

CLAIMS

What is claimed is:

1. An apparatus configured to measure pulmonary parameters of a user, comprising:
a sampling unit having a breath sampling port;
5 at least one pressure sensor located within the sampling unit and in communication
with the breath sampling port;
 at least one gas sensor configured to detect an analyte of interest from a sample breath
exhaled by the user into the breath sampling port, wherein the at least one gas sensor is
positioned in the sampling unit and in fluid communication with at least a portion of the
10 sample breath,
 a processor in communication with the at least one pressure sensor and the at least one
gas sensor,
 wherein the processor is configured to prompt a user with instructions to exhale a
sample breath for a first predetermined period of time into the breath sampling port,
15 wherein the processor is further configured to measure a pressure change relative to an
ambient pressure via the pressure sensor and correlate this pressure to a flow rate,
 wherein the processor is further configured to receive a measurement from the at least
one gas sensor and correlate this measurement to the analyte of interest from the sample
breath, and
20 wherein the processor is further configured to calculate a pulmonologic parameter of
the user based on the flow rate.

2. The apparatus of claim 1 wherein the processor is configured to prompt the user
with instructions to exhale at a constant flow rate or constant pressure.
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3. The apparatus of claim 1 wherein the processor is configured to further prompt the
user with instructions to inhale for a second predetermined period of time through the breath
sampling port.

4. The apparatus of claim 1 wherein the processor is further configured to prompt the user with instructions to hold their breath for at least 10 seconds prior to exhaling the sample breath.

5 5. The apparatus of claim 1 wherein the processor is further configured to prompt a user with instructions to exhale the sample breath for at least 6 to 12 seconds.

6. The apparatus of claim 3 wherein the processor is further configured to prompt the user to exhale for a third predetermined period of time into the breath sampling port.

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7. The apparatus of claim 1 wherein the at least one gas sensor is configured to sense a CO level from the sample breath.

8. The apparatus of claim 7 wherein the at least one gas sensor is configured to sense
15 a level of H₂, CH₄, CO₂, O₂, or C₃H₆O.

9. A method of measuring pulmonary parameters of a user, comprising:
prompting the user with instructions to exhale a sample breath into a sampling unit for
a first predetermined period of time;
20 measuring a first pressure change of the sample breath over the first predetermined
period of time via a pressure sensor in communication with the sample breath;
correlating the first pressure change to a flow rate via a processor in communication
with the pressure sensor;
measuring a biological parameter from the sample breath via at least one gas sensor in
25 fluid communication with at least a portion of the sample breath;
correlating a measurement of the biological parameter to an analyte of interest via the
processor in communication with the at least one gas sensor; and
calculating a pulmonologic parameter of the user via the processor based on the flow
rate.

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10. The method of claim 9 further comprising:

prompting the user with instructions to inhale through the sampling unit for a second predetermined period of time via the pressure sensor;

measuring a second pressure change of the sample breath over the second predetermined period of time; and

5 determining a total volume of air corresponding to a lung capacity of the user via the processor based on the first and second pressure changes over the first and second predetermined periods of time.

11. The method of claim 9 further comprising comparing the pulmonologic parameter
10 against a subsequent pulmonologic parameter to estimate lung capacity of the user over time.

12. The method of claim 9 further comprising prompting the user with instructions to hold their breath for at least 10 seconds prior to exhaling the sample breath.

13. The method of claim 9 further comprising prompting the user with instructions to
15 exhale at a constant flow rate or constant pressure when exhaling the sample breath.

14. The method of claim 9 wherein prompting the user with instructions to exhale
comprises prompting the user to exhale the sample breath for at least 6 to 12 seconds.

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15. The method of claim 10 further comprising prompting the user to exhale for a third predetermined period of time into the breath sampling port.

16. The method of claim 9 wherein measuring the biological parameter from the
25 sample breath comprises venting a remainder of the sample breath.

17. The method of claim 9 wherein measuring the biological parameter comprises sensing a CO level from the sample breath.

18. The method of claim 9 wherein measuring the biological parameter comprises
30 sensing a level of H₂, CH₄, CO₂, O₂, or C₃H₆O from the sample breath.

19. An apparatus configured to determine sampling compliance by a user, comprising:

a sampling unit having a breath sampling port;

5 at least one pressure sensor located within the sampling unit and in communication with the breath sampling port;

a processor in communication with the at least one pressure sensor,

wherein the processor is configured to prompt a user with instructions to exhale a sample breath for a predetermined period of time into the breath sampling port, to measure a pressure change relative to an ambient pressure via the pressure sensor upon sensing the sample breath, and to measure a timing of the pressure change imparted by the sample breath upon the pressure sensor,

10 wherein the processor is further configured to compare the timing of the sample breath against the predetermined period of time and to further compare an intensity of the pressure change against the ambient pressure.

20 20. The apparatus of claim 19 wherein the processor is further configured to prompt the user with instructions to hold their breath for at least 10 seconds prior to exhaling the sample breath.

