Medical Coverage Policy | Measurement of Exhaled Nitric Oxide and Exhaled Breath Condensate in the Diagnosis and Management of Respiratory Disorders

EFFECTIVE DATE: 03|03|2015
POLICY LAST UPDATED: 06|21|2023

OVERVIEW
Evaluation of exhaled nitric oxide (NO) and exhaled breath condensate (EBC) are proposed as techniques to diagnose and monitor asthma and other respiratory conditions. There are commercially available devices for measuring NO in expired breath and various laboratory techniques for evaluating components of EBC.

MEDICAL CRITERIA
Not applicable

PRIOR AUTHORIZATION
Not applicable

POLICY STATEMENT
Medicare Advantage Plans
Measurement of exhaled nitric oxide is not covered in the diagnosis and management of asthma, eosinophilic asthma, and other respiratory disorders including but not limited to chronic obstructive pulmonary disease and chronic cough as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Measurement of exhaled breath condensate is not covered in the diagnosis and management of asthma and other respiratory disorders including but not limited to chronic obstructive pulmonary disease and chronic cough as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Commercial Products
Measurement of exhaled nitric oxide is considered not medically necessary in the diagnosis and management of asthma, eosinophilic asthma, and other respiratory disorders including but not limited to chronic obstructive pulmonary disease and chronic cough as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Measurement of exhaled breath condensate is considered not medically necessary in the diagnosis and management of asthma and other respiratory disorders including but not limited to chronic obstructive pulmonary disease and chronic cough as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

COVERAGE
Benefits may vary between groups and contracts. Please refer to the appropriate Benefit Booklet, Evidence of Coverage or Subscriber Agreement for applicable not medically necessary/not covered benefits/coverage.

BACKGROUND
ASTHMA
Asthma is characterized by airway inflammation that leads to airway obstruction and hyper-responsiveness, which in turn lead to characteristic clinical symptoms including wheezing, shortness of breath, cough, and chest tightness. In the United States, the burden of asthma falls disproportionately on Black, Hispanic, and

American Indian and Alaska Native populations. Asthma-related emergency department visits are nearly 5 times higher for Black patients when compared to White patients, and Black patients are nearly 3 times as likely to die from asthma when compared to White patients. Differences in life experiences (eg, family, social, and economic environment), lifestyle choices (smoking, obesity, leisure-time physical activities), and exposure to adverse indoor and outdoor environment factors (e.g., mold, pollens, house dust mites, cockroaches, rodents, animal allergens, and other air pollutants) may account for some of the racial and ethnic differences in asthma prevalence. A gender disparity also exists in asthma prevalence – in children, asthma is more common in boys versus girls, whereas among adults, women are more likely than men to have an asthma diagnosis.

Management

Guidelines for the management of persistent asthma stress the importance of long-term suppression of inflammation using inhaled corticosteroids as primary treatment. Existing techniques for monitoring the status of underlying inflammation have focused on bronchoscopy, with lavage and biopsy, or analysis by induced sputum. Given the cumbersome nature of these techniques, the ongoing assessment of asthma focuses not on the status of the underlying chronic inflammation, but rather on regular assessments of respiratory parameters such as forced expiratory volume in 1 second and peak flow. Therefore, there has been an interest in noninvasive techniques to assess the underlying pathogenic chronic inflammation as reflected by measurements of inflammatory mediators.

Fractional Exhaled Nitric Oxide

One proposed strategy is the measurement of fractional exhaled nitric oxide (FeNO). Nitric oxide (NO) is an important endogenous messenger and inflammatory mediator that is widespread in the human body, with functions including the regulation of peripheral blood flow, platelet function, immune reactions, neurotransmission, and the mediation of inflammation. Patients with asthma have been found to have high levels of FeNO, which decreases with treatment with corticosteroids. In biologic tissues, NO is unstable, limiting measurement. However, in the gas phase, NO is fairly stable, permitting its measurement in exhaled air. FeNO is typically measured during single breath exhalations. First, the subject inspires NO-free air via a mouthpiece until total lung capacity is achieved, followed immediately by exhalation through the mouthpiece into the measuring device. Devices measuring FeNO are commercially available in the United States. According to a 2009 joint statement by the American Thoracic Society and European Respiratory Society, there is a consensus that FeNO is best measured at an exhaled rate of 50 mL per second maintained within 10% for more than 6 seconds at an oral pressure between 5 and 20 cm H2O. Results are expressed as the NO concentration in parts per billion, based on the mean of 2 or 3 values.

