Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide, placing a major economic burden on healthcare systems. Emphysema and chronic bronchitis are the two primary conditions of COPD. Patients with COPD face significant physiological changes that severely compromise their respiratory systems.

It is estimated that 12M people in the U.S. are currently diagnosed with COPD, and research shows us that there are likely another 12M undiagnosed COPD patients.\(^1\) COPD resulted in a total of $49.9B direct and indirect costs to the U.S. healthcare system in 2010.\(^2\) Approximately 75% of those costs are associated with exacerbations,\(^3\) one of the leading causes of hospitalizations in U.S. adults. Medicare data shows us that an alarming 22% of these COPD patients are readmitted to the hospital within 30 days of a hospital discharge.\(^4\) This has drawn the attention of policymakers, regulatory makers and federal government, with a focus on improving the care and management of these patients.

There are many treatment options for COPD, one of which is noninvasive ventilation (NIV). NIV is well established as an effective treatment for patients hospitalized with acute exacerbations of hypercapnic COPD. Routine long-term use of home NIV for COPD has not been established as the standard of care; however, it has been shown to reduce the risk of death in COPD patients over one year by 76%\(^5\).

The intense burden that COPD has on patients and global healthcare systems has everyone looking for a solution. ResMed is working with pulmonologists, healthcare systems and payors to increase awareness of NIV therapy as an effective treatment solution for hypercapnic COPD. In the following brochure, you will find abstracts that demonstrate how the use of NIV can reduce healthcare costs and hospital readmissions, plus improve mortality and patient quality of life.

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\(^1\) National Heart, Lung, and Blood Institute, COPD Learn More Breathe Better\(^6\).
\(^2\) American Lung Association, State of Lung Disease in Diverse Communities 2010.
\(^3\) ATS/ERS Standards for the diagnosis and management of patients with COPD 2004.
Non-invasive positive pressure ventilation for the treatment of severe stable chronic obstructive pulmonary disease: a prospective, multicentre, randomised, controlled clinical trial


Source: Department of Respiratory Medicine, Hannover Medical School, Hannover, Germany.

**Background:** Evidence is weak for the ability of long-term non-invasive positive pressure ventilation (NPPV) to improve survival in patients with stable hypercapnic chronic obstructive pulmonary disease (COPD). Previous prospective studies did not target a reduction in hypercapnia when adjusting ventilator settings. This study investigated the effect of long-term NPPV, targeted to markedly reduce hypercapnia, on survival in patients with advanced, stable hypercapnic COPD.

**Methods:** This investigator-initiated, prospective, multicentre, randomised, controlled clinical trial enrolled patients with stable GOLD stage IV COPD and a partial carbon dioxide pressure (PaCO2) of 7 kPa (51.9 mm Hg) or higher and pH higher than 7.35. NPPV was targeted to reduce baseline PaCO2 by at least 20% or to achieve PaCO2 values lower than 6.5 kPa (48.1 mm Hg). Patients were randomly assigned (in a 1:1 ratio) via a computer-generated randomisation sequence with a block size of four, to continue optimised standard treatment (control group) or to receive additional NPPV for at least 12 months (intervention group). The primary outcome was 1-year all-cause mortality. Analysis was by intention to treat. The intervention was unblinded, but outcome assessment was blinded to treatment assignment. This study is registered with ClinicalTrials.gov, number NCT00710541.

**Findings:** Patients were recruited from 36 respiratory units in Germany and Austria, starting on Oct 29, 2004, and terminated with a record of the vital status on July 31, 2011. 195 patients were randomly assigned to the NPPV group (n=102) or to the control group (n=93). All patients from the control group and the NPPV group were included in the primary analysis. 1-year mortality was 12% (12 of 102 patients) in the intervention group and 33% (31 of 93 patients) in the control group; hazard ratio 0.24 (95% CI 0.11-0.49; p=0.0004). 14 (14%) patients reported facial skin rash, which could be managed by changing the type of the mask. No other intervention-related adverse events were reported.

**Interpretation:** The addition of long-term NPPV to standard treatment improves survival of patients with hypercapnic, stable COPD when NPPV is targeted to greatly reduce hypercapnia.

![Figure 2: Kaplan-Meier estimate of cumulative all-cause mortality during the first year after randomisation (primary outcome)](image)
Acute exacerbations of COPD in the United States: inpatient burden and predictors of costs and mortality

Perera PN, Armstrong EP, Sherrill DL, Skrepnek GH.

Source: The University of Arizona, College of Pharmacy, Center for Health Outcomes and PharmcoEconomic Research, Tucson, Arizona 85721, USA.

