

# PCRS National Respiratory Conference

Building confidence in a changing world

Is FeNO feasible?

Carol Stonham

Co-facilitator Carla Astles



28-29 September 2018  
Telford International Centre

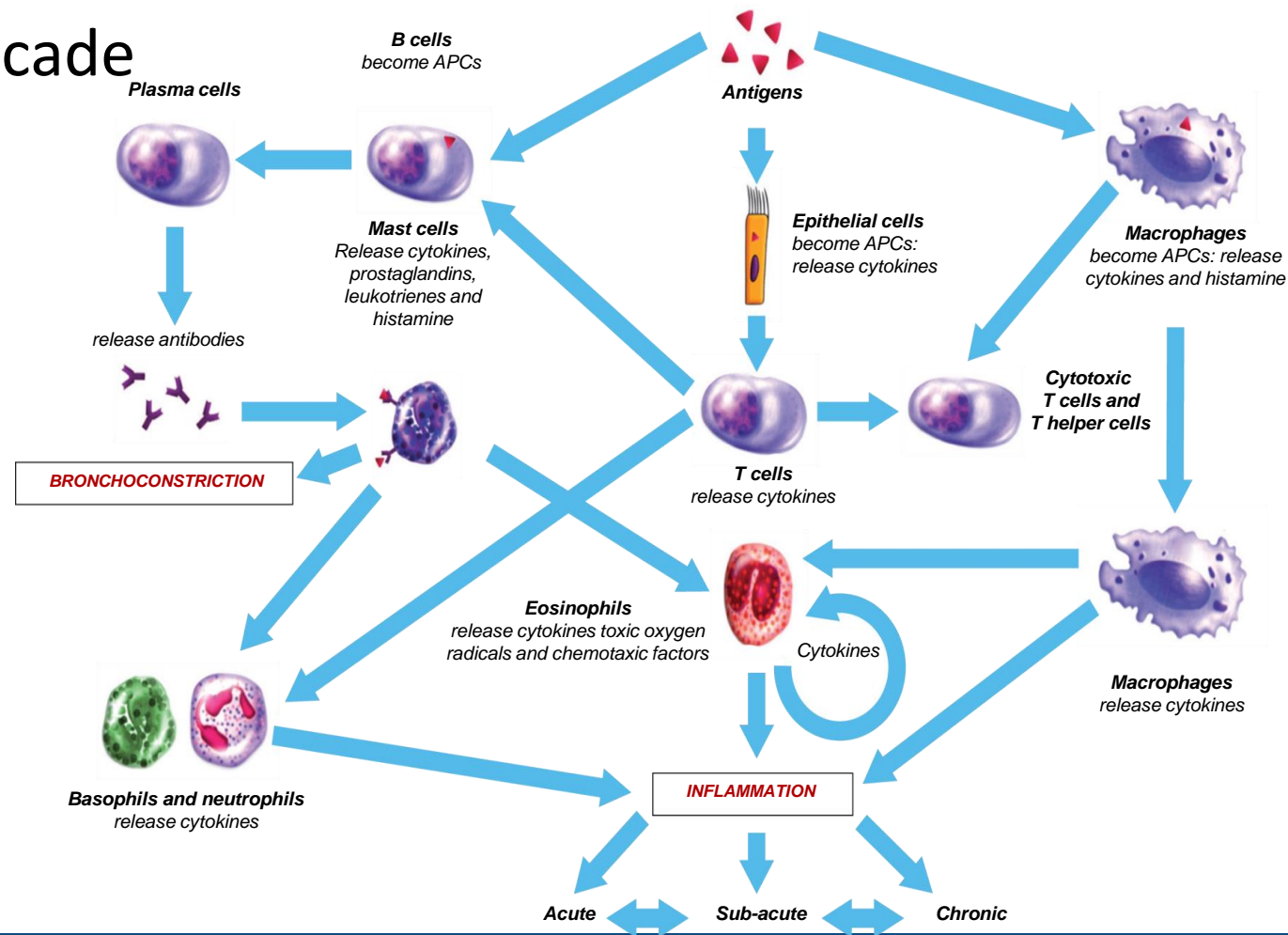
# Understanding FeNO



- What is FeNO?
- What does it measure?
- Where does FeNO testing sit in asthma guidelines?
- What is the practical application?
- What service deliver model might work?
- Who pays?

# What is FeNO?

## Inflammatory cascade

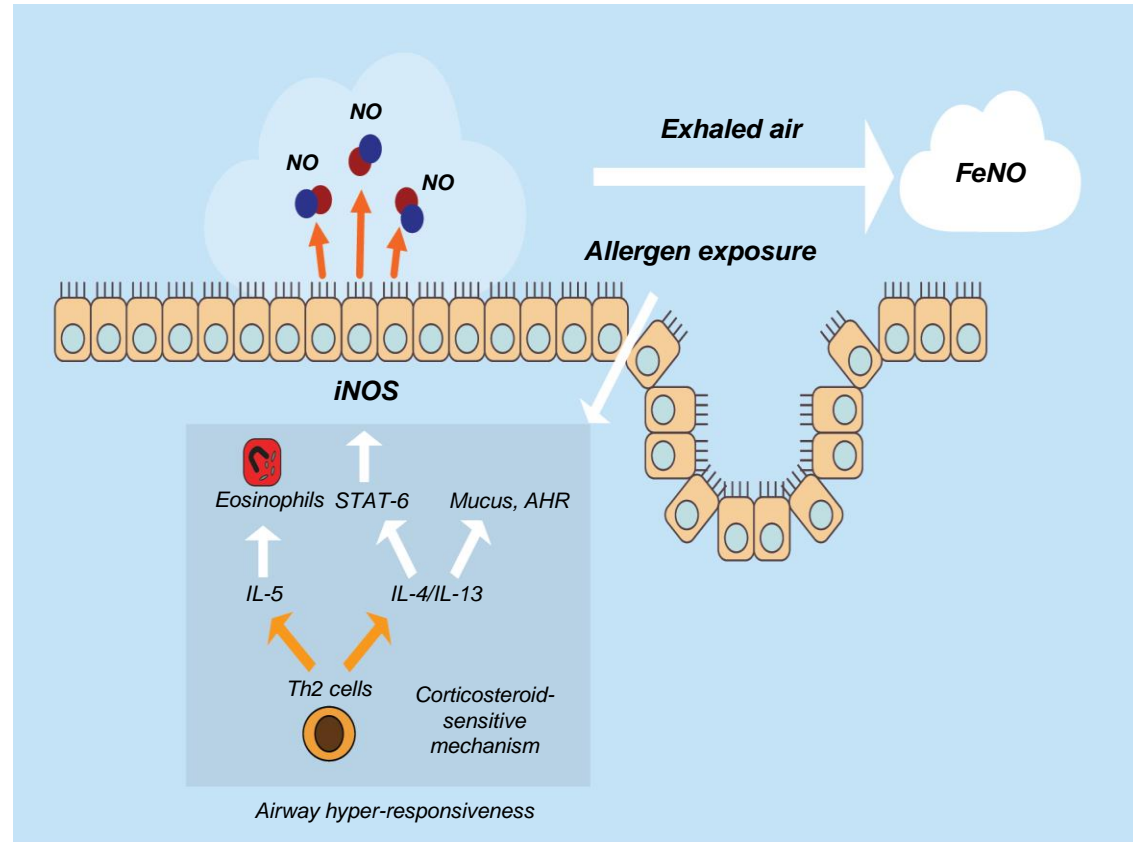


APCs, antigen-presenting cells  
1. Barnes PJ et al.  
Pharmacol Rev  
1998;50:515-96

