

Knowledge of Spirometry in Foundation Doctors and Basic Specialist Trainees in Medicine

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Background: Basic interpretation of spirometry is important to any clinician, since respiratory disease is one of the most encountered in everyday clinical practice.

Methods: The aim of this audit is to assess the basic knowledge (via a questionnaire) of spirometry interpretation by foundation doctors and basic specialist trainees working in medicine, in Mater Dei Hospital, Malta. This included the interpretation of the values for Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC) and their ratio.

Results: The maximum score from the questionnaire was 9. A total of 21 FYs and 30 BSTs participated in the data collection. The mean score for the FY group was 6.8, the least score being 4 (obtained by 1 participant) and the highest being 8 (obtained by 6 participants). The mean score for the BST group was 6.8 as well, the least score being 5 (obtained by 6 participants) and the highest being 9 (obtained by 2 participants).

Conclusion: Although relatively satisfactory scores were obtained from the two groups, it is still concerning that a significant amount of participants answered basic questions incorrectly; these basic principles being important in the interpretation of a spirometry result. Further education is required to standardise the knowledge on the basic interpretation of spirometry. Interpretation of lung function testing is important as this could affect management, including organising further investigations or identification of important reversible obstructive lung diseases such as Asthma.

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Spirometry, also known as 'lung function testing', is a simple non-invasive technique by which lung volumes can be measured in patients with suspicion of known respiratory disease¹. Basic interpretation is important to any clinician, since respiratory disease is one of the most encountered in everyday clinical practice.

The aim of this audit is to assess the basic knowledge of spirometry interpretation by Foundation Year Doctors (FYs) and Basic Specialist Trainees (BSTs) working in medicine, in Mater Dei Hospital, Malta. The knowledge assessed would include interpretation of the values for Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC) and their ratio; along with interpretation of reversibility testing (indication and positive/negative results). The doctors will also be assessed on the knowledge of contra-indications for spirometric testing.²

MATERIALS AND METHODS

A questionnaire was used to assess the knowledge of FYs, some of whom were working in the Pre-Operative Assessment clinic, and Medical BSTs. All participants were informed regarding the aim of the audit beforehand and were asked whether they accept to be assessed in the audit. All data collected is anonymised.

The questionnaire is in accordance with clinical practice guidelines on spirometry indication and interpretation³. One point will be scored for each correct answer in the questionnaire. The results were then assessed for any statistical significance using the independent t-test, with statistical significance being met if the p value was <0.05.

The questions that were asked during the data collection can be found in [Supplemental File 1](#).

RESULTS

A total of 21 FYs and 30 BSTs participated in the data collection. During the data collection for this audit, a new update was issued by the European Respiratory Society and American Thoracic Society regarding interpretation of variability in FEV1/FVC, with the new guidance suggesting bronchodilator positivity when there is a 10% relative to the predicted FEV1/FVC, rather than a 12% change (or 200ml change)

between pre- and post-bronchodilator values⁵. In view of this update, questions in our audit with regards to lung reversibility (Questions 7 and 10) were discarded, to avoid confusion with regards to accurate responses. Therefore, the maximum score one could have obtained was 9.

Table 1 depicts a summary of the results for the Foundation Doctor Group.

The mean score for the FY group was 6.8, the least score being 4 (obtained by 1 participant) and the highest being 8 (obtained by 6 participants). The least correctly answered question was Question 11, which asks regarding the recommended spirometry time for an accurate result.

FYs who have previously worked in a Respiratory Rotation (n=10) scored a mean of 6.6, whilst those who didn't (n=11) had a mean score of 7. When comparing the means of the two groups, the results were not statistically significant when using an independent two-tailed t-test (p= 0.43).

Table 2 depicts a summary of the Medical BSTs results.

The mean score for the BST group was 6.8 as well, the least score being 5 (obtained by 6 participants) and the highest being 9 (obtained by 2 participants). The least correctly answered question was also Question 11, with 22 participants answering incorrectly.

Although the mean scores for both groups were 6.8, there was no statistical significance when being assessed with an independent two-tailed t-test (p=0.90).

DISCUSSION

The 2005 Technical Standards for Spirometry were updated in 2019 by a joint task force between the European Respiratory Society (ERS) and the American Thoracic Society (ARS)⁴. The changes reflect the improvements in instrumentation and research to ensure international standards are met.

Spirometry measures the maximal volume or flow of air that can be inspired and expired. It helps diagnose respiratory conditions and assess general respiratory health, effect of a disease and therapeutic interventions on lung function, airway responsiveness, pre-operative risk and prognosis. The

Table 1 Results of the Foundation Doctor Group. Questions 7 and 10 being discarded.