Abstract: Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are a leading cause of hospitalizations in the United States and the major cost driver of COPD. This study determined the national inpatient burden of AECOPD and assessed the association of co-morbidities and hospital characteristics with inpatient costs and mortality. Discharge records from the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample for 2006 was utilized. Outcomes of costs and mortality were assessed for AECOPD hospitalizations in cases ≥40 years of age. Multivariate regression analyses using a generalized linear model framework were conducted to determine predictors of inpatient costs and mortality controlling for patient demographics, primary payer, co-morbidity index, length of stay, hospital region, mechanical ventilation, and admission period. Overall, 1,254,703 hospitalizations for AECOPD were observed with mean costs of $9545 (±12,700) and total costs of $11.9 billion. In-hospital mortality was 4.3% (N = 53,748). Discharges averaged 70.6 (±11.9) years of age. The majority were female (52.8%) and of white race (83.6% of reported race). Several co-morbidities were significantly associated with both costs and mortality (p < 0.001): acute myocardial infarction; congestive heart failure; cerebrovascular disease; lung cancer; cardiac arrhythmias; pulmonary circulation disorders; and weight loss. Significantly higher costs (p < 0.001) were associated with large and urban hospitals. The importance of co-morbidities in AECOPD is indicated in their association with prognosis and inpatient costs. Future research should determine if better management of these conditions can favorably impact the COPD disease burden.

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<th>Table 1. Hospitalization costs due to AECOPD</th>
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<td>AECOPD (overall)a</td>
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aInclusion criteria: 1) ICD–9 code for obstructive chronic bronchitis (491.2x); or 2) presence of any other ICD–9 code for COPD (490-492, 494-496) with a concurrent diagnosis for pneumonia (481-486) or, a procedure code for mechanical ventilation (93.90, 96.70, 96.71, 96.72).
bInclusion criteria: ICD–9 code 491.21 indicating an AECOPD in the principal diagnosis position.
cSame as a) above excluding procedure codes for mechanical ventilation (93.90, 96.70, 96.71, 96.72).
dHospitalizations with a procedure codes for mechanical ventilation (93.90, 96.70, 96.71, 96.72) from overall sample initially identified as described in a) above.
eInflation adjusted to 2010 US$. 
Rationale: Patients with COPD and hypercapnic respiratory failure have a worse prognosis and experience a faster deterioration in their pulmonary function. The benefit of home NPPV following an acute exacerbation of COPD with hypercapnic respiratory failure is not well understood.

Objectives: To evaluate the effect of home NPPV use in patients following a hospitalization for AECOPD with acute hypercapnic respiratory failure on event-free survival after an index admission.

Methods: We conducted a retrospective, single-center, chart review on patients hospitalized in 2011 with a diagnosis of AECOPD, hypercapnia, and used NPPV during hospitalization. 166 patients were included and were divided into two groups: patients who used NPPV post discharge and patients who did not.

Results: Patients in the NPPV post discharge group demonstrated superior event-free survival compared to the no-NPPV post discharge group ($\chi^2 = 23.8$, $p < 0.0001$). The NPPV post discharge group had a statistically significant reduction in hospital readmissions (40% versus 75%, $p < 0.0001$) through 180 days from the index admission.

Conclusions: Patients who used NPPV following an admission for AECOPD with hypercapnic respiratory failure had lower readmission rates and improved event-free survival after 180 days from an index admission compared to patients who did not use NPPV post discharge.

![Figure 2 Kaplan Meier curve of event-free survival comparing patients who used NPPV post discharge versus patients who did not use NPPV post discharge.](image)
Monitoring breathing rate at home allows early identification of COPD exacerbations


Source: Fundación de Investigación Sanitaria Illes Balears, Edificio S. Hospital Universitario Son Espases, Palma de Mallorca, Spain.

Background: Respiratory frequency increases during exacerbations of COPD (ECOPD). We hypothesized that this increase can be detected at home before ECOPD hospitalization.

Methods: To test this hypothesis, respiratory frequency was monitored at home daily for 3 months in 89 patients with COPD (FEV₁, 42.3% ± 14.0%; reference) who were receiving domiciliary oxygen therapy (9.6 ± 4.0 h/d).

Results: During follow-up, 30 patients (33.7%) required hospitalization because of ECOPD. In 21 of them (70%), mean respiratory frequency increased (vs baseline) during the 5 days that preceded it (from 15.2 ± 4.3/min to 19.1 ± 5.9/min, P < .05). This was not the case in patients without ECOPD (16.1 ± 4.8/min vs 15.9 ± 4.9/min). Receiver operating characteristic analysis showed that 24 h before hospitalization, a mean increase of 4.4/min (30% from baseline) provided the best combination of sensitivity (66%) and specificity (93%) (area under the curve [AUC] = 0.79, P < .05). Two days before hospitalization, a mean increase of 2.3/min (15% change from baseline) was associated with a sensitivity of 72% and a specificity of 77% (AUC = 0.76, P < .05).