# FeNO is a biomarker of allergic airway inflammation

Exhaled NO concentrations increase during Th2 (allergic) inflammation

- NO produced is generally higher in individuals with asthma than in those without asthma<sup>2</sup>
- Often correlates with eosinophilic inflammation<sup>2</sup>



Adapted from<sup>1</sup>

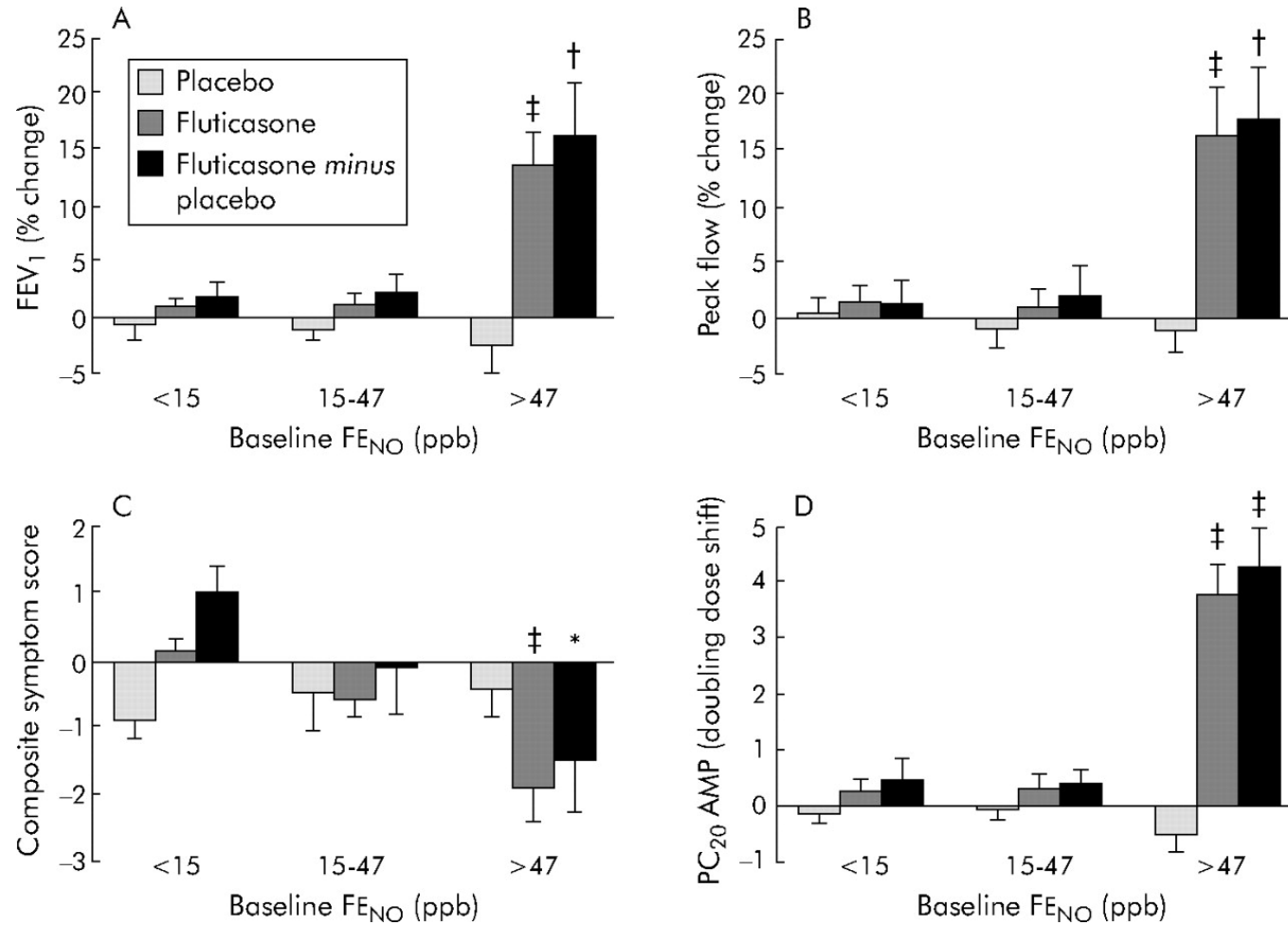
AHR, airway hyper-responsiveness; FeNO, fractional exhaled nitric oxide; IL, interleukin; iNOS, inducible nitric oxide synthase; NO, nitric oxide; STAT, signal transducer and activator of transcription; Th2, T helper type 2 cells  
 1. Ludviksdottir D et al. Clin Respir J 2012;6:193–207; 2. Alving K et al. Eur Respir Mon 2010;49:1–31

# What does it measure?

- Increasing eosinophilic inflammation in the airways increases the NO exhaled



# Raised FeNO predicts steroid responsiveness

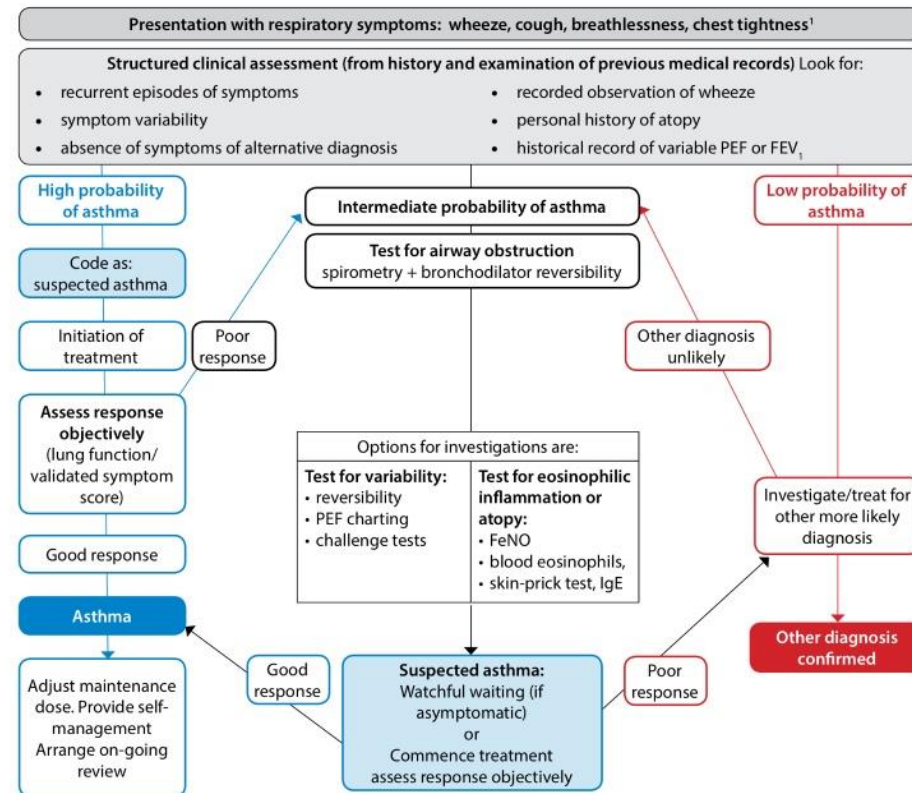


Smith AD, Cowan JO, Brassett KP, *et al.* Exhaled nitric oxide: a predictor of steroid response. *Am J Respir Crit Care*

*Med*2005;**172**:453–9.

