

# MEDICAL POLICY

MEDICAL POLICY DETAILS	
Medical Policy Title	MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA
Policy Number	2.01.41
Category	Technology Assessment
Effective Date	04/15/04
Revised Date	02/17/05, 12/15/05, 02/16/06, 12/21/06, 11/15/07, 11/20/08, 11/19/09, 11/18/10, 01/19/12, 03/21/13, 01/16/14, 01/22/15, 01/21/16, 01/19/17, 01/18/18
Archived Date	01/17/19
Edited Date	
Product Disclaimer	<ul style="list-style-type: none"> <li>• <i>If a product excludes coverage for a service, it is not covered, and medical policy criteria do not apply.</i></li> <li>• <i>If a commercial product (including an Essential Plan product) or a Medicaid product covers a specific service, medical policy criteria apply to the benefit.</i></li> <li>• <i>If a Medicare product covers a specific service, and there is no national or local Medicare coverage decision for the service, medical policy criteria apply to the benefit.</i></li> </ul>

## POLICY STATEMENT

- I. Based upon our criteria and assessment of peer-reviewed literature, measurement of exhaled or nasal nitric oxide, as yet, has not demonstrated a benefit to patient outcomes and is considered **not medically necessary** in the diagnosis and management of asthma.
- II. Based upon our criteria and assessment of peer-reviewed literature, the collection and analysis of exhaled breath condensate as yet, has not demonstrated a benefit to patient outcomes and is considered **not medically necessary** in the diagnosis and management of asthma.

## POLICY GUIDELINES

The Federal Employee Health Benefit Program (FEHBP/FEP) requires that procedures, devices or laboratory tests approved by the U.S. Food and Drug Administration (FDA) may not be considered investigational and thus these procedures, devices or laboratory tests may be assessed only on the basis of their medical necessity.

## DESCRIPTION

Guidelines for the management of persistent asthma stress the importance of long-term suppression of inflammation using corticosteroids, leukotriene inhibitors or other anti-inflammatory drugs. Existing techniques for monitoring the status of underlying inflammation currently are limited but include bronchoscopy with lavage and biopsy or analysis of induced sputum. Due to the nature of these techniques, ongoing assessment of asthma has traditionally focused less on the status of underlying inflammation and more on assessment of pulmonary function tests such as peak flow rates and FEV1/FVC. Therefore, there has been interest in noninvasive techniques to assess the underlying pathogenic chronic inflammation as reflected by measurements of inflammatory mediators. Two strategies that have been investigated include measuring exhaled nitric oxide and the evaluation of exhaled breath condensate.

Nitric oxide is an important endogenous messenger that is widespread in the human body, functioning for example, to regulate peripheral blood flow, platelet function, immune reactions, neurotransmission and as an inflammatory mediator. In the gas phase, nitric oxide is fairly stable, permitting measurement in exhaled air. Recent studies defining the normal and abnormal values in different age groups have shown that asthma patients have nitric oxide measurements in the range

## **Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 2 of 7**

of 25-85 ppb (part per billion) compared to control patients whose exhaled nitric oxide measurement is generally less than 20 ppb.

Exhaled breath condensate (EBC) has been investigated as another technique to assess pathogenic chronic inflammation in asthma. EBC consists of exhaled air passed through a condensing or cooling apparatus, resulting in an accumulation of fluid. Although EBC is primarily derived from water vapor, it also contains aerosol particles or respiratory fluid droplets, which in turn contain various nonvolatile inflammatory mediators, such as cytokines, leukotrienes, oxidants, antioxidants, and various other markers of oxidative stress. The pH of EBC can also be measured. Various studies have focused on different components of EBC as inflammatory markers in respiratory disease.

The following clinical roles for measurement of nitric oxide and EBC have been investigated in the diagnosis and management of asthma:

- I. Diagnosis of asthma – as an alternative or adjunct to spirometry;
- II. Response to anti-inflammatory treatment – declining levels suggest declining inflammation;
- III. Monitoring compliance of anti-inflammatory treatment – persistent elevation may suggest poor compliance with long-term therapy;
- IV. Detection of corticosteroid resistance – reflected by persistently high nitric oxide levels despite corticosteroid treatment;
- V. Prediction of exacerbation – increasing levels of nitric oxide may precede onset of clinical symptoms or changes in peak flow values; and
- VI. Dose optimization – to guide dosing of anti-inflammatory medications.