Participant Number	At POAC or Ward?	Surgical or Medical Rotation	Ever worked in a Respiratory Rotation?	Q1	Q2	Q3	Q4	Q5	Q6	Q8	Q9	Q11	Result
1	Ward	Surgery	No	✓	X	✓	✓	✓	X	✓	X	✓	6
2	Ward	Medicine	Yes	✓	✓	✓	✓	✓	✓	X	X	✓	7
3	Ward	Medicine	No	✓	✓	✓	✓	✓	✓	X	✓	X	7
4	POAC	Surgery	No	X	✓	X	✓	✓	✓	X	✓	X	5
5	Ward	Medicine	Yes	✓	✓	✓	✓	✓	✓	X	✓	X	7
6	POAC	Surgery	No	✓	✓	✓	✓	✓	✓	✓	✓	X	8
7	Ward	Medicine	Yes	✓	X	✓	✓	✓	✓	✓	✓	✓	8
8	POAC	Surgery	No	✓	X	✓	✓	✓	✓	✓	✓	✓	8
9	Ward	Medicine	Yes	X	X	✓	✓	X	✓	✓	X	X	4
10	Ward	Medicine	No	✓	✓	✓	✓	✓	X	✓	X	X	6
11	Ward	Medicine	Yes	✓	✓	✓	✓	✓	X	X	✓	✓	7
12	Ward	Surgery	No	✓	✓	✓	✓	✓	✓	✓	✓	X	8
13	Ward	Medicine	No	✓	X	✓	✓	✓	X	✓	✓	✓	7
14	Ward	Medicine	Yes	✓	✓	✓	✓	✓	✓	✓	✓	X	8
15	POAC	Surgery	Yes	✓	✓	X	✓	X	✓	✓	X	✓	6
16	POAC	Surgery	No	✓	✓	✓	✓	✓	✓	✓	✓	X	8
17	Ward	Surgery	Yes	✓	✓	✓	✓	✓	X	✓	✓	X	7
18	POAC	Surgery	No	✓	✓	✓	✓	✓	X	✓	✓	X	7
19	Ward	Medicine	Yes	✓	✓	✓	✓	X	✓	✓	✓	X	7
20	POAC	Surgery	Yes	X	X	X	✓	✓	✓	✓	✓	X	5
21	Ward	Medicine	No	✓	✓	✓	✓	✓	✓	✓	X	X	7

Table 2 Results of the Medical Basic Specialist Trainee Group. Questions 7 and 10 being discarded.

Participant Number	Q1	Q2	Q3	Q4	Q5	Q6	Q8	Q9	Q11	Result
1	X	✓	X	X	✓	✓	✓	✓	X	5
2	X	X	X	✓	✓	✓	✓	✓	✓	6
3	✓	✓	✓	✓	X	✓	X	✓	✓	6
4	✓	✓	✓	✓	✓	✓	✓	✓	X	8
5	✓	✓	X	✓	✓	X	X	✓	X	5
6	✓	X	✓	✓	X	X	✓	✓	X	5
7	✓	X	✓	✓	✓	✓	✓	✓	X	7
8	X	✓	✓	✓	X	✓	✓	✓	X	6
9	✓	✓	X	✓	✓	✓	✓	✓	X	7
10	✓	X	X	✓	✓	✓	X	✓	X	5
11	✓	✓	✓	✓	✓	✓	✓	✓	X	8
12	✓	✓	✓	✓	X	✓	✓	✓	✓	8
13	X	X	✓	X	✓	✓	✓	✓	X	5
14	✓	✓	✓	✓	✓	✓	✓	✓	✓	9
15	✓	X	✓	✓	✓	✓	✓	✓	✓	8
16	✓	✓	✓	✓	✓	✓	✓	✓	✓	9
17	X	✓	✓	✓	✓	✓	✓	✓	X	7
18	X	X	✓	✓	✓	X	✓	✓	X	5
19	✓	X	✓	✓	✓	✓	✓	X	X	6
20	✓	✓	✓	✓	✓	X	✓	✓	X	7
21	✓	✓	X	✓	✓	✓	✓	✓	✓	8
22	✓	X	✓	✓	✓	✓	✓	✓	✓	8
23	✓	✓	✓	✓	✓	✓	✓	✓	X	8
24	✓	✓	✓	✓	X	✓	✓	✓	X	7
25	✓	X	✓	✓	X	✓	✓	✓	X	6
26	✓	X	✓	✓	✓	✓	✓	✓	X	7
27	✓	✓	✓	✓	✓	✓	✓	✓	X	8
28	✓	X	✓	✓	✓	✓	✓	✓	X	7
29	✓	✓	✓	X	✓	X	✓	✓	X	6
30	✓	X	✓	X	✓	✓	✓	✓	X	6

Forced Vital Capacity (FVC) and the Forced Expiratory Volume in the first second (FEV1) are important parameters that are measured. The FVC is the volume of air forcefully expired up to completion starting

from full inspiration. The FEV1 is the volume of expired air in the first second of an FVC manoeuvre.