# Where does FeNO testing sit in asthma guidelines?

Figure 1: Diagnostic algorithm

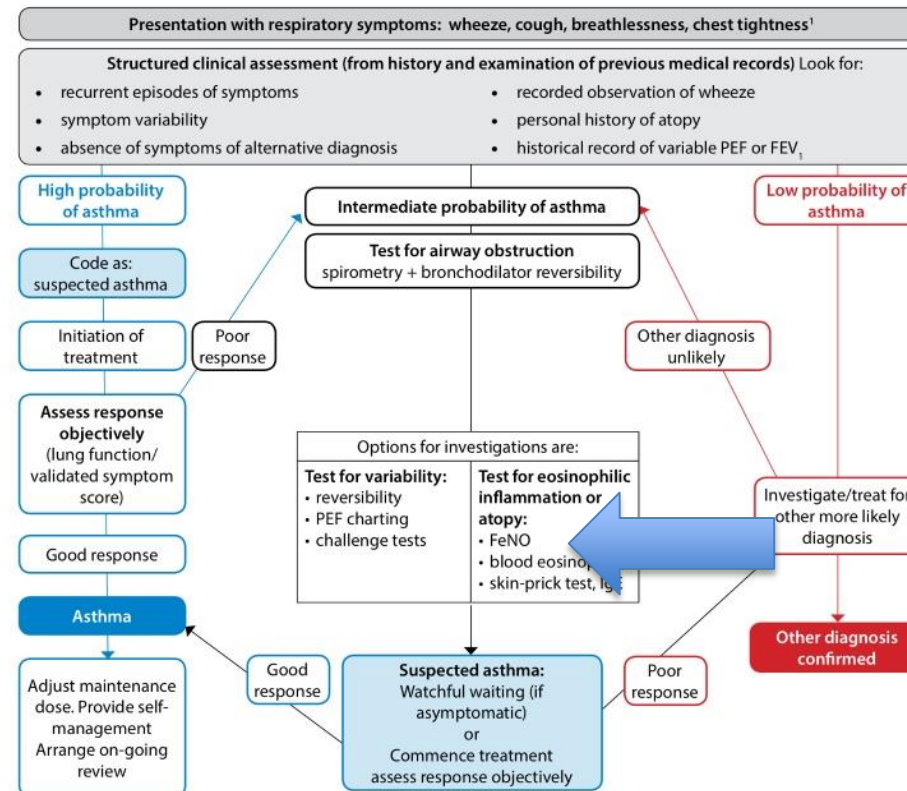


<sup>1</sup> In children under 5 years and others unable to undertake spirometry in whom there is a high or intermediate probability of asthma, the options are monitored initiation of treatment or watchful waiting according to the assessed probability of asthma.

1 British Thoracic Society, Scottish Intercollegiate Guidelines Network. British guideline on the management of asthma. SIGN 153. 2016. Available at: <https://www.brit-thoracic.org.uk/document-library/clinical-information/asthma/btssign-asthma-guideline-2016/> (accessed 26 June 2018).

# Where does FeNO testing sit in asthma guidelines?

Figure 1: Diagnostic algorithm

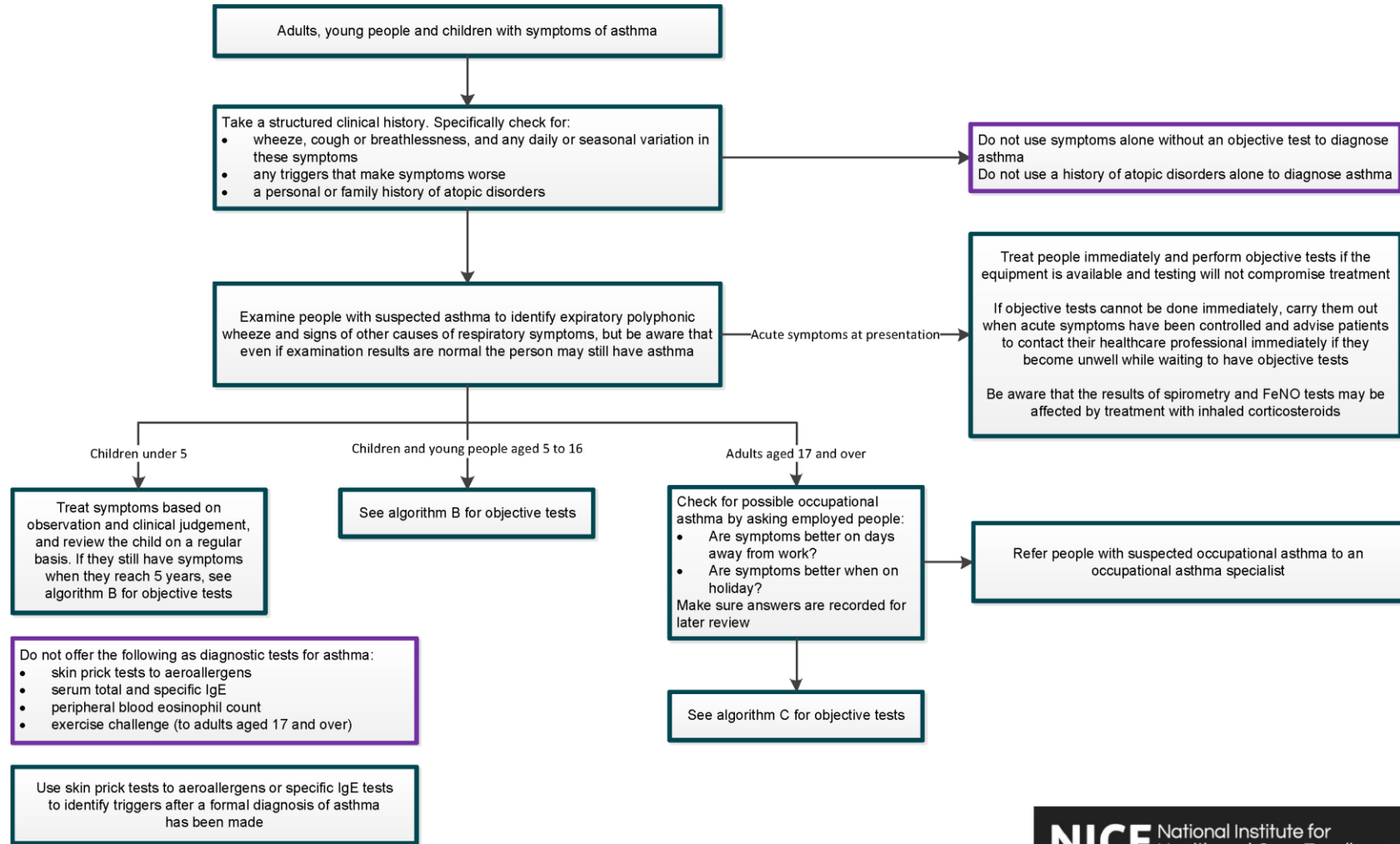


<sup>1</sup> In children under 5 years and others unable to undertake spirometry in whom there is a high or intermediate probability of asthma, the options are monitored initiation of treatment or watchful waiting according to the assessed probability of asthma.

1 British Thoracic Society, Scottish Intercollegiate Guidelines Network. British guideline on the management of asthma. SIGN 153. 2016. Available at: <https://www.brit-thoracic.org.uk/document-library/clinical-information/asthma/btssign-asthma-guideline-2016/> (accessed 26 June 2018).