Exhaled Breath Condensate

Exhaled breath condensate (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 other markers of oxidative stress. There are a variety of laboratory techniques to measure the components of EBC, including such simple techniques as pH measurement and the more sophisticated gas chromatography/mass spectrometry or high-performance liquid chromatography, depending on the component of interest.

Clinical Uses of FeNO and EBC

Measurement of FeNO has been associated with an eosinophilic asthma phenotype. Eosinophilic asthma is a subtype of asthma associated with sputum and serum eosinophilia, along with later-onset asthma. Until recently, most asthma management strategies did not depend on the recognition or diagnosis of a particular subtype. However, anti-interleukin 5 inhibitors have been approved by the Food and Drug Administration (FDA) for the treatment of severe asthma with an eosinophilic phenotype. Anti-IL-4 receptor/anti-IL-13 monoclonal antibodies, anti-immunoglobulin E monoclonal antibodies, and thymic stromal lymphopoietin

blocker monoclonal antibodies are also available to improve uncontrolled asthma that does not necessarily have an eosinophilic phenotype.

Measurement of NO and EBC has been investigated in the diagnosis and management of asthma. Potential management uses include assessing response to anti-inflammatory treatment, monitoring compliance with treatment, and predicting exacerbations. Aside from asthma, they have also been proposed in the management of patients with chronic obstructive pulmonary disease, cystic fibrosis, allergic rhinitis, pulmonary hypertension, and primary ciliary dyskinesia.

For individuals who have suspected asthma who receive measurement of fractional exhaled nitric oxide (FeNO) for diagnosis, the evidence includes multiple retrospective and prospective studies of diagnostic accuracy, along with systematic reviews of those studies. Relevant outcomes are test validity, symptoms, change in disease status, morbid events, and functional outcomes. There are multiple reports on the sensitivity and specificity of FeNO in asthma diagnosis; however, most studies are in the setting of patients with asthma symptoms without previous testing (or with unclear previous testing), which is unlikely to be how the test is used in a U.S. setting. The available evidence is limited by variability in FeNO cutoff levels used to diagnose asthma, lack of data on performance characteristics in challenging diagnostic settings, and lack of data on the incremental value of adding FeNO to existing diagnostic algorithms from studies with concurrent controls. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have asthma who receive medication management directed by FeNO, the evidence includes diagnostic accuracy studies, multiple randomized controlled trials (RCTs) and systematic reviews of those trials. Relevant outcomes are symptoms, change in disease status, morbid events, and functional outcomes. The available RCTs evaluating the use of FeNO tests to guide step-up/step-down therapy in patients have not consistently found improvement in health outcomes. Two Cochrane reviews from 2016, one on adults and the other on children, found FeNO-guided asthma management to guide step-up/step-down therapy reduced the number of individuals who had more than 1 exacerbation in children but not in adults compared with guidelines-driven therapy. However, it had no impact on day-to-day symptoms or hospitalizations. Limitations of the published evidence preclude determining the effects of the technology on net health outcome. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have severe asthma who receive a measurement of FeNO to select treatment, the evidence includes diagnostic accuracy studies and subgroup analyses of RCTs and observational studies. Relevant outcomes are test validity, symptoms, change in disease status, morbid events, and functional outcomes. For the use of FeNO to identify eosinophilic asthma for the purpose of selecting patients for therapy with anti-interleukin (IL)-5 therapy or an anti-IL-4 receptor (IL-4R)/anti-IL-13 monoclonal antibody, subgroup analyses of RCTs are available. The evidence that points toward an interaction between baseline FeNO and treatment for the outcome of response suggests that there may be a quantitative but not necessarily a qualitative interaction between baseline FeNO and anti-IL-4R/anti-IL-13 treatment (dupilumab). Therefore, it is unclear if baseline FeNO can identify a group for whom there is no benefit from dupilumab. Similarly, a subgroup analysis for mepolizumab suggested a more pronounced effect compared to placebo in those with elevated levels of both blood eosinophils and FeNO. However, outcomes were not reported stratified based on FeNO alone precluding insight into the utility of using FeNO to predict response to treatment. For use of FeNO to predict response to therapy for patients with other severe asthma phenotypes, such as the allergic subtype, where anti-immunoglobulin E therapy is used, a subgroup analysis of a RCT is available. Subgroup analysis of omalizumab showed an association with more favorable outcomes in patients with high FeNO levels, but as with dupilumab, a qualitative interaction has not been established. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have suspected or confirmed respiratory disorders other than asthma who receive measurement of FeNO, the evidence includes a crossover trial, an open-label trial, a pilot study, and observational studies. Relevant outcomes are test validity, symptoms, change in disease status, morbid events, and functional outcomes. The available evidence assessing the use of FeNO for respiratory disorders other than asthma is limited by heterogeneity in the conditions evaluated and uncertainty about how the test fits in defined clinical management pathways. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have suspected or confirmed respiratory disorders who receive a measurement of EBC, the evidence includes observational studies reporting on the association between various EBC components and disease severity. Relevant outcomes are test validity, symptoms, change in disease status, morbid events, and functional outcomes. There is considerable variability in the particular EBC components measured and criteria for standardized measurements. Also, there is limited evidence on the use of EBC for determining asthma severity, diagnosing other respiratory conditions, or guiding treatment decisions for asthma or other respiratory conditions. The available published evidence does not support conclusions on the utility of EBC for any indication. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

