Job Aid: Using the NDD Easy on PC Spirometer for Lung Function Diagnosis

Aim: This job aid outlines the steps to follow when using the NDD EasyOne PC spirometer to perform a lung function test.

A. Introduction

Spirometry ("measurement of breath") is the cornerstone of respiratory function testing and is essential for monitoring and diagnosing the most common respiratory conditions [1,2]. It measures the speed at which air is emptied from the lungs (flow) and the proportion (volume) of air that can be moved during a maximal exhalation [1].

Spirometry can help in

- Diagnosing asthma, chronic obstructive pulmonary disease (COPD), and other restrictive lung diseases [3].
- excluding respiratory disease as a cause of current symptoms,
- assessing the severity of any impairment in function,
- monitoring the effects of any therapeutic intervention or of disease progression.

B. Equipment and Materials

- NDD spirometer
- Windows laptop/tablet containing the NDD software ,
- Disposable or sterilizable spirettes,
- Nose clips/cotton wool (optional, especially when testing relatively healthy individuals [4])
- Ndd marked calibration syringe with adapter (for verification of calibration) [5]
- Personal protective equipment (PPE): gloves, face masks, etc
- Timer or stopwatch (optional)
- Alcohol wipes or sterilization solution (to clean the equipment after use)

C. Preparation

1. Patient Preparation:
   - Explain the procedure to the patient and respond to their questions.
   - Ensure the patient is seated comfortably and wears loose-fitting clothing.
   - Instruct the patient to avoid heavy meals, caffeine, alcohol, smoking, and vigorous exercise for at least 4 hours before the test.
2. Equipment Preparation:
   - Calibrate the spirometer according to the manufacturer's instructions [5]. According to the manufacturer, the easyone on PC spirometer does not need daily calibration.
   - Insert a sterile spirrette in the spirometer.

D. Procedure

Follow the steps below to perform a spirometry exam with the Easyone on PC spirometer.

1. Connect the spirometer to a USB port of the laptop/tablet containing the ndd software.
2. Open the application by double clicking the icon on the desktop. Once this is done, we are taken to the homepage (Figure 1a).

3. Click the dropdown and select the “ATS/ERS Standardization of Spirometry 2019 Update” spirometry standard. Then click on the “Confirm” button (Figure 1b)

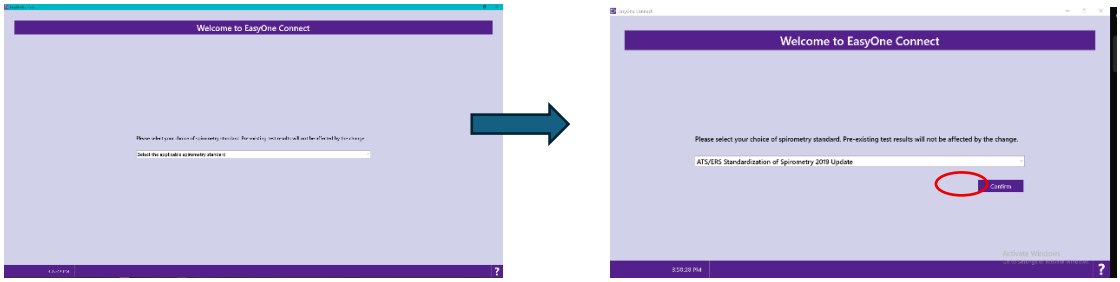


Figure 1: a.Ndd software home page(left) b. confirm spirometry standard(right)

4. Next we would be asked if we would like to use the NDD’s bacterial/viral filters for pulmonary function tests. Select “**NO”** and proceed (Figure 2a).
5. Next change the predicted set by clicking on “Edit” (Figure 2b).