## Algorithm A Initial clinical assessment for adults, young people and children with suspected asthma



This algorithm is based on recommendations from NICE's guideline on [asthma: diagnosis, monitoring and chronic asthma management](#) (2017)

### Algorithm B Objective tests for asthma in children and young people aged 5 to 16

#### Order of tests

- Perform spirometry in children and young people with symptoms of asthma
- Consider BDR test if spirometry shows an obstruction

If a child is unable to perform objective tests:

- treat based on observation and clinical judgement **and**
- try doing the tests again every 6 to 12 months

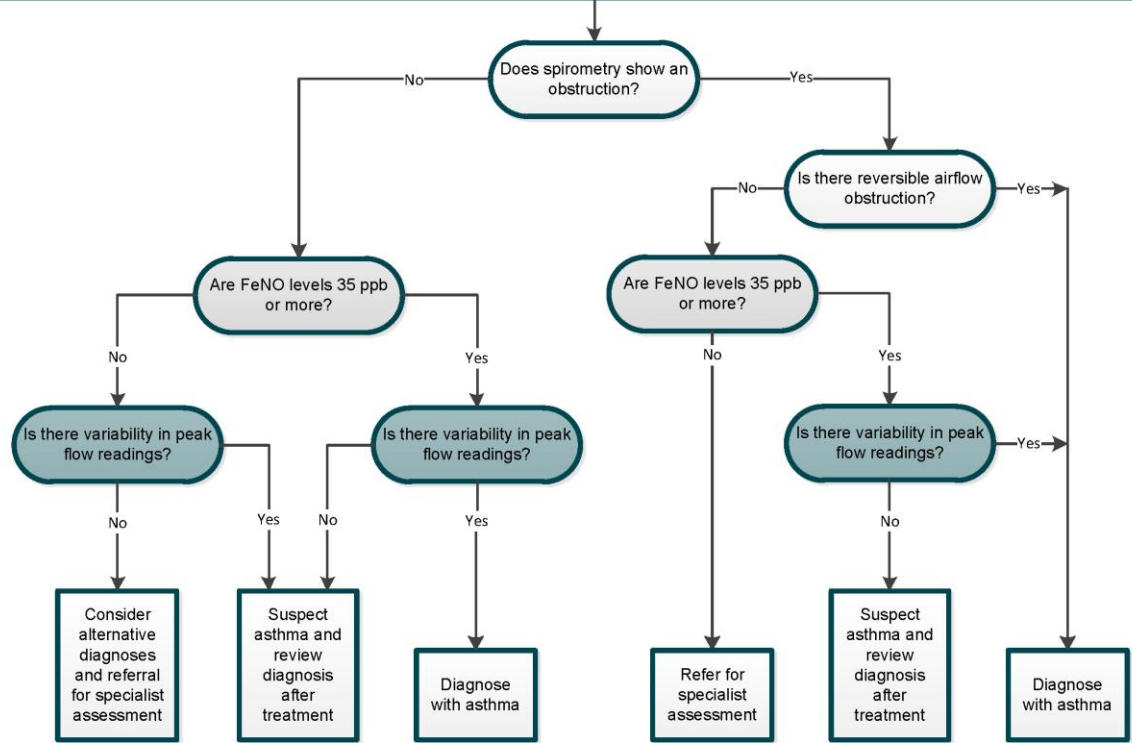
If diagnostic uncertainty remains after spirometry and BDR, consider FeNO

If diagnostic uncertainty remains after FeNO, monitor peak flow variability for 2 to 4 weeks

**Abbreviations:**  
 FeNO, fractional exhaled nitric oxide  
 BDR, bronchodilator reversibility

This algorithm is based on recommendations from NICE's guideline on [asthma diagnosis, monitoring and chronic asthma management](#) (2017)

#### Interpretation of test results for children and young people aged 5 to 16 with symptoms suggestive of asthma

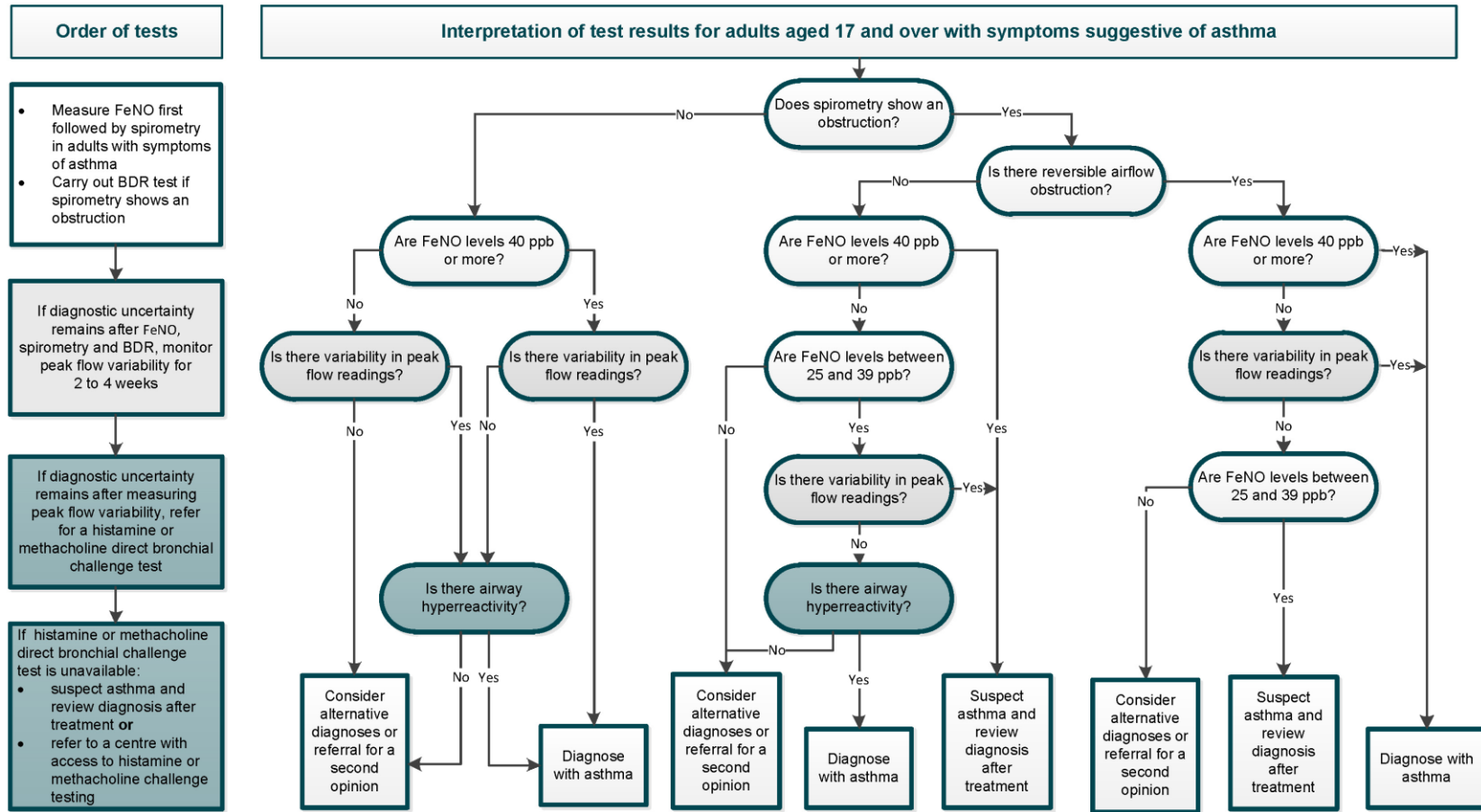


**Positive test thresholds**  
**Obstructive spirometry:** FEV1/FVC ratio less than 70% (or below the lower limit of normal if available)  
**FeNO:** 35 ppb or more  
**BDR:** improvement in FEV1 of 12% or more  
**Peak flow variability:** variability over 20%

**NICE** National Institute for Health and Care Excellence

© NICE 2017. All rights reserved. Subject to [Notice of rights](#).

