Peak Flow and Spirometry: The Good, The Bad & The Ugly

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To be discussed

• Peak Flow Meters
  – Why use
  – How to use PF meters
  – Various uses

• Spirometry:
  – Why perform
  – How to perform
  – Introduction to pattern recognition and interpretation
History of Peak Flow

• First used in 1942
• 1978 Mini Wright introduced
• 2004 A new standard scale (EN 13826) is introduced across Europe
• 2014 Digital peak flows widely available
Performance of Peak Flow

- Ensure peak flow meter is clean and working
- Insert new/clean mouthpiece
- Ask patient to sit/stand straight (standing preferable)
- Explain test and ensure patients hands do not cover the vents/path of pointer on scale
- Ask patient to take a full inspiration through the mouth and immediately place teeth and lips around the mouthpiece to make tight seal
- The patient should then make a short, sharp, hard blow with an empty glottis (can stop after one second)
- Return pointer to zero
- Highest reading of at least three acceptable blows should be recorded (these should be within 20L.min\(^{-1}\) of each other)
Normal values for peak expiratory flow (PEF)
EN 13826 or EU scale

PEF (L/min)

Height
190 cm or 75”
183 cm or 72”
175 cm or 69”
167 cm or 66”
160 cm or 63”
183 cm or 72”
175 cm or 69”
167 cm or 66”
160 cm or 63”
152 cm or 60”

Age (years)

15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
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Possible errors

- Poor effort
  - Poor comprehension
  - Lack of motivation
  - Lack of co-ordination
  - Sub-max inspiration

- Leak at mouthpiece
  - Lips not tight
  - Loose dentures
  - Teeth not over mouthpiece
  - Tongue blocking mouthpiece
  - Facial palsy

(also inadequate rest)
Interpretation of Peak Flow

Many respiratory abnormalities/diseases will cause a reduction in peak flow

• Obstructive airway diseases:
  – COPD
  – Asthma

• Restrictive airway diseases
  – Interstitial disease ie fibrosis
  – Chest wall deformities ie scoliosis
  – Neuromuscular diseases
Normal PF=Undiseased Lungs?

• Unfortunately not!
• Normal PF can be seen in:
  – Normal lungs
  – Controlled/stable Asthma
  – Mild COPD
  – Restrictive disease
  – Asymtomatic smokers
Why use a Peak Flow

- Assess peak flow and compare to normal values
- To assess diurnal variation
- Bronchodilator response
- Steroid Trial
- Management Plan
- Occupational
Uses of a Peak Flow

- Assessment of diurnal variation
- Perform PF 2-4 times daily (We suggest TDS, but tailor to patients needs)
- Record best attempt on PF chart
- Use for at least 3 weeks
- Normal variation is 8%
- 20% variations indicate asthma (BTS guidelines)
- If diurnal variation does not occur, this does not exclude asthma, further testing advised

- To calculate % Change

\[ \frac{(\text{Daily Max} - \text{Daily Min}) \times 100}{\text{Daily Max}} \]

- Ex: Daily Max = 400, Daily Min = 300

\[ \frac{400 - 300 \times 100}{400} = 25\% \text{ Change} \]
Uses of a Peak Flow

• Bronchodilator Response
  – Obtain baseline
  – Administer Bronchodilator (400mcg Salbutamol via spacer device)
  – Wait 12-15 minutes
  – Repeat 3 peak flow manoeuvres
  – 20% increase in peak flow is indicative of asthma
Uses of a Peak Flow

• Steroid Trial
  – Patient should use PF BD for 1/52
  – Trial of oral steroids:
    • 30mg per day for 3/52 for adults
    • 1mg/kg for children for 1/52

Change in 20% in PF after steroids indicates asthma
Uses of a Peak Flow

• Management plan
  – Have patients record their baseline when they are feeling well
  – Patient can then compare with when they are feeling unwell, monitor their own response to therapy
  – Puts power and responsibility in the hands of the patient
Uses of a Peak Flow

• Occupational Asthma
  – Over a number of weeks
  – Allows patient to measure PF in work versus at home
  – Delayed “dip” in PF is possible, this may happen outside work environment
  – If no significant change is noted it is beneficial to repeat testing when patient is outside of work for longer period ie before, during and after a week of holiday
Occupational Asthma

Average Hour from Waking for Rest and Work days

PEF (L/Min)

00-02 02-04 04-06 06-08 08-10 10-12 12-14 14-16 16-18 18-20
9 21 9 19 8 20 7 21 9 19 9 17 9 16 9 2 8 0 1 0

ABC Score: 51 l/min/hour

Hours From Waking, Number of Readings And Areas (Working x) (Rest □)
Advantages & Disadvantages of using a Peak Flows

• Advantages
  – Readily available
  – Useful tool in diagnosis and monitoring of asthma
  – Quick to perform
  – Cheap and portable

• Disadvantages
  – Effort dependant
  – Poor compliance
  – False high readings
  – Possibility of manipulation of results
Uses of Spirometry

• The most widely utilized test of respiratory function
• Not used enough in primary care settings
• Can provide important clinical information
• Identify and quantify defects in the respiratory system
• Necessary for the diagnosis of Asthma and COPD
Why do Spirometry?

- Diagnostic
  - To evaluate symptoms, signs or abnormal laboratory tests
  - To measure the effect of disease on pulmonary function
  - To screen individuals at risk of having pulmonary disease
  - To assess pre-operative risk
  - To assess prognosis
  - To assess health status before beginning strenuous physical activity programmes
  - Monitoring
  - To assess therapeutic intervention
  - To describe the course of diseases that affect lung function
  - To monitor people exposed to injurious agents
  - To monitor for adverse reactions to drugs with known pulmonary toxicity
  - Disability/impairment evaluations
  - To assess patients as part of a rehabilitation programme
  - To assess risks as part of an insurance evaluation
  - To assess individuals for legal reasons
- Public health
- Epidemiological surveys
- Derivation of reference equations
- Clinical research
Who should have Spirometry?