Conclusions: Respiratory frequency can be monitored daily at home in patients with COPD receiving domiciliary oxygen therapy. In these patients, breathing rate increases significantly days before they require hospitalization because of ECOPD. This may offer a window of opportunity for early intervention.

![Figure 1](image-url). Individual time-series of mean breathing rate of three different day-time periods (8:00 AM to 4:00 PM, 4:00 PM to 12:00 AM, and 12:00 AM to 8:00 AM) in a patient who required hospitalization because of ECOPD during follow-up. An upward trend in respiratory frequency occurred prior to exacerbation. For further explanation, see the “Results” and “Discussion” sections. ECOPD = exacerbation of COPD.
Domiciliary non-invasive ventilation for recurrent acidotic exacerbations of COPD:
an economic analysis

Tuggey JM, Plant PK, Elliott MW

Source: Department of Respiratory Medicine,
St James’s University Hospital, Beckett Street,
Leeds LS9 7TF, UK.


Background: Patients with chronic obstructive pulmonary disease (COPD) pose a
significant burden to healthcare providers with frequent exacerbations necessitating
hospital admission. Randomised controlled data exist supporting the use of acute
non-invasive ventilation (NIV) in patients with exacerbations of COPD with mild to
moderate acidosis. The use of NIV is also described in chronic stable COPD, with
evidence suggesting a reduction in hospital admissions and general practitioner
care. We present economic data on the impact of domiciliary NIV on the need for
admission to hospital and its attendant costs.

Methods: A cost and consequences analysis of domiciliary NIV based on a
before and after case note audit was performed in patients with recurrent acidotic
exacerbations of COPD who tolerated and responded well to NIV. The primary
outcome measure was the total cost incurred per patient per year from the
perspective of the acute hospital. Effectiveness outcomes were total days in
hospital and in intensive care.

Results: Thirteen patients were identified. Provision of a home NIV service resulted
in a mean (95% CI) saving of pound sterling 8254 (pound sterling 4013 to pound
sterling 12,495) (Euro 11,720; Euro 5698 to Euro 17,743) per patient per year. Total
days in hospital fell from a mean (SD) of 78 (51) to 25 (25) (p=0.004), number of
admissions from 5 (3) to 2 (2) (p=0.007), and ICU days fell from a total of 25 to 4
(p=0.24). Outpatient visits fell from a mean of 5 (3) to
4 (2) (p=0.14).

Conclusions: This study suggests that domiciliary NIV for a highly selected group
of COPD patients with recurrent admissions requiring NIV is effective at reducing
admissions and minimises costs from the perspective of the acute hospital. Such
evidence is important in obtaining financial support for providing such a service.

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<td>Outpatient appointments</td>
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Data are expressed as mean (SD).
*p=0.007; **p=0.0004; ***p=0.03; NS not significant.
A pilot trial of non-invasive home ventilation after acidotic respiratory failure in chronic obstructive pulmonary disease

Cheung AP, Chan VL, Liong JT, Lam JY, Leung WS, Lin A, Chu CM.

Source: Division of Respiratory Medicine, Department of Medicine, United Christian Hospital, Hong Kong Special Administrative Region, China.

**Background:** Patients with chronic obstructive pulmonary disease (COPD) who survive an episode of acute hypercapnic respiratory failure (AHRF) after treatment with non-invasive ventilation (NIV) have a high risk of recurrent AHRF. We hypothesised that continuation of NIV at home in these patients would reduce the likelihood of recurrent AHRF.

**Method:** A pilot prospective randomised controlled study was designed to compare continuation of active home NIV and continuous positive airway pressure (CPAP) 5 cm H$_2$O (controls) in COPD patients who had survived an episode of AHRF treated with acute NIV. Patients with significant obstructive sleep apnoea, non-COPD causes of AHRF, adverse psychosocial circumstances and serious comorbidities were excluded. The primary end-point was recurrent AHRF requiring acute NIV, intubation or resulting in death in the first year.

**Results:** Twenty-three patients were randomised to receive home NIV and 24 received CPAP. There was no significant difference in the baseline characteristics between the two study groups. The proportion of patients developing recurrent AHRF in the NIV and the CPAP groups was 38.5% vs. 60.2% at 1 year (P = 0.039). Four and eight patients, respectively, were withdrawn from the CPAP and NIV groups before the end of the pre-defined study duration.

**Conclusion:** In selected COPD patients with AHRF treated with acute NIV, continuation with home NIV is associated with a lower risk of recurrent severe COPD exacerbation with AHRF when compared with CPAP.