### Algorithm C Objective tests for asthma in adults aged 17 and over



**Abbreviations:**  
 FeNO, fractional exhaled nitric oxide  
 BDR, bronchodilator reversibility

This algorithm is based on recommendations from NICE's guideline on [asthma, diagnosis, monitoring and chronic asthma management](#) (2017)

**Positive test thresholds**  
**Obstructive spirometry:** FEV1/FVC ratio less than 70% (or below the lower limit of normal if available)  
**FeNO:** 40 ppb or more  
**BDR:** improvement in FEV1 of 12% or more and increase in volume of 200 ml or more  
**Peak flow variability:** variability over 20%  
**Direct bronchial challenge test with histamine or methacholine:** PC20 of 8 mg/ml or less

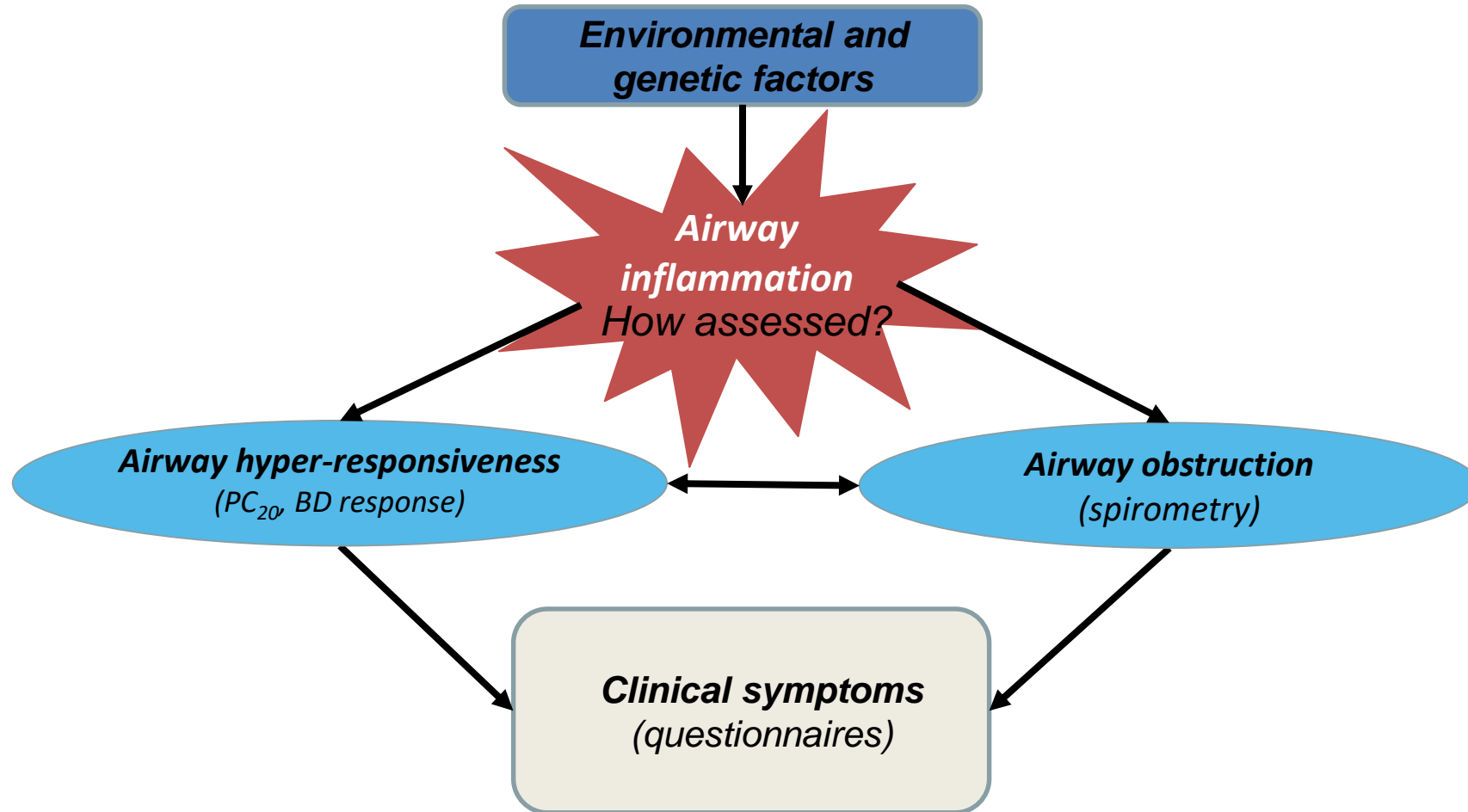
**NICE** National Institute for Health and Care Excellence

© NICE 2017. All rights reserved. Subject to [Notice of rights](#).

# What is the practical application?



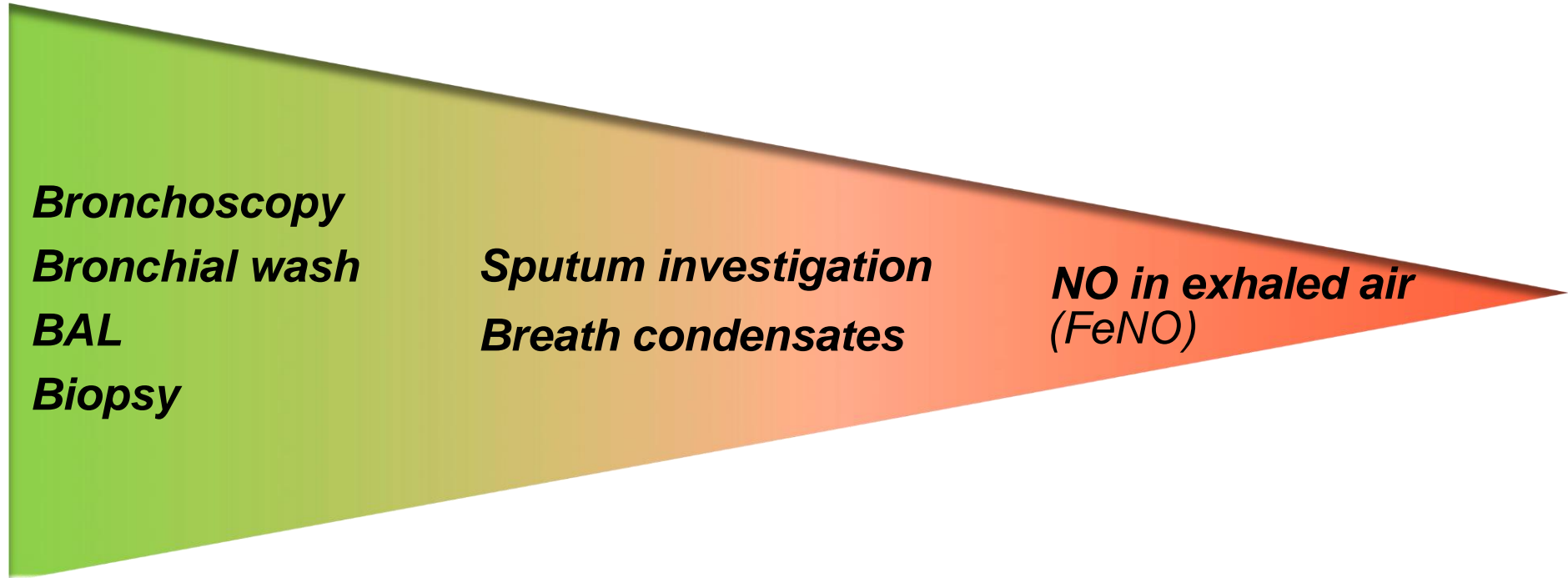
# The significance of inflammation



# Assessment of airway inflammation

*Invasive*

*Non-invasive*



# What about blood eosinophils?

- What is the threshold?
- Time period to consider
- Systemic factors affecting results
- Systemic marker for localized inflammation?



