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# Cost Savings from Reduced Hospitalizations with Use of Home Noninvasive Ventilation for COPD

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ABSTRACT

**Background:** Although evidence suggests significant clinical benefits of home noninvasive ventilation (NIV) for management of severe chronic obstructive pulmonary disease (COPD), economic analyses supporting the use of this technology are lacking. **Objectives:** To evaluate the economic impact of adopting home NIV, as part of a multifaceted intervention program, for severe COPD. **Methods:** An economic model was developed to calculate savings associated with the use of Advanced NIV (averaged volume assured pressure support with autoexpiratory positive airway pressure; Trilogy100, Philips Respironics, Inc., Murrysville, PA) versus either no NIV or a respiratory assist device with bilevel pressure capacity in patients with severe COPD from two distinct perspectives: the hospital and the payer. The model examined hospital savings over 90 days and payer savings over 3 years. The number of patients with severe COPD eligible for home Advanced NIV was user-defined. Clinical and cost data were obtained from a quality improvement program and published reports. Scenario analyses calculated savings for hospitals and payers covering different COPD patient cohort sizes. **Results:** The hospital base case (250 patients) revealed cumulative savings of $402,981 and $449,101 over 30 and 90 days, respectively, for Advanced NIV versus both comparators. For the payer base case (100,000 patients), 3-year cumulative savings with Advanced NIV were $326 million versus no NIV and $1.04 billion versus respiratory assist device. **Conclusions:** This model concluded that adoption of home Advanced NIV with averaged volume assured pressure support with autoexpiratory positive airway pressure, as part of a multifaceted intervention program, presents an opportunity for hospitals to reduce COPD readmission-related costs and for payers to reduce costs associated with managing patients with severe COPD on the basis of reduced admissions.

*Keywords:* chronic obstructive pulmonary disease, economic model, health economics, home care, noninvasive ventilation.



## Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive disease characterized by airflow limitation and loss of lung function that is not fully reversible [1–3]. In the United States, COPD is a major cause of morbidity and mortality, and a cause of substantial increases in health care costs, mainly as a result of inpatient admissions [3–6]. National data indicate that more than 20% of patients hospitalized because of COPD are rehospitalized within 30 days [7,8]. In an effort to reduce COPD readmissions, the Centers for Medicare & Medicaid Services (CMS) Hospital Readmission Reduction Program (HRRP) now includes penalties for all-cause unplanned readmissions within 30 days of an index admission for a COPD exacerbation [9]. Thus, implementation of innovative measures to reduce readmissions among patients with COPD represents an important objective for hospitals and payers [7,10].

Noninvasive ventilation (NIV) is considered a standard of care for in-hospital treatment of acute COPD exacerbations [3,11]. Nevertheless, its use in long-term management of stable, chronic COPD is less common in the United States, in part because evidence has not demonstrated a consistent improvement in survival [12–16]. From the lung physician's perspective, some of these previous studies [12,13] may have failed to show favorable outcomes because they did not achieve a reduction in hypercapnia during ventilation [17]. This was recently supported by a randomized controlled trial, which demonstrated improved survival with home NIV with high backup rates targeted to markedly reduce hypercapnia versus optimized COPD therapy without NIV, but not reduced rates of emergency hospital admission [17]. More recently, a quality improvement program in a severe COPD cohort with a history of two or more admissions in the previous year demonstrated that multifaceted in-home intervention, including use of an advanced NIV modality (averaged volume assured pressure support with autoexpiratory positive airway pressure; Trilogy100, Philips Respironics, Inc., Murrysville, PA; Advanced NIV), which automatically titrates the device to simultaneously

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maintain airway patency and a target tidal volume, significantly reduced rehospitalization rates [18]. Collectively, these data suggest additional benefits to using advanced NIV approaches in long-term management of stable chronic COPD.

Given this data-driven evidence and growing emphasis on reducing inpatient COPD admissions, an economic model was developed to assess the economic impact of using different categories of home NIV for long-term management of severe COPD.

## Methods

### *Perspective*

The economic model, constructed using Microsoft Excel 2013, was designed to assess the economic impact of using home NIV for the management of patients with severe COPD within the United States (at the time this article was written) from two different perspectives: the hospital and the payer (health insurance provider).

### *Model and Analytic Framework*

The economic model directly compared outcome-driven costs and savings associated with the use of Advanced NIV as part of a multifaceted intervention program, versus either no NIV or a respiratory assist device (RAD), bilevel pressure capacity with backup rate for in-home care.