CODING

Medicare Advantage Plans and Commercial Products

The following CPT codes are not covered for Medicare Advantage Plans and not medically necessary for Commercial Products:

83987 pH; exhaled breath condensate
95012 Nitric oxide expired gas determination

RELATED POLICIES

None

PUBLISHED

Provider Update, August 2023
Provider Update, November 2022
Provider Update, March 2021
Provider Update, March 2020
Provider Update, April 2019

REFERENCES

1. Reddel HK, Taylor DR, Bateman ED, et al. An official American Thoracic Society/European Respiratory Society statement:asthma control and exacerbations: standardizing endpoints for clinical asthma trials and clinical practice. Am J Respir CritCare Med. Jul 01 2009; 180(1): 59-99. PMID 19535666
2. Chung KF, Wenzel SE, Brozek JL, et al. International ERS/ATS guidelines on definition, evaluation and treatment ofsevere asthma. Eur Respir J. Feb 2014; 43(2): 343-73. PMID 24337046
3. National Heart Lung and Blood Institute. Guidelines for the Diagnosis and Management of Asthma (EPR-3) 2007;https://www.nhlbi.nih.gov/health-topics/guidelines-for-diagnosis-management-of-asthma. Accessed April 21, 2023.
4. Bossuyt PM, Irwig L, Craig J, et al. Comparative accuracy: assessing new tests against existing diagnostic pathways.BMJ. May 06 2006; 332(7549): 1089-92. PMID 16675820
5. National Institute for Health and Care Excellence (NICE). Asthma: diagnosis, monitoring and chronic asthma management[NG80]. 2017; https://www.nice.org.uk/guidance/ng80. Accessed April 23, 2023.
6. Harnan SE, Essat M, Gomersall T, et al. Exhaled nitric oxide in the diagnosis of asthma in adults: a systematic review. ClinExp Allergy. Mar 2017; 47(3): 410-429. PMID 27906490
7. Karrasch S, Linde K, Rücker G, et al. Accuracy of FENO for diagnosing asthma: a systematic review. Thorax. Feb 2017;72(2): 109-116. PMID 27388487