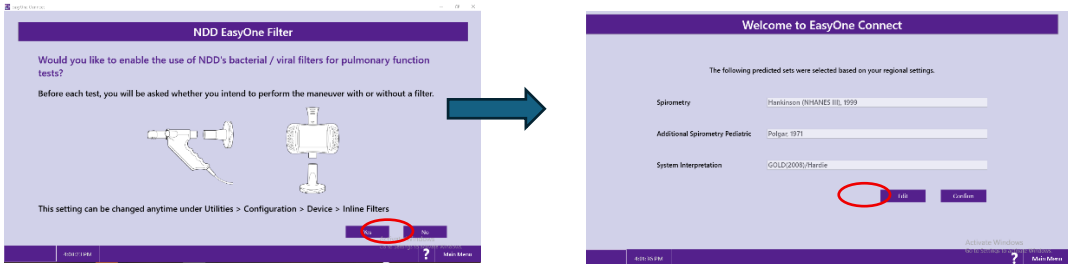


*Figure 2: a.Select **NO** to use of NDD filter(left) b. Click **EDIT** to change the predicted set(right).*

6. In the spirometry section, click the dropdown and select the option “Knudson, 1983” and save (Figure 3).

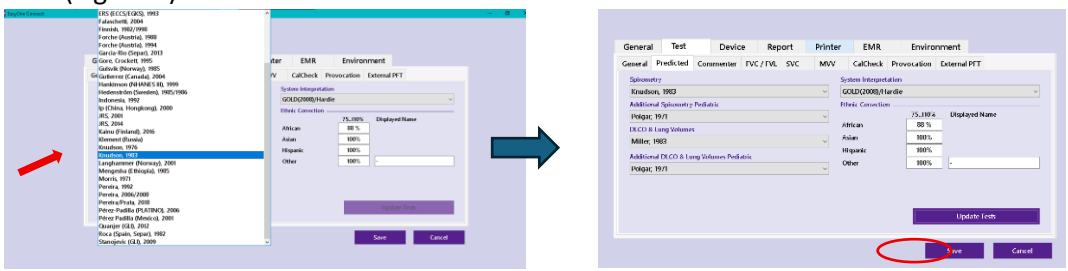


*Figure 3: a. Select “**Knudson, 1983”** in the spirometry section(left) b. click on **SAVE** to save the selected set(right).*

7. Click on “Patients” ( )to access the client registration page. Then click on “New” ( ) to register a new client (Figure 4)..

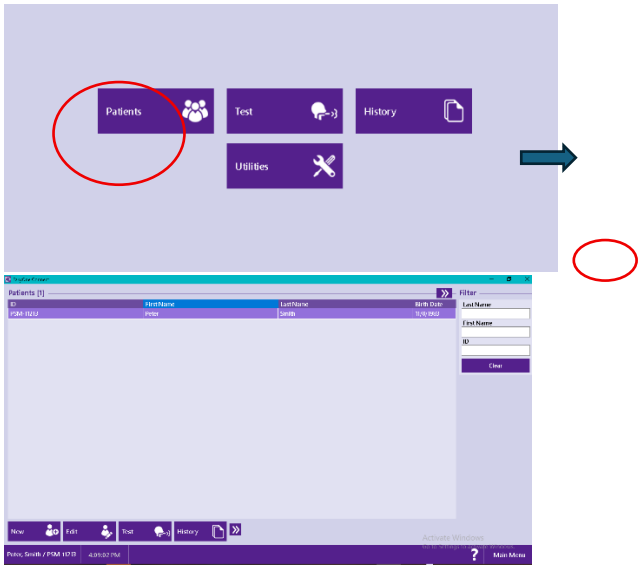


*Figure 4: a. click on "**Patient"s** to access client registration page(left) b. click on **New** to register a new client(right).*

8. Enter all the required information on the page that is displayed (Figure 5).
   Note: enter the accurate age, weight and height of the clients as these values are important in assessing abnormal lung function values.
9. Enter the smoking history in the "Smoking History" tab and click OK.

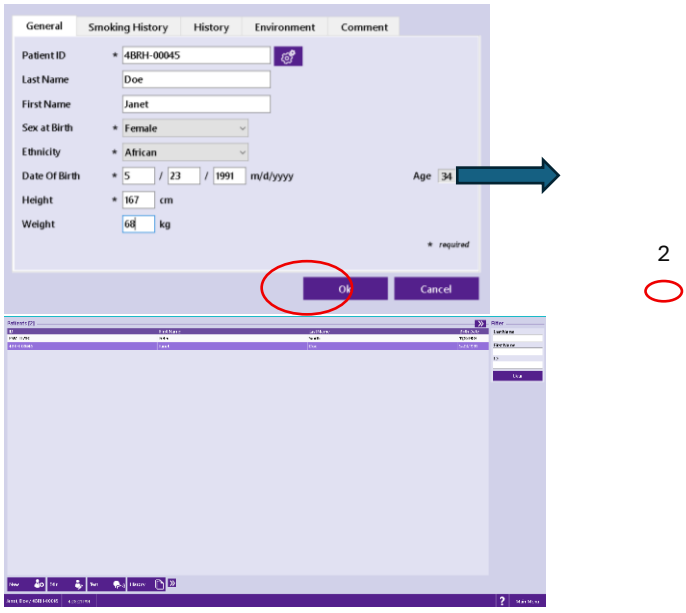


Figure 5: a. Enter client's information and click OK (left) b. select the client in the client list (1) and click on test(2) (right).