For the hospital, the model calculates readmission-associated savings over 0 to 30, 31 to 60, and 61 to 90 days. The first time horizon reflects the period during which hospitals are presently subject to COPD readmission penalties, and the last two time horizons were examined to provide a longitudinal view of COPD readmission costs. For the payer, the model calculates annual and cumulative savings over a 3-year period.

### *Model Inputs and Data Sources*

Model inputs are presented in Table 1. In this analysis, *Advanced NIV* is defined as a pressure support ventilator with volume control mode (Trilogy100; Healthcare Common Procedure Coding System [HCPCS] code E0464) and *RAD* as a respiratory assist device, bilevel pressure capacity with backup rate (HCPCS code E0471) (see Appendix Table 1 in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.09.2401). Patients with severe COPD who qualified for home NIV were required to fulfill the following CMS criteria for reimbursement coverage of home NIV: diagnosis of severe COPD, obstructive sleep apnea and continuous positive airway pressure therapy ruled out, and interruption or failure of respiratory support potentially leading to death [19].

The number of admissions per patient per year for Advanced NIV was derived from an unpublished analysis of a quality improvement program demonstrating significantly reduced readmissions associated with the use of Trilogy100 NIV with averaged volume assured pressure support with autoexpiratory positive airway pressure, as part of a multifaceted program including oxygen therapy, respiratory therapist (RT)-led respiratory care, patient education, and medication reconciliation, in patients with severe COPD with two or more exacerbations in the previous year [18]. *Severe COPD* was defined as Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages II to IV, Bode Index Score of 5 or higher, and at least one of the following: $PaCO_2$ of 52 mm Hg or higher, $PaO_2$ of 60 mm Hg or less, or forced expiratory volume in 1 second of 40% or less. In total, there were 397

**Table 1 – Summary of model inputs.**

| Model input | Value | Source |
|---|---|---|
| Number of patients with severe COPD* eligible for home NIV | | |
| Hospital, n | 250 | Base-case assumption |
| Payer, n | 100,000 | Base-case assumption |
| Event frequency (30-d hospital readmission rate) | 6.9% | [20] |
| No NIV | | |
| 1-y mortality rate | 29.0% | [15] |
| Admissions per patient per year, n | 3.1 | [17] |
| RAD | | |
| 1-y mortality rate | 29.7% | [15] |
| Admissions per patient per year, n | 3.1† | [15,17] |
| Dropout rate | 18.2% | Mean from [21] and [13,15,16,22] |
| Patients requiring sleep study | 100% | Base-case assumption |
| Advanced NIV | | |
| 1-y mortality rate | 18.3% | [18] |
| Admissions per patient per year, n | 0.16 | [18] |
| Dropout rate | 18.2% | Mean from [21] and [13,15,16,22] |
| Admission costs | $7946 | [20] |
| Hospital reimbursement‡ | | |
| Admission (outside of 30 d) | $7570 | [23] |
| Sleep study | $657 | [24] |
| Device reimbursement‡ | | |
| RAD | | |
| Device (per month) | $475 | [24] |
| Reimbursement cap | 13 mo | [24] |
| Supplies (per year) | $462§ | [25] ‖ |
| Advanced NIV | | |
| Device (per month; no cap) | $1592¶ | [24] |

CMS, Centers for Medicare & Medicaid Services; COPD, chronic obstructive pulmonary disease; DME, durable medical equipment; $FEV_1$, forced expiratory volume in 1 s; GOLD, Global Initiative for Chronic Obstructive Lung Disease; NIV, noninvasive ventilation; RAD, respiratory assist device.

* *Severe COPD* defined as GOLD stages II–IV, Bode Index Score of ≥5, and at least one of the following: $PaCO_2 \geq 52$ mm Hg, $PaO_2 \leq 60$ mm Hg, or $FEV_1 \leq 40\%$.

† Same value as for no NIV, on the basis of finding no difference in readmission rates from published source.

‡ Calculations are based on 2015 reimbursement rates. Given that reimbursement rates are expected to change over time and may vary by geographical areas, consulting payers for present rates is advised.

§ Includes humidification (water chamber) at $18.29 (2 times/year), filters (ultrafine, disposable, 2-pack) at $4.74 (6 times/year), NIV mask (full face) at $180.47 (2 times/year), tubing (System One Performance Tubing, 15 mm) at $38.00 (4 times/year).

‖ $462 based on the assumption that the payer is responsible for payment of 80% of total supplies reimbursement amount ($578) listed in the CMS 2015 DME Fee Schedule.

¶ Includes device, supplies, and supportive care.