8. Wang Z, Pianosi PT, Keogh KA, et al. The Diagnostic Accuracy of Fractional Exhaled Nitric Oxide Testing in Asthma: ASystematic Review and Meta-analyses. Mayo Clin Proc. Feb 2018; 93(2): 191-198. PMID 29275031
9. Wang Z, Pianosi P, Keogh K, et al. The Clinical Utility of Fractional Exhaled Nitric Oxide (FeNO) in Asthma Management(Comparative Effectiveness Review No. 197). Rockville, MD: Agency for Healthcare Research and Quality; 2017.
10. Tang W, Zhou J, Miao L, et al. Clinical features in patients of cough variant asthma with normal and high level of exhaledfractional nitric oxide. Clin Respir J. Feb 2018; 12(2): 595-600. PMID 27731932
11. Engel J, van Kampen V, Lotz A, et al. An increase of fractional exhaled nitric oxide after specific inhalation challenge ishighly predictive of occupational asthma. Int Arch Occup Environ Health. Oct 2018; 91(7): 799-809. PMID 29850946
12. Kim K, Cho HJ, Yoon JW, et al. Exhaled nitric oxide and mannitol test to predict exercise-induced bronchoconstriction.Pediatr Int. Aug 2018; 60(8): 691-696. PMID 29786927
13. Guo Z, Wang Y, Xing G, et al. Diagnostic accuracy of fractional exhaled nitric oxide in asthma: a systematic review andmeta-analysis of prospective studies. J Asthma. 2016; 53(4): 404-12. PMID 26796787
14. Keßler A, Kragl U, Glass Ä, et al. Exhaled nitric oxide can't replace the methacholine challenge in suspected pediatricasthma. Respir Med. Oct 2019; 157: 21-25. PMID 31476569
15. Busse WW, Morgan WJ, Taggart V, et al. Asthma outcomes workshop: overview. J Allergy Clin Immunol. Mar 2012; 129(3Suppl): S1-8. PMID 22386504
16. Fuhlbrigge A, Peden D, Apter AJ, et al. Asthma outcomes: exacerbations. J Allergy Clin Immunol. Mar 2012; 129(3 Suppl):S34-48. PMID 22386508
17. Cloutier MM, Schatz M, Castro M, et al. Asthma outcomes: composite scores of asthma control. J Allergy Clin Immunol.Mar 2012; 129(3 Suppl): S24-33. PMID 22386507
18. Juniper EF, Svensson K, Mörk AC, et al. Measurement properties and interpretation of three shortened versions of theasthma control questionnaire. Respir Med. May 2005; 99(5): 553-8. PMID 15823451
19. Schatz M, Zeiger RS, Zhang F, et al. Development and preliminary validation of the Asthma Intensity Manifestations Score(AIMS) derived from Asthma Control Test, FEV(1), fractional exhaled nitric oxide, and step therapy assessments. JAsthma. Mar 2012; 49(2): 172-7. PMID 22304003
20. Petsky HL, Kew KM, Turner C, et al. Exhaled nitric oxide levels to guide treatment for adults with asthma. CochraneDatabase Syst Rev. Sep 01 2016; 9(9): CD011440. PMID 27580628
21. Petsky HL, Kew KM, Chang AB. Exhaled nitric oxide levels to guide treatment for children with asthma. CochraneDatabase Syst Rev. Nov 09 2016; 11(11): CD011439. PMID 27825189
22. Petsky HL, Cates CJ, Kew KM, et al. Tailoring asthma treatment on eosinophilic markers (exhaled nitric oxide or sputumeosinophils): a systematic review and meta-analysis. Thorax. Dec 2018; 73(12): 1110-1119. PMID 29858277
23. Szefler SJ, Mitchell H, Sorkness CA, et al. Management of asthma based on exhaled nitric oxide in addition to guideline-based treatment for inner-city adolescents and young adults: a randomised controlled trial. Lancet. Sep 20 2008;372(9643): 1065-72. PMID 18805335
24. Turner S, Cotton S, Wood J, et al. Reducing asthma attacks in children using exhaled nitric oxide (RAACENO) as abiomarker to inform treatment strategy: a multicentre, parallel, randomised, controlled, phase 3 trial. Lancet Respir Med.Jun 2022; 10(6): 584-592. PMID 35101183