Aside from asthma, the following clinical applications for nitric oxide measurement have been proposed:

- I. Assessment of chronic cough – chronic cough may be related to smoking, postnasal drip, gastroesophageal reflux, COPD or asthma. Elevation of exhaled nitric oxide may point to asthma as the etiology.
- II. Assessment of cystic fibrosis – exhaled nitric oxide appears to be decreased in patients with CF.
- III. Rhinitis – nasal nitric oxide (as opposed to exhaled nitric oxide) may be increased in patients with allergic rhinitis.
- IV. Primary ciliary dyskinesia – nasal nitric oxide may be decreased in patients with this condition.

## **RATIONALE**

### Exhaled Nitric Oxide

In 2003, the FDA approved the Nitric Oxide Monitoring System (NIOX) as a device intended to measure changes in fractional exhaled nitric oxide concentration in human breath to aid in evaluating an asthma patient's response to anti-inflammatory therapy, as an adjunct to established clinical and laboratory assessment of asthma. NIOX cannot be used with infants or by children approximately under the age of four, as measurement requires patient cooperation. NIOX should not be used in critical care, emergency care or in anesthesiology. The Breathmeter is another device used to measure exhaled nitric oxide using laser spectroscopy. The Breathmeter has not yet received FDA approval.

While many studies demonstrate the potential role of measurements of exhaled nitric oxide in the diagnosis and management of asthma, few well-designed, controlled studies that compare the conventional diagnosis and management of asthma to diagnosis and management utilizing measurement of exhaled nitric oxide have been published. Compared to asthma, the data regarding the measurement of exhaled nitric oxide is more limited for other respiratory conditions, including COPD, cystic fibrosis and ciliary dyskinesia.

The 2007, National Asthma Education and Prevention Program of the National Health Lung and Blood Institute expert panel report on guidelines for the diagnosis and management of asthma does not include measurement of nitric oxide among its recommendations.

The National Heart, Lung, and Blood Institute's Global Initiative for Asthma (GINA) updated its Global Strategy for Asthma Management and Prevention in December 2008. The GINA guidelines state that level of exhaled nitric oxide has

## **Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 3 of 7**

been suggested as a noninvasive marker of airway inflammation in asthma. Levels of nitric oxide are elevated in people with asthma who are not taking inhaled glucocorticosteroids, compared to people without asthma, yet these findings are not specific for asthma. The guideline further states that nitric oxide has not been evaluated prospectively as an aid in asthma diagnosis, but these measurements are being evaluated for potential use in determining optimal treatment.

In October 2005, a BCBS TEC Assessment on exhaled nitric oxide monitoring as a guide to treatment decisions in chronic asthma made the following conclusions:

- I. The available evidence does not permit the conclusion that use of nitric oxide monitoring to guide treatment decisions in asthma leads to improved outcomes.
- II. The two RCTs included in the assessment, Smith and Pijnenburg, suggest possible benefits for nitric oxide monitoring but are not sufficient to conclude that outcomes are improved. Each study reported different benefits that have not been reproduced. Smith reported that equivalent outcomes were achieved in the nitric oxide group, with a lower overall dose of inhaled corticosteroids. Pijnenburg reported that bronchial hyper-reactivity was improved in the nitric oxide group. However, bronchial hyper-reactivity is an intermediate outcome that is not well benchmarked to true health outcomes.
- III. Differences in the control management strategy raise questions about the optimal management strategy to which nitric oxide monitoring should be compared.
- IV. The 7 studies that evaluated the ability of nitric oxide to provide prognostic information that could lead to changes in management had considerable methodologic limitations and variability in study methodology that precluded synthesis of their results and definitive conclusions.

Based on the available evidence, the BCBS Medical Advisory Panel determined that the use of FENO levels for monitoring patients with chronic asthma does not meet TEC criteria.

The American Thoracic Society guidelines (2011): interpretation of exhaled nitric oxide levels (F<sub>E</sub>NO) for clinical applications recommends:

- 1) that F<sub>E</sub>NO may be used to support the diagnosis of asthma in situations in which objective evidence is needed (weak recommendation, moderate quality of evidence).
- 2) the use of cut points rather than reference values when interpreting F<sub>E</sub>NO levels (weak recommendation, low quality of evidence).
- 3) using the following values to determine a significant increase in F<sub>E</sub>NO: greater than 20% for values over 50 ppb or more than 10 ppb for values lower than 50 ppb from one visit to the next (weak recommendation, low quality of evidence).
- 4) using a reduction of at least 20% in F<sub>E</sub>NO for values over 50 ppb or more than 10 ppb for values lower than 50 ppb as the cut point to indicate a significant response to anti-inflammatory therapy (weak recommendation, low quality of evidence).

