be elucidated.

**Methods:** Four daytime measurements (each 60 minutes, randomized) were performed in 20 patients receiving NIV and ≥2L $O_2$/min: active valve circuit (AVC) or leak circuit (LC) with and without additional artificial leak (4mm I.D.) next to the fullface mask. $FiO_2$ was measured at the site of oxygen ($FiO_2$-ventilator) as well as mask ($FiO_2$-mask) following exhalation system (AVC or LC) and opened or closed artificial leak. Capillary blood gas analyses were performed at start and end of each measurement.

**Results:** Overall, $FiO_2$-mask (29±5%) was lower compared to $FiO_2$-ventilator (34±4%) with a mean (95%CI) difference of 5.1 (4.2 to 5.9, p<0.0001)%. With LC $FiO_2$-mask decreased by 3.2 (2.6 to 3.9, p<0.0001)% compared to AVC (Figure). $PaO_2$ tended to be 6.3 (-1.0 to 13.7)mmHg lower after 60 minutes of NIV comparing LC and ACV, p=0.08. Implementing an artificial leak $FiO_2$-mask decreased by 5.7 (5.1 to 6.4, p<0.0001)% (Figure) with lowered $PaO_2$ of 10.4 (3.1 to 17.7, p<0.0001)mmHg.

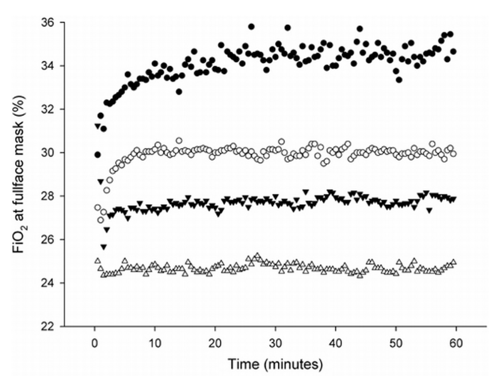


**Figure:** $FiO_2$-mask over 60 minutes of NIV with supplemental oxygen (N=20). Active valve circuit without artificial leak (filled circle), leak circuit without artificial leak (blank circle), Active valve circuit with artifical leak (filled triangle), leak circuit with artifical leak (blank triangle).

**Conclusion:** Leak circuits regularly used for exhalation during NIV and unintended air leak significantly reduce $FiO_2$ in patients receiving NIV and $O_2$, which substantially deteriorates patients' oxygenation.

**1435**

**Monitoring of non-invasive ventilation: Is the strategy used in daily practice enough?**

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**Background:** Non-invasive ventilation (NIV) is recognized as an effective treat-

ment in respiratory failure. However, empirically determined NIV settings may not achieve optimal ventilatory support. As a result, NIV should be systematically monitored. Current strategy used for this monitoring includes clinical assessment, arterial blood gases (ABG) and oximetry. Ideally, complete polysomnography should be done but actually this practice is infrequent. Simple tools such as capnography ($TcPCO_2$) or built-in ventilator software (VPAP-Reslink™, ResMed, Australia) provide reliable information but their role should be defined.
**Objectives:** To determine effectiveness of current strategy versus different simplified tools in assessing NIV effectiveness.
**Methods:** Efficacy of NIV was assessed in 95 patients. They underwent oximetry, $TcPCO_2$, Reslink and ABG during spontaneous ventilation. Subjective comfort of NIV was evaluated by questionnaire.
**Results:** While the usual approach including oximetry and ABG considered 42 patients as correctly ventilated, only 10 patients (11%) are effectively treated as questionnaire, ABG, oxymetry, $TcPCO_2$ and Reslink were normal. Therefore, current strategy gave a wrong estimate of NIV quality in 34% of patients. Adding Reslink to this strategy recognized 20 patients as inadequately ventilated whereas adding $TcPCO_2$ allowed to identify 8 patients.
An alternative non-invasive strategy combining Reslink and $TcPCO_2$ identified 21 patients with good NIV performance. Among them, 8 (9%) had pathological ABG and were badly classified.
**Conclusion:** The usual strategy overestimates quality of NIV. Combining Reslink and $TcPCO_2$ allows detecting NIV failure in 75% of patients without ABG.

**1436**

**Impact of three back-up rate (BUR) on subjective quality of sleep (QoS) and residual events in obesity-hypoventilation (OHS) treated by home non invasive ventilation (NIV): A randomised controlled trial**

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**Introduction:** NIV is widely used to treat OHS. There is however no evidence in the literature for defining optimal BUR.
**Aim of study:** To compare the impact of spontaneous ventilation (SV; BUR=0), low BUR (10.9±0.9/min) and high BUR (20.5±1.5/min) applied in random order during 3 consecutive nights in OHS patients. Main outcome: Sleep structure assessed PSG Secondary outcome: Hypoventilation and residual events.
**Methods:** Polysomnography were scored for sleep structure, obstructive (OE), central (CE) and mixed (ME) respiratory events,% time spent with patient ventilator asynchrony (PVA) and nocturnal hypoventilation meaured by TcPCO2. Two questionnaires assessed subjective QoS.
**Results:** Ten stable OHS patients under long term NIV (mean±SD; aged 55.7±9.2 yrs; BMI 48.5±5 $kg/m^2$, $PaCO_2$: 5.5±0.7 kPa) were included. Table 1 depicts main results.

Table 1

| | SV Mean (SD) | Low BURR Mean (SD) | High BURR Mean (SD) | SV vs. Low BURR | SV vs. High BURR | Low vs High BURR |
|---|---|---|---|---|---|---|
| Average $SpO_2$ (%) | 92.4 (1.4) | 92 (1.4) | 92.2 (1.3) | n.s. | n.s. | n.s. |
| ODI (/hr) | 59.3 (19.7) | 29.9 (19.5) | 21 (15) | 0.007 | 0.002 | n.s. |
| Average $PtcCO_2$ (mmHg) | 46.7 (12.1) | 45.1 (6.1) | 45.6 (7.5) | n.s. | n.s. | n.s. |
| Micro Arousals (/hr) | 37.9 (17.8) | 30.5 (15.4) | 32(19.1) | n.s. | n.s. | n.s. |
| Respiratory Event Index (/hr) | 62.3 (22.7) | 25.7 (22.2) | 16.7 (16.4) | 0.012 | 0.002 | n.s. |
| Central Event Index (/hr) | 26.9 (21.7) | 2.6 (3.9) | 3 (5.5) | 0.009 | 0.011 | n.s. |
| Mixed Event Index (/hr) | 9.7 (6.1) | 0.6 (0.9) | 0.4 (0.6) | 0.001 | 0.001 | n.s. |
| Obstructive Event Index (/hr) | 25.6 (14.9) | 22.5 (22.5) | 13.4 (16.1) | n.s. | n.s. | n.s. |
| patient ventilator asynchrony (%) | 6.4 (7.4) | 18.3 (25.6) | 13 (16.3) | n.s. | n.s. | n.s. |

ODI, CE, ME and time spent with PVA were all much higher with SV than with either low or high BUR. Subjective QoS did not differ between SV and low BUR. However subjects with high BUR perceived more awakenings and a lower QoS than with low BUR whereas their Sleep efficiency was lower.
**Conclusion:** In stable OHS patients under long term NIV, SV was associated with a very high rate of ODI, CE and ME when compared to low and high BUR. High BUR was perceived as less comfortable than low BUR.