21. The apparatus of claim 19 wherein the processor is further configured to prompt a user with instructions to exhale the sample breath for at least 6 to 12 seconds.

22. The apparatus of claim 19 wherein the processor is further configured to prompt the user when the pressure sensor detects a negative pressure change during the predetermined period of time.

23. The apparatus of claim 19 wherein the processor is further configured to prompt the user when the timing of the sample breath falls outside the predetermined period of time.

24. The apparatus of claim 19 wherein the processor is further configured to prompt the user with a corrective suggestion when the timing of the sample breath falls outside the predetermined period of time or when the intensity of the pressure fails to change relative to the ambient pressure or the pressure is negative.

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25. A method of determining sampling compliance by a user, comprising:

prompting the user with instructions to exhale a sample breath into a sampling unit for a predetermined period of time;

10 receiving the sample breath through a breath sampling port defined on the sampling unit;

measuring a pressure change relative to an ambient pressure via at least one pressure sensor located within the sampling unit and in communication with the breath sampling port upon sensing the sample breath;

15 measuring a timing of the pressure change imparted by the sample breath upon the at least one pressure sensor via a processor in communication with the at least one pressure sensor;

comparing the timing of the sample breath against the predetermined period of time; and

20 comparing an intensity of the pressure change against the ambient pressure.

26. The method of claim 25 further comprising prompting the user with instructions to hold their breath for at least 10 seconds prior to prompting the user with instructions to exhale the sample breath.

25 27. The method of claim 25 wherein prompting the user with instructions to exhale comprises prompting the user with instructions to exhale the sample breath for at least 6 to 12 seconds.

30 28. The method of claim 25 further comprising prompting the user when the pressure sensor detects a negative pressure change during the predetermined period of time.

29. The method of claim 25 further comprising prompting the user when the timing of the sample breath falls outside the predetermined period of time.

5 30. The method of claim 25 further comprising prompting the user with a corrective suggestion when the timing of the sample breath falls outside the predetermined period of time or when the intensity of the pressure fails to change relative to the ambient pressure or the pressure is negative.

10 31. An apparatus configured to determine sampling compliance by a user, comprising:
a sampling unit having a breath sampling port;
a first pressure sensor located in communication with a primary flow path within the sampling unit and in fluid communication with the breath sampling port;
a second pressure sensor located in communication with a secondary flow path within
15 the sampling unit and in fluid communication with the breath sampling port and one or more vent openings; and,
a processor in communication with the first and second pressure sensors, wherein the processor is configured to obtain a first pressure measurement from the first pressure sensor and a second pressure measurement from the second pressure sensor and determine a pressure
20 ratio of the second pressure measurement to the first pressure measurement.

25 32. The apparatus of claim 31 wherein the processor is further configured to prompt the user with instructions to exhale a sample breath for a predetermined period of time into the breath sampling port.

33. The apparatus of claim 32 wherein the processor is further configured to measure a pressure change relative to an ambient pressure upon sensing the sample breath.

30 34. The apparatus of claim 33 wherein the processor is further configured to measure a timing of the pressure change imparted by the sample breath.

35. The apparatus of claim 34 wherein the processor is further configured to compare the timing of the sample breath against the predetermined period of time and to further compare an intensity of the pressure change against the ambient pressure.

5 36. The apparatus of claim 31 wherein the processor is further configured to compare subsequent pressure ratios obtained from subsequent breath sample measurements against the pressure ratio such that deviations of the subsequent pressure ratios relative to the pressure ratio are indicative of the one or more vent openings being obstructed.

10 37. The apparatus of claim 36 wherein the processor is further configured to prompt the user with a corrective suggestion when the deviations are detected.

 38. A method of determining sampling compliance by a user, comprising:
 receiving a sample breath through a sampling port defined on a sampling unit such
15 that a first portion of the sample breath flows into a primary flow path and a second portion of the sample breath flows into a secondary flow path and through one or more vent openings;
 obtaining a first pressure measurement via a first pressure sensor in the primary flow path;
 obtaining a second pressure measurement via a second pressure sensor in the
20 secondary flow path;
 determining a pressure ratio of the second pressure measurement to the first pressure measurement via a processor in communication with the first and second pressure sensors;
 and
 comparing the pressure ratio against subsequent pressure ratios obtained from
25 subsequent breath sample measurements for deviations.

 39. The method of claim 38 further comprising prompting the user with instructions to exhale a sample breath for a predetermined period of time into the breath sampling port prior to receiving the sample breath.

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40. The method of claim 39 further comprising measuring a pressure change relative to an ambient pressure upon sensing the sample breath.

5 41. The method of claim 40 further comprising measuring a timing of the pressure change imparted by the sample breath.

42. The method of claim 41 further comprising comparing the timing of the sample breath against the predetermined period of time and to further compare an intensity of the pressure change against the ambient pressure.

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43. The method of claim 38 further comprising prompting the user with a corrective suggestion when the deviations are detected.