10. When this is done, you will be redirected to the patient registration page and the client you are from registering will be highlighted in purple. If it is not highlighted, do so by clicking on the client's tab once.

11. Insert a clean Spirette mouthpiece into the spirometer lumen, aligning the arrow on the Spirette with the one on the spirometer. Be careful not to touch the part of the mouthpiece that will be in contact with the client's mouth (see Figure 6).

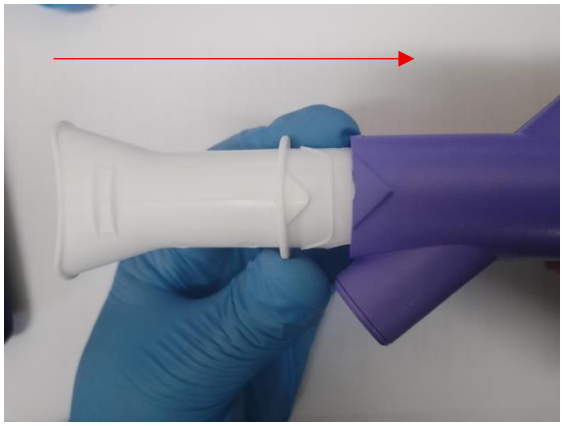
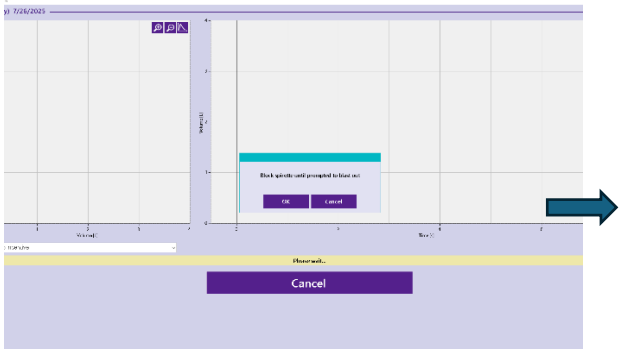


Figure 6: Align the arrow on the spirette and spirometer when inserting.

12. Click on the test tab () located in the bottom left corner of the window to begin the spirometry test.
13. A message appears asking you to block air flow to establish air flow, to this block the outlet of the spirette with the palm of your non dominant hand while holding it in place with your dominant hand as shown in figure xx



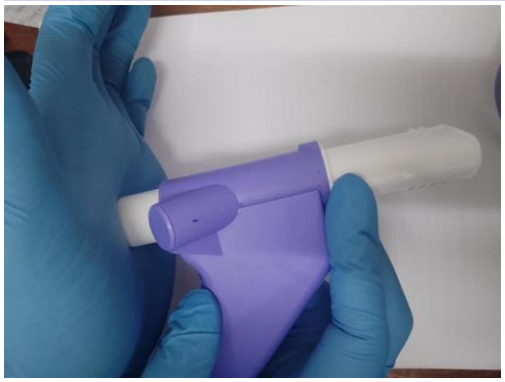


Figure 7: a click Okon the Pop up to set baseline b. Block the outlet of the spirette with the Palm of your hand.

