CLAIMS

~~WHAT IS CLAIMED IS:~~

~~1. A system to determine an occurrence of a symptom of a respiratory condition of a patient, the system comprising:~~

~~a transceiver operable to receive data from a monitor attached to a patient, the monitor including a plurality of sensors, each of the plurality of sensors configured to output physiological data related to the respiratory condition of the patient; and~~

~~an analytics platform, coupled to the transceiver, configured to:~~

~~analyze the physiological data to determine the occurrence of a symptom of the respiratory condition.~~

~~2. The system of claim 1, wherein the plurality of sensors includes a heart rate sensor and a respiratory sensor.~~

~~3. The system of any one of claims 1 to 2, further comprising a portable computing device that is operable to receive the physiological data from the transceiver and transmit the physiological data to the analytics platform.~~

~~4. The system of any one of claims 1 to 3, wherein the analytics platform is further configured to analyze environmental data related to the patient in determining the occurrence of the symptom of the respiratory condition.~~

~~