The European Respiratory Society and American Thoracic Society reviewed the definition and provided recommendations and guidelines on the evaluation and treatment of severe asthma in children and adults (2016). The task force suggested that clinicians do not use FeNO to guide therapy in adults or children with severe asthma (conditional recommendation, very low quality evidence). This recommendation places a higher value on avoiding additional resource expenditure and a lower value on uncertain benefit from monitoring FeNO.

### Exhaled Breath Condensate

The basic technique of collecting EBC consists of a technique to cool exhaled air and collect EBC droplets. One commercially available system, the RTube consists of a disposable polypropylene condensation chamber that is cooled by an overlying aluminum-cooling sleeve. There is a variety of laboratory techniques to measure the components of EBC,

**Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 4 of 7**

including such simple techniques as pH measurement, to the more sophisticated gas chromatography/mass spectrometry or high performance liquid chromatography, depending on the component of interest.

Similar to exhaled nitric oxide, there is intense research interests in the analysis of exhaled breath condensate (EBC) as a biomarker of inflammation. However, it appears from the published literature that EBC is at an earlier stage of development compared to exhaled nitric oxide. For example, several review articles note that before routine clinical use in the diagnosis and management of respiratory disorders can be considered the following issues must be resolved:

- I. Standardization of collection and storage techniques,
- II. Effect of dilution of respiratory droplets by water vapor,
- III. Techniques of measuring concentrations of nonvolatile substances in EBC; in most cases these concentrations are very low, which may be at the lower limits of detection of conventional analytic techniques,
- IV. Variability in EBC assays for certain substances,
- V. Further investigation of levels of compounds in health and disease.

The National Heart, Lung, and Blood Institute’s GINA Global Strategy for Asthma Management and Prevention, updated in 2007, makes no mention of measurement of EBC.

Ultimately, controlled trials will be required to determine how evaluated of exhaled breath condensate can be used to direct patient management. The National Institute of Allergy and Infectious Disease is currently recruiting asthmatic children to a clinical trial evaluating the use of pH measurement of EBC in the management of asthma. This trial will evaluate both asthmatic patients and normal controls with EBC pH, expired nitric oxide, pulmonary lung function tests and peak flow meters over a period of a year. Neither exhaled nitric oxide or EBC pH are used in the management of the patient, but the study will determine whether these measures are correlated of known parameters of disease including number of hospitalizations, absenteeism from school, number of asthma exacerbations, lost work days (if applicable), and extent of rescue medication used.

**CODES**

- *Eligibility for reimbursement is based upon the benefits set forth in the member’s subscriber contract.*
- ***CODES MAY NOT BE COVERED UNDER ALL CIRCUMSTANCES. PLEASE READ THE POLICY AND GUIDELINES STATEMENTS CAREFULLY.***
- *Codes may not be all inclusive as the AMA and CMS code updates may occur more frequently than policy updates.*

**CPT Codes**

<b>Code</b>	<b>Description</b>
83987 (NMN)	pH; exhaled breath condensate
95012 (NMN)	Nitric oxide expired gas determination