14. Ask the participant to take a deep breath to fill the lungs with air

15. Then ask them to put their mouth round the spirette mouthpiece up to the mark and seal it with their lips to prevent air leakage.
    Note: Spirettes should not be sent above the indicators as this might induce choking, neither should they put their tongue in the lumen of the spirette as it would obstruct air flow.
16. They should blow forcefully through the spirette as long as possible during a single effort (at least 6 seconds).
    Note. During the process they should avoid coughing or taking in additional air as this is an expiratory exercise.
17. While they are doing this, stand at their side away from the exhaled air current and verbally encourage them through the process (e.g. by saying "keep going") while monitoring the time on the time graph to make sure they last for at least 6 seconds.
18. As they are performing the exercise, two graphs will be displayed on the screen. The flow vs volume graph on the left (Figure 8a) and the volume vs time graph on the right (Figure 8b).
19. Examine the graph to make sure it is interpretable (see section E below)

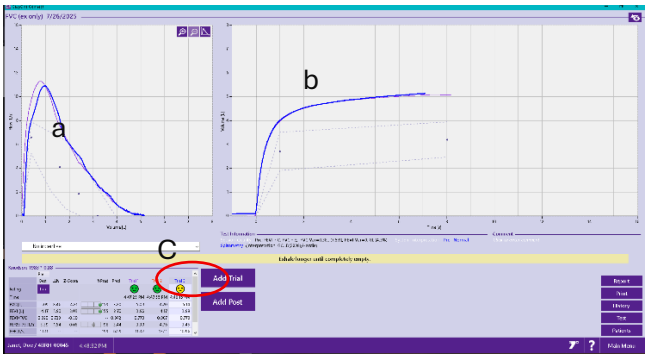


Figure 8: a. Flow vs volume graph b. Volume vs time graph c. click on Add Trial to begin a new exam.

20. Click on "**Add Trail"** to begin a new exam for the same client (Figure 8c). Add trials until at least three similar curves of good quality are obtained**.**
    Note: Trials can be repeated up to **8 times**, however if the client feels dizzy or out of breath stop trials and program another session if good curves are not obtained**.**
21. Repeat steps 7 to 20 to register a new client and perform their spirometry exam.

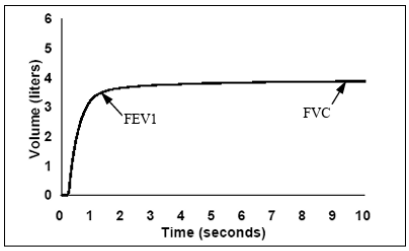
E. Interpretation of Results [7,8,9]

Values measured by spirometer

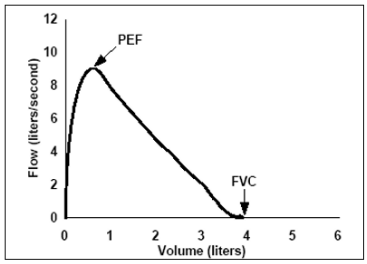
1. The Forced Vital Capacity (FVC) is the total amount of air exhaled during the test. Normal value is ≥80% of predicted value for age, gender, height and ethnicity.
2. The Forced Expiratory Volume in 1 Second (FEV1) is the amount of air exhaled in the first second of the test. The Normal value is ≥80% of predicted value for age, gender, height and ethnicity.
3. The FEV1/FVC Ratio used to diagnose obstructive and restrictive lung diseases. The Normal value is ≥0.70.
   Based on these values, spirometry results can indicate normal lung function or suggest the presence of obstructive or restrictive lung disease.

i. Normal Lung Function:

A lung function test is normal if all spirometry values fall within the predicted range for the client.



Normal volume-time curve



Normal flow-volume curve

Figure 9: a. Normal Volume vs time curve and b. Normal flow vs volume curve

ii. **Obstructive Lung Disease:**

An obstructive lung disease is characterized by reduced airflow, typically with a decreased FEV1 and a low FEV1/FVC ratio. During the BREATHE activities, an FEV1/FVC ratio less than 0.7 will be considered indicative of airway obstruction. For such clients, salbutamol spray should be administered, and the spirometry test should be done to assess reversibility.

a. **COPD** diagnosis is confirmed if post-bronchodilator FEV1/FVC ration is less than <0.70 (this indicates persistent airflow limitation) [7].

b. **Asthma** diagnosis is made when the FEV1 increases by >12% and/or >200 mL after bronchodilator use) [8,9].

Lung diseases and spirometry results

Interpretation	FVC	FEV1	FEV1/FVC%
Normal spirometry	Normal	Normal	Normal
Airway obstruction	Low or normal	Low	Low
Lung restriction	Low	Low	Normal
Combination of obstruction and restriction	Low	Low	Low

Figure 10: Spirometry results' Association with Respiratory Conditions [2]

iii. **Restrictive Lung Disease:**

Is characterized by reduced lung volume, typically with a decreased FVC and a normal or slightly reduced FEV1/FVC ratio.