The patient should be provided with all the relevant information about the test and on what medications

to withhold prior the test. This, together with operator feedback and display of flow on a screen, helps improve patient experience and give more accurate results. 3 key elements required for high quality spirometry are:

- accurate instrumentation;
- acceptable, repeatable measurements by a co-operative patient;
- motivated and trained operator to ensure best performance by patient.

Tests performed while standing yield similar results but FEV1 and FVC may be higher. Patient age, gender, height (in centimetres) and weight (wearing indoor clothes and without shoes) are recorded; these values will provide a predicted value for the FEV1 and FVC, which would then be expressed as a percentage compared to the recorder values.

Before lung function testing, patients should be advised to avoid smoking (from 1 hour before), alcohol/intoxicants (8 hours), vigorous exercise (1 hour) and wearing tight clothing. Bronchodilators should be stopped if the study is performed to diagnose an underlying lung condition. If spirometry is done to assess response to an existing therapeutic regimen, these need not be withheld. The medication, dose and time of last administration should be recorded. Inhaled corticosteroids and leukotriene modifiers need not be withheld.

The largest values of FEV1 and FVC are reported and their ratio used for the FEV1/FVC. Values may not necessarily come from the same manoeuvre. Pre- and post-bronchodilator values are recording using both percentages and absolute values. As mentioned in the results section, the new recommendation by the European Respiratory Society and American Thoracic Society on reversibility of FEV1/FVC, is that there needs to be a 10% change relative to the predicted FEV1/FVC, rather than a 12% change (or 200ml change)⁵. Three acceptable FEV1 and FVC values are usually enough. The manoeuvre can be repeated up to 8 times but this increases the risk of fatigue.

When comparing to the literature, a similar audit was performed by Kamdar et al⁶. The results of the latter indicated a similar trend of results after subjects were assessed with a questionnaire; also improvement of the results were noted after appropriate training in spirometry interpretation,

this could be adapted locally (for example, via an online summary on the basic interpretation of spirometry, available easily on the national hospital network) and then performing a re-audit.

Although relatively satisfactory scores were obtained from the two groups in our audit, it is still concerning that a significant number of participants answered basic questions incorrectly; these basic principles being important in the interpretation of a spirometry result, especially in the context of patients having a pre-operative assessment or those who are being investigated with obstructive and/or restrictive lung diseases. It is particularly concerning to note that Question 2, which asks a basic question with regards to the cut-off for an obstructive FEV1/FVC Ratio, was answered incorrectly by 13 participants in the BST group.

It is recommended that basic interpretation skills of spirometry should be part of the post-graduate learning curriculum, either in the form of lectures or tutorials. Another suggestion could be that an information sheet can be present with the spirometry result, which would aid interpretation and direct further investigations or consultation with a respiratory physician. This can also be addressed through implementation of online education resources, guidelines and information material (locally referred to as clinibytes) which is readily available to all doctors locally.

Limitations of this audit included the relatively low number of participants required to achieve statistical significance, as well as a disproportionate number of participants who were willing to participate in each respective group. There was also no formal randomisation with regards to data collection.

CONCLUSION

Further education is required to standardise the knowledge on the basic interpretation of spirometry, in both foundation doctors and medical basic specialist trainees. Interpretation of lung function testing is important as this could affect management, including organising further investigations or identification of important reversible obstructive lung diseases such as Asthma.

REFERENCES

1. Moore VC. Spirometry: step by step. *Breathe* 2012;8:232-40.
2. Cooper BG. An update on contraindications for lung function testing. *Thorax* 2010;66:714-23.
3. Barreiro TJ, Perillo I. An Approach to Interpreting Spirometry. *Am Fam Physician* 2004;69:1107-15.
4. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, Hallstrand TS, Kaminsky DA, McCarthy K, McCormack MC et al. Standardization of Spirometry 2019 Update: An Official American Thoracic Society and European Respiratory Society Technical Statement. *American Journal of Respiratory and Critical Care Medicine* 2019;200:70-88.
5. Stanojevic S, Kaminsky DA, Miller MR, Thompson B, Aliverti A, Barjaktarevic I, Cooper BG, Culver B, Derom E, Hall GL et al. ERS/ATS technical standard on interpretive strategies for routine lung function tests, *European Respiratory Journal* 2022;60:2101499.
6. Kamdar U, Tariq K, Morjaria J, Anderson G. Junior Doctors Performance and Interpretation of Spirometry. *Thorax* 2012;67:168.