*Copyright © 2019 American Medical Association, Chicago, IL*

**HCPCS Codes**

<b>Code</b>	<b>Description</b>
No specific codes	

**ICD10 Codes**

<b>Code</b>	<b>Description</b>
Not Medically Necessary for all diagnoses	

**Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 5 of 7**

**REFERENCES**

- \*Al Obaidi AH and Al Samarai AM. Biochemical markers as a response guide for steroid therapy in asthma. J Asthma 2008 Jun;45(5):425-8.
- \*American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology and Joint Council of Allergy, Asthma and Immunology. Attaining optimal asthma control: a practice parameter. J Allergy Clin Immunol 2005 Nov;116(5):S3-11.
- \*Beck-Ripp J, et al. Changes of exhaled nitric oxide during steroid treatment of childhood asthma. Eur Respir J 2002 Jun;19(6):1015-9.
- Bernholm KF, et al. FeNO-based asthma management results in faster improvement of airway hyperresponsiveness. ERJ Open Res 2018;4(4):00147-2017.
- Bjerregaard A, et al. High fractional exhaled nitric oxide and sputum eosinophils are associated with an increased risk of future virus-induced exacerbations: a prospective cohort study. Clin Exp Allergy. 2017 Aug;47(8):1007-1013.
- BlueCross BlueShield Association. Measurement of exhaled nitric oxide in the diagnosis and management of asthma and other respiratory disorders. Medical Policy Reference Manual Policy #2.01.61. 2018 Jun 14.
- \*BlueCross BlueShield Technology Evaluation Center (TEC). Exhaled nitric oxide monitoring as a guide to treatment decisions in chronic asthma TEC Bulletin 2005 Nov; 22(3).
- \*Bohadana A, et al. Reproducibility of exhaled nitric oxide in smokers and non-smokers: relevance for longitudinal studies. BMC Pulm Med 2008;8:4 [http://www.biomedcentral.com/1471-2466/8/4] accessed 12/20/18.
- \*Boot JD, et al. Comparison of exhaled nitric oxide measurements between NIOX MINO((R)) electrochemical and Ecomedics chemiluminescence analyzer. Respir Med 2008 Nov;102(11):1667-71.
- Brody FJ, et al. Reference values and factors associated with exhaled nitric oxide: U.S. youth and adults. Respir Med 2013 Nov;107(11):1682-91.
- Chung KF, et al. International ERS/ATS guidelines on definition, evaluation and treatment of severe asthma. Eur Respir J. 2014 Feb;43(2):343-73.
- \*Dupont LJ, et al. Prospective evaluation of the validity of exhaled nitric oxide for the diagnosis of asthma. Chest 2003 Mar;123(3):751-6.
- Dweik RA, et al. An official ATS clinical practice guideline: interpretation of exhaled nitric oxide levels (FENO) for clinical applications. Am J Respir Crit Care Med 2011 Sep1;184(5):602-15.
- \*El Halawani SM, et al. Exhaled nitric oxide as a predictor of exercise-induced bronchoconstriction. Chest 2003 Aug;124(2):639-43.
- Gomersal T, et al. A systematic review of fractional exhaled nitric oxide in the routine management of childhood asthma. Pediatr Pulmonol. Mar 2016;51(3):316-328.
- Guo Z, et al. Diagnostic accuracy of fractionated exhaled nitric oxide in asthma: a systematic review and meta-analysis of prospective studies. J Asthma. 2016;53(4):404-12.
- Harnan S, et al. Measurement of exhaled nitric oxide concentration in asthma; NIOX MINO and NObreath. Health Technology Assessment. 2014.

**Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 6 of 7**

\*Hunt J. Exhaled breath condensate: an evolving tool for noninvasive evaluation of lung disease. J Allergy Clin Immunol 2002;110(1):28-34.

Ishizuka T, et al. Prevalence of asthma symptoms based on the European community respiratory health survey questionnaire and FENO in university students: gender differences in symptoms and FENO. Allergy Asthma Clin Immunol 2011 Sep 19;7(1):15.

Jarri T, et al. Childhood asthma management guided by repeated Fe NO measurements: a meta-analysis. Paediatr Respir Rev 2012 Sep;13(3):178-83.

Kalliola S, et al. Can we use portable nitric oxide analyzer in young children? Pediatr Pulmonol 2011 Jul;46(7):627-31.

\*Kharitonov SA, et al. Dose-dependent onset and cessation of action of inhaled budesonide on exhaled nitric oxide and symptoms in mild asthma Thorax 2002;57(10):889-96.

\*Kharitonov SA, et al. Reproducibility of exhaled nitric oxide measurements in healthy and asthmatic adults and children Eur Respir J 2003 Mar;21(3):433-8.

Kim HB, et al. Exhaled NO: determinants and clinical application in children with allergic airway disease. Allergy Asthma Immunol Res 2016 Jan;8(1):12-21.

LaForce C, et al. Impact of exhaled nitric oxide measurements on treatment decisions in an asthma specialty clinic. Ann Allergy Asthma Immunol 2014 Dec;113(6):619-23.

Lee JW, et al. Exhaled nitric oxide as a better diagnostic indicator for evaluating wheeze and airway hyperresponsiveness in preschool children. J Asthma 2015; Dec(10):1054-9.

Li Z, et al. Diagnostic accuracy of exhaled nitric oxide in asthma: a meta-analysis of 4,691 participants. In J Clin Exp Med 2015;8(6):8516-24.

Lu Z, et al. Exhaled nitric oxide in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis. Int J Chron Obstruct Pulmon Dis 2018 Aug 30;13:2695-2705.

McCormack MC, et al. Guideline-recommended fractional exhaled nitric oxide is a poor predictor of health-care use among inner-city children and adolescents receiving usual asthma care. Chest 2013 Sep;144(3):923-9.

\*Narang I, et al. Nitric oxide in chronic airway inflammation in children: diagnostic use and pathophysiological significance Thorax 2002 Jul;57(7):586-9.