# Consider a patient.....



- 17yr old boy with asthma, plays a lot of football
- Stopped ICS as 'felt no longer needed it'
- Little symptom breakthrough recognised but once pressed realised he had "normalised" and tolerated some symptoms.

.



# Where might extra info be useful?



# Useful additional information



- FeNO was in 70's
- Education re action of ICS and developing lung health
- Dad "upset" they hadn't recognised symptoms - all went away with intention to stick to ICS
- Failed follow up appointment

Sex: Female Age: 63  
 Factor: 100 (Caucasian)  
 Height: 175cm Weight: 65kg BMI: 21.2  
 Smoking: Non-smoker

Turbine Transducer

(\* is for auto best; ^ for manual best)

UC	Var	Warnings	Time: Date:
Base	3.28 *	(Good blow)	09:21 26/07/17
Base	3.19 -2x	(Good blow)	09:22 26/07/17
Base	3.12 -4x	(Good blow)	09:20 26/07/17
Post!	3.36 *	(Good blow)	10:01 26/07/17
Post!	3.31 -1x	(Good blow)	10:00 26/07/17
Post!	3.29 -2x	(Good blow)	10:00 26/07/17

BTS Quality Criteria (Relaxed):  
 Base: Met.  
 Post!: Met.

FEV1	FVC	FEV1/FVC	PEF	Var	Warnings	Time:
Base Date: 26/07/17						
Base	1.77	3.25	54.5	302	-1x (Good blow)	09:24
Base	1.78	3.31	53.8	312	0x (Good blow)	09:25
Base	1.71	3.41	50.1	296	* (Good blow)	09:26
Post! Date: 26/07/17						
Post!	1.82	3.46	52.6	305	0x (Good blow)	10:02
Post!	1.77	3.35	52.8	298	-3x (Good blow)	10:03
Post!	1.88	3.41	55.1	318	* (Good blow)	10:04

Variation is based on FEV1 + FVC.

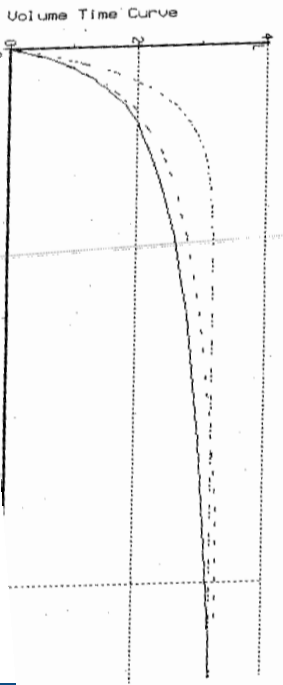
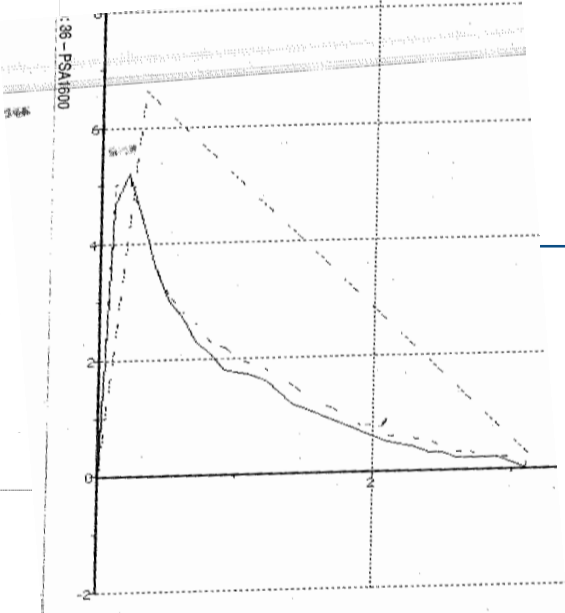
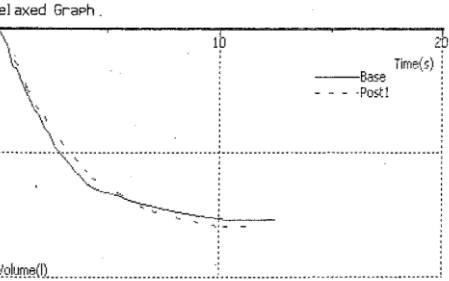
BTS Quality Criteria (Forced):  
 Base: Met  
 Post!: Met

Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

	Base	xPr	Min	Pred	Max	Post	xPr	zChe
EUC	3.28	101	2.55	3.24	3.93	3.36	104	2 1
UC	3.28	101	2.55	3.24	3.93	3.36	104	2 1
FEV1	1.78	65	2.12	2.74	3.36	1.88	69	6 1
FVC	3.41	106	2.51	3.22	3.93	3.46	107	1 1
PEF	312	78	309	398	486	318	80	2 1/min
FEV1/UC	54					56		3 x
FEV1/FVC	52	68	66	77	88	54	70	4 x
FEF25	1.83	32	3.44	5.66	7.88	2.27	40	24 1/s
FEF50	0.72	19	2.06	3.87	5.68	1.03	27	43 1/s
FEF75	0.19	14	0.24	1.37	2.50	0.29	21	53 1/s
FEF25-75	0.54	18	1.57	2.97	4.37	0.77	26	43 1/s
FET	11.9					10.7		-11 s

Lung Age 90yrs  
 Interpretation (Nice (2010)):  
 Base: Obstruction.  
 Post!: Moderate Obstruction.



## Another person to consider.....

- Female never smoker
- Diagnosed with asthma age 22 now age 63
- 2-3 infections/year treated with oral abs, rarely steroids due to purulence of sputum & lack of wheeze.
- MRC2
- Relevant other Sx or Hx incl.
- nasal polyps, indigestion
- Rx Symbicort 400/12 BD
- C/O "tight chest" on occasion
- Her concern = Chest infections
- FeNO 63ppb
- Observation = ?element of dysfunctional breathing
- Discuss Spirometry, relevance of FeNO, consideration of further Ix and any next steps.
- Did FeNO add value or change your plan?

# Where might extra info be useful?

- Diagnosis
- Symptom management – stepping up
- Confidence in stepping down
- Demonstrating inflammation
- Compliance/concordance/adherence
- Asthma or COPD?