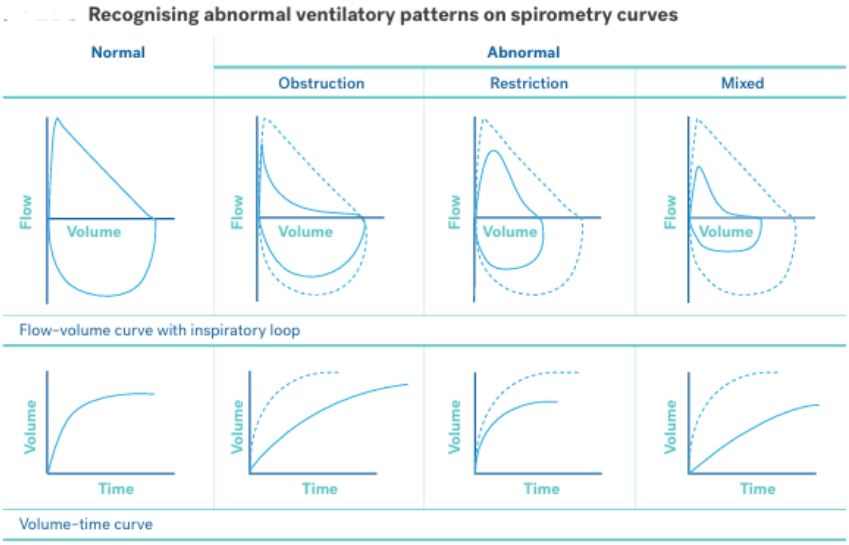


Figure 11: Abnormal Ventilatory Patterns [10]

F. Safety Precautions

1. Ensure the spirometer is properly calibrated to avoid inaccurate results.
2. Use disposable mouthpieces to prevent cross-contamination.
   - Ensure proper hand hygiene before and after handling the device
   - Monitor the patient for any signs of discomfort, distress, or dizziness during the test.
3. If the patient experiences any breathing difficulty or chest pain, stop the test immediately and seek medical attention
4. -Spirometry is contraindicated for participants with: recent eye surgery • recent thoracic and abdominal surgery • aneurysms (e.g. cerebral, abdominal) • unstable cardiac function • hemoptysis of unknown cause (i.e. infection risk) • pneumothorax • chest and abdominal pain • nausea and diarrhoea.

G. References

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2. Spirometry Procedures Manual: Spirometry Procedures Manual
3. American Lung Association. (n.d.). Pulmonary function tests (PFTs). Retrieved from https://www.lung.org/lung-health-diseases/lung-procedures-and-tests/lung-function-tests
4. World Journal of Pharmaceutical Research. Nose Clip in Spirometry -To Use or Not to Use? *volume-4,-june-issue-6_2962.pdf
5. Wu, Z., Peng, Y., Lin, K. *et al.* Quality inspection and result analysis of the spirometer calibration cylinder. *BMC Pulm Med* 22, 218 (2022). https://doi.org/10.1186/s12890-022-02010-1
6. Miller, M. R., et al. (2005). Standardisation of spirometry. European Respiratory Journal, 26(2), 319-338.

7. Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2023). Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease.
8. -Global Initiative for Asthma (GINA). (2023). Global Strategy for Asthma Management and Prevention.
9. American Thoracic Society (ATS). (2005). Standardization of Spirometry
10. Spirometry Handbook for primary care_2020: NAC_Spirometry-Handbook-for-primary-care_2020.pdf

Additional Resources

-Considerations in the use of different spirometers in epidemiological studies
https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0478-2

-The Effect of Inspiratory Muscle Training, Incentive Spirometer and Deep Breathing Exercise in Asthmatic Patient: A Narrative Review
https://www.ijsr.net/archive/v13i1/SR231229151237.pdf

-Comparison of Incentive Spirometer vs Balloon Blowing on Pulmonary Function in Post-Surgical Upper Abdominal Conditions
https://www.worldwidejournals.com/international-journal-of-scientific-research-%28IJSR%29/recent_issues_pdf/2024/March/comparision-of-incentive-spirometer-vs-balloon-blowing-on-pulmonary-function-in-post-surgical-upper-abdominal-conditions_March_2024_9238670141_3503691.pdf
-Spirometry-Guide-Book.pdf