National Institute for Health and Care Excellence. Measuring fractional exhaled nitric oxide concentration in asthma: NIOX MINO, NIOX VERO, and NObreath. Issued 2013 Oct [https://www.nice.org.uk/guidance/dg12/documents/measuring-fractional-exhaled-nitric-oxide-concentration-in-asthma-niox-mino-niox-vero-and-nobreath-diagnostics-consultation-document-pdf-document2] accessed 12/20/18.

National Institutes of Health, National Heart, Lung, and Blood Institute. National Asthma Control Initiative. Updated 2011 Feb [http://www.nhlbi.nih.gov/health/prof/lung/asthma/naci/] accessed 12/20/18.

National Institutes of Health (NIH) 2007 NAEP EPR-3. National Asthma Education and Prevention Program Expert Panel Report 3 [http://www.nhlbi.nih.gov/files/docs/guidelines/asthgdln.pdf] accessed 12/20/18.

Nguyen DT and Akinbami LJ. Prevalence of high fractional exhaled nitric oxide among US youth with asthma. Pediatr Pulmonol. 2017 Jun;52(6):737-745.

Petsky HL, et al. A systematic review and meta-analysis: tailoring asthma treatment on eosinophilic markers (exhaled nitric oxide or sputum eosinophils). Thorax 2012 Mar;67(3):199-208.

## **Medical Policy: MEASUREMENT OF EXHALED MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH ASTHMA**

**Policy Number: 2.01.41**

**Page: 7 of 7**

\*Petsky HL, et al. Tailored interventions based on exhaled nitric oxide versus clinical symptoms for asthma in children and adults. Cochrane Database Syst Rev. 2008 Apr 16;(2):CD006340.

Price DB, et al. Fractional exhaled nitric oxide as a predictor of response to inhaled corticosteroids in patients with non-specific respiratory symptoms and insignificant bronchodilator reversibility: a randomized controlled trial. Lancet Respir Med. 2018 Jan;6(1):29-39.

Price D, et al. Using fractional exhaled nitric oxide (FeNO) to diagnose steroid-responsive disease and guide asthma management in routine care. Clin Transl Allergy 2013 Nov7;3(1):37.

Powell H, et al. Management of asthma in pregnancy guided by measurement of fraction of exhaled nitric oxide: a double-blind, randomized controlled trial. Lancet 2011 Sep 10;378(9795):983-90.

Raj D, et al. Fractional exhaled nitric oxide (FENO) in children with acute exacerbation of asthma. Indian Pediatr 2014 Feb;51(2):105-11.

Schneider A, et al. Influence of the practice setting on diagnostic prediction rules using FENO measurement in combination with clinical signs and symptoms of asthma. BMJ Open 2015;5(11):e009676.

Schneider A, et al. FENO measurement and sputum analysis for diagnosing asthma in clinical practice. Respir Med 2013 Feb;107(2):209-16.

\*Steerenberg PA, et al Relationship between exhaled NO, respiratory symptoms, lung function, bronchial hyperresponsiveness, and blood eosinophilia in school children. Thorax 2003 Mar;58(3):242-5.

Stewart L, et al. Exhaled nitric oxide. Immunol Allergy Clin North Am 2012 Aug;32(3):347-62.

\*Strunk RC, et al. Relationship of exhaled nitric oxide to clinical and inflammatory markers of persistent asthma in children. J Allergy Clin Immunol 2003 Nov;112(5):883-92.

Turner S. Exhaled nitric oxide and the management of childhood asthma – yet another promising biomarker “has been” or a misunderstood gem. Paediatr Respir Rev 2015 Mar;16(2):88-96.

Wilson E, et al. Exhaled nitric oxide and inhaled corticosteroid dose reduction in asthma: a cohort study. Eur Respir J 2014 Dec;44(6):1705-7.

Wu YK, et al. Treatment of chronic obstructive pulmonary disease in patients with different fractional exhaled nitric oxide levels. Medicine (Baltimore) 2018 Nov;97(47):e11922.

Yoon JY, et al. Fractional exhaled nitric oxide and forced expiratory flow between 25% and 75% of vital capacity in children with controlled asthma. Korean J Pediatr 2012 Sep;55(9):330-6.

\*Key Article

### **KEY WORDS**

Exhaled nitric oxide, asthma, NIOX, exhaled breath condensate

### **CMS COVERAGE FOR MEDICARE PRODUCT MEMBERS**

There is currently no National Coverage Determination (NCD) or Local Coverage Determination (LCD) for Measurement of Exhaled Markers of Airway Inflammation in Patients with Asthma.