# What service deliver model might work?

- Practice based delivery (cost, training, care close to home)
- Cluster delivery (share costs)
- Locality delivery
- Specialist service
- Secondary care service
- Private investors

# PC Locality based service model



Building confidence in a changing world

# FeNO Pilot – Data

## Outcomes

14 patients confirmed with Respiratory Diagnosis, 14 confirmed Not Respiratory Diagnosis (see Chart 6)  
For the 14 patients confirmed Not Respiratory, these patients would otherwise have been prescribed Clenil 100mcg 2 puffs twice daily and Salbutamol (as needed) for life, with an estimated cost per patient per year of £35.41

- Extrapolated **1 year saving** (52 Non Respiratory patients over 1 year of clinics) = 52x £35.41 = **£1841**  
Total avoided cost per patient would vary greatly down to age
- For these 14 patients, based on the assumption they would have been prescribed the above medications for life (calculated using local life expectancy of 82 years in 2012), there is an extrapolated total cost avoidance of **£19,263** over their lifetimes

12 prescriptions were stopped and 3 doses reduced; 10 new prescriptions were started (Chart 7)

FeNO test changed diagnosis for 10 patients, and assisted with diagnosis for 33 patients (Chart 9)

We would also look to analyse impact on hospital admissions for respiratory related conditions, when we have sufficient amount of data.

Chart 6: Outcome of Attendance

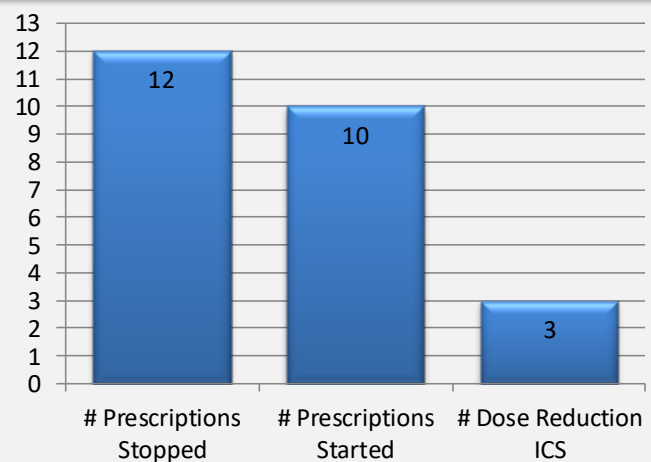
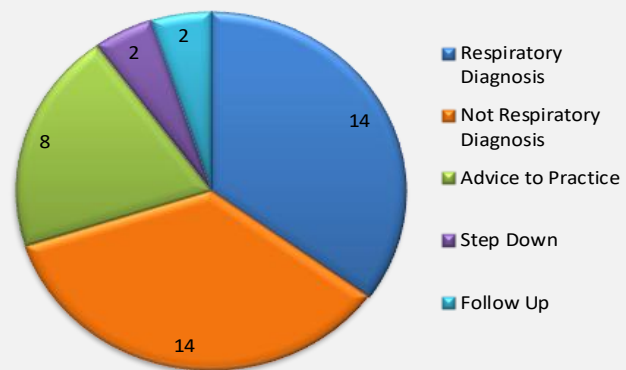
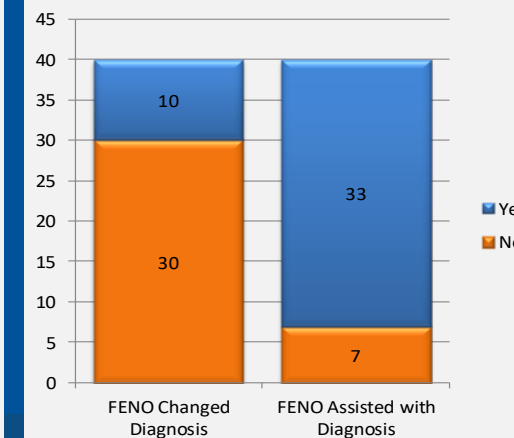
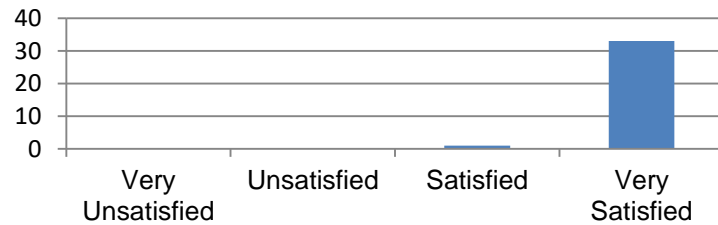


Chart 9: Diagnosis Outcomes

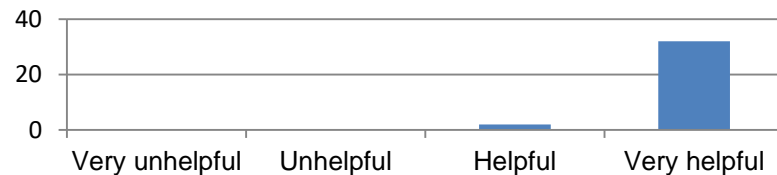


# FeNO Pilot Phase 2 – Patient Feedback

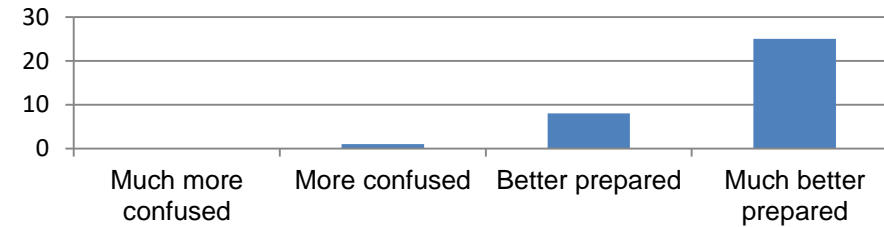
**How satisfied are you with your appointment at today's respiratory service?**



**How helpful was your appointment today in better understanding your...**



**Do you feel better prepared to manage your condition following today's Respiratory appointment?**



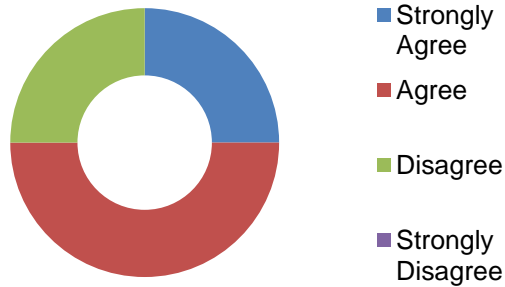
**Would you recommend the Respiratory Service to a friend or family...**



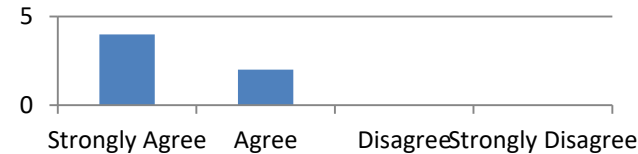


# FeNO Pilot Phase 2 - Practice Feedback

**Appointment booking was quick and easy**

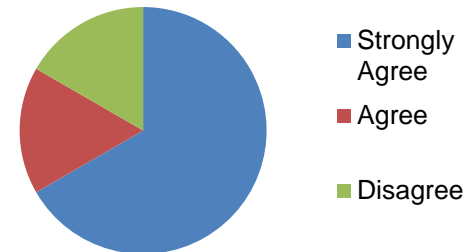


**The referral form was quick and easy to complete and send.**

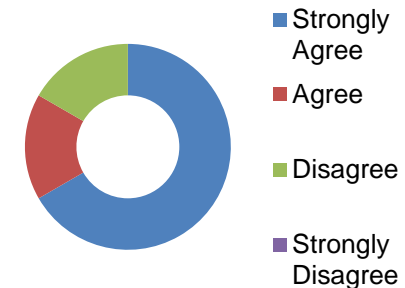


■ The referral form was quick and easy to complete and send.