- Smokers
- COPD
- Asthma
- Chest tightness
- Unexplained chronic cough
- Neuromuscular disease
- Exertional dispnea
- Systemic diseases
Relative contraindications to Spirometry

- Known or suspected respiratory infection
- Haemoptysis of unknown origin
- Pneumothorax
- Unstable cardiovascular status: recent (within 1 month) myocardial infarction, uncontrolled hypertension or pulmonary embolism
- Uncontrolled hypertension or history of haemorrhagic cerebrovascular event
- Recent thoracic, abdominal or eye surgery
- Nausea/vomiting/Pain
- Confusion/dementia
Performing the test

• The patient should be sitting comfortably with both feet on the ground, and tight clothing loosened
• The patient begins by tidal breathing with their lips and teeth around the mouthpiece for at least three breaths*
• The patient should inspire maximally and rapidly and immediately blow out as hard and as fast as possible
• After a full and complete expiration the patient should inhale maximally again in a relaxed manner

*for a closed circuit system, a bacterial filter should always be used
• [http://www.youtube.com/watch?v=lWHx31BquBA](http://www.youtube.com/watch?v=lWHx31BquBA)
What are the most important measurements?

- **FVC**: Forced Vital Capacity is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration (expressed in litres)
- **FEV1**: FEV1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration (expressed in litres)
- **FEV1/FVC ratio**
- **PEF**: Peak expiratory flow is the measurement of fastest flow
Spirometry: the Good

Satisfactory peak flow must be achieved
Exhalation should be for at least 6 seconds (3 for a child)
A minimum of three trials must be performed (two of which are reproducible within 5%)
When expiring the patient must do so without hesitation
A nose clip should be worn
Test should be performed with an open glottis and without a cough
The patient should have their mouth and teeth around the mouthpiece with their lips tight
The results must be reproducible
Examples: unsatisfactory spirometry
Normal Spirometry

- Satisfactory performance of test
- Full inspiration followed by complete forceful expiration
- Reproducible
Obstructive Spirometry

- Seen in:
  - COPD
  - Uncontrolled asthma
  - Emphysema
Restrictive Spirometry

- Seen in
- Neuromuscular disease
- Kyphoscoliosis
- Fibrosis of the Lung
- Diaphragm paralysis
- Obesity
Patterns of Spirometric Curves

There are 3 basic patterns to recognise:

**Normal**
- FEV1 and FVC above 80% predicted
- FEV1/FVC >0.7

**Restrictive**
- FEV1 below 80% predicted
- FVC below 80% predicted
- FEV1/FVC ratio normal (>0.7)

**Obstructive**
- FEV1 below 80% predicted
- FVC can be normal or reduced
- FEV1/FVC ratio <0.7
### How to differentiate between Obstructive and Restrictive

<table>
<thead>
<tr>
<th>Disease Type</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt; / FVC ratio</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;</th>
<th>FVC (threshold 80%)</th>
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<tbody>
<tr>
<td>Obstructive disease</td>
<td>↓</td>
<td>↓</td>
<td>N</td>
</tr>
<tr>
<td>Restrictive disease</td>
<td>Normal</td>
<td>↓</td>
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A Guide to interpretation

1. Begin with FEV1/FVC ratio
   • 70% + Normal or restriction
   • Look at FEV1 to decide
   • <70% Obstruction

2. Characterize degree of airflow obstruction
   FEV1 – 70-80% predicted - Mild airflow obstruction
   FEV1 – 60-69% predicted - Moderate airflow obstruction
   FEV1 – 50-59% predicted – Moderate Severe airflow obstruction
   FEV1 -- 35-49% predicted – Severe airflow obstruction
   FEV1 – <35% predicted – Very Severe airflow obstruction

3. Assess reversibility
   Give Salbutamol through volumatic spacer
   Reversibility > 12% and 200 mls

4. Assess flow volume curve
Interpretation algorithm

FVC curve

normal

abnormal

FVC/FEV₁ ratio

<70%

FEV₁

<80% exp

>80% exp

Obstructive:

>70% Mild

60-69% mod- severe

50-59% severe

35-49% Severe

<35 Very severe

Borderline obstructive

>70%

FVC

<80% exp

>80% exp

Restrictive

<80% mild

<60% moderate

<50% severe

normal
Examples of Spirometry

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<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Pred</th>
<th>Act.</th>
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<td>84</td>
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<th>FVC</th>
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## Mild Obstruction

### Spirometry: Flow-Volume

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Moderate obstruction

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Severe obstruction

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|                | FEV\(_1\) / FVC ratio | FEV\(_1\) | FVC (threshold 80 %)
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## Restriction

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<td>Obstructive disease</td>
<td>↓</td>
<td>↓</td>
<td>N</td>
</tr>
<tr>
<td>Restrictive disease</td>
<td>Normal</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>
Bronchodilator Response

<table>
<thead>
<tr>
<th></th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt; / FVC ratio</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;</th>
<th>FVC (threshold 80 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructive disease</td>
<td>↓</td>
<td>↓</td>
<td>N</td>
</tr>
<tr>
<td>Restrictive disease</td>
<td>Normal</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>
conclusion

• Peak flow is a cheap and useful tool in practice
• In both spirometry and peak flow technique is vital
• Correctly performed tests can give vital information in primary care
• Any Questions?