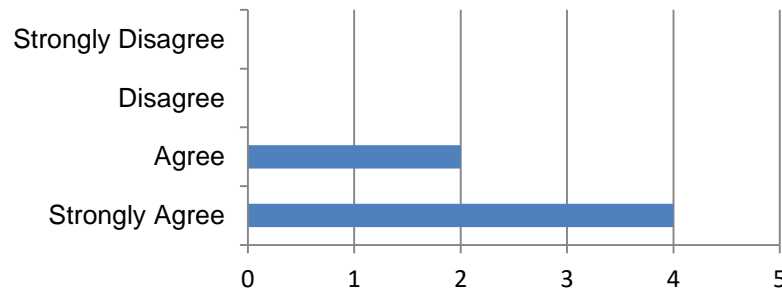
**The information was relevant to the reason for referral/answered the question I had asked.**



**Overall I am happy with the service.**

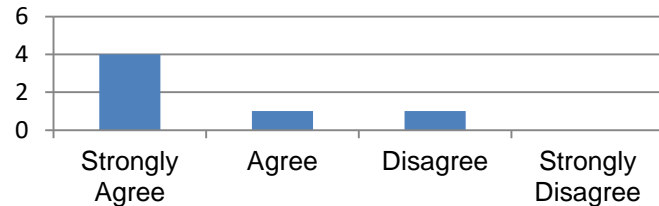


**Waiting time for an appointment was reasonable.**



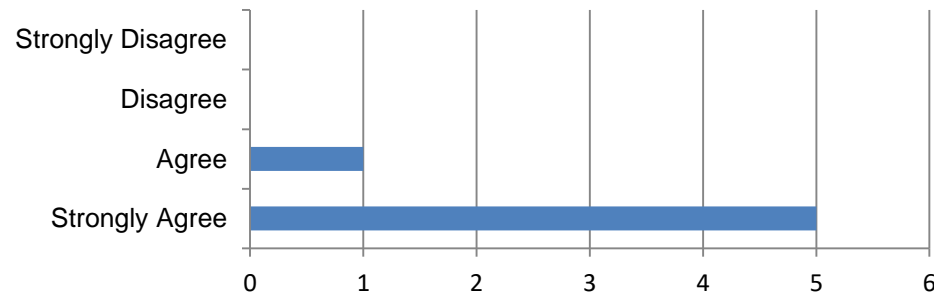
# FeNO Pilot Phase 2- Practice Feedback

**The quality of information back to the practice was good**



*“Support with sometimes tricky diagnosis has been invaluable.”*

**The timeliness of the information back to the practice was good.**



**“Excellent service, hugely beneficial to some difficult patients. This saved a referral to a secondary care respiratory team.”**

# Where are we now?

Primary care provision for FeNO?

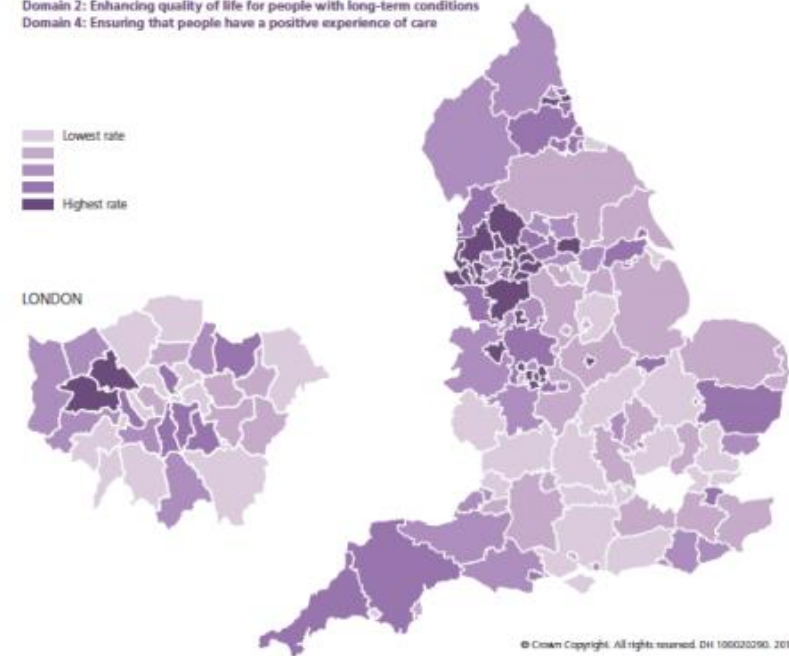
‘Specialist’ provision?



## PROBLEMS OF THE RESPIRATORY SYSTEM

**Map 19:** Emergency admission rate for children with asthma per population aged 0–17 years by PCT  
Directly standardised rate 2009/10

Domain 2: Enhancing quality of life for people with long-term conditions  
Domain 4: Ensuring that people have a positive experience of care



# Enablers for FeNO



- Inclusion in guidelines
- Demonstration of cost savings
- Better care
- Federations, clusters, CCGs, ICOs, ICSs
- Broadening health care teams – clinical pharmacists, Physicians Assistants
- Campaign groups – Asthma UK.

# Barriers for using FeNO

- Conflicting guidelines
- Confusion amongst clinicians
- Cost
- Independent budgets
- Unfamiliarity

# Who pays?



- Individual practices
- Clusters or federations
- Localities
- CCGs
- Hospital trusts
- Private investors
- Manufacturers

# Is FeNO Feasible?



- What is FeNO?
- What does it measure?
- Where does FeNO testing sit in asthma guidelines?
- What is the practical application?
- What service deliver model might work?
- Who pays?

# Hands on practice

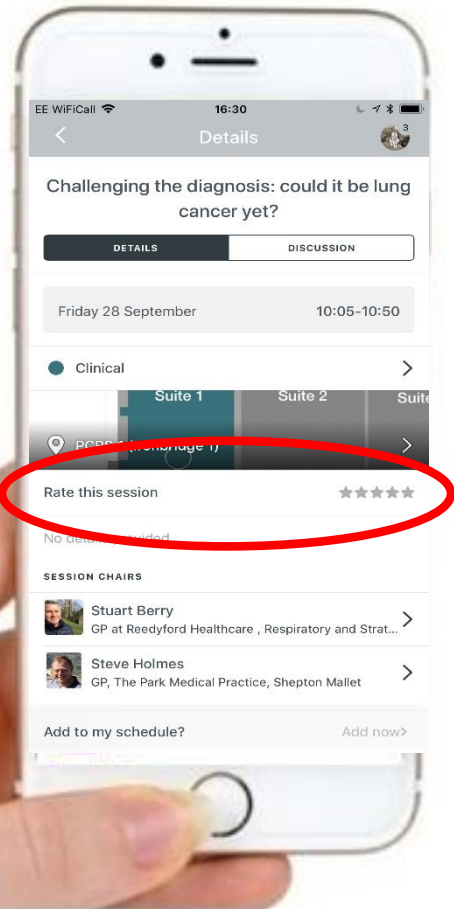
- Bedfont
- Bosch
- Circassia







# We need your feedback !



## Rate each session:

Please check into each session you attend on the app and give it a star rating from 1 (poor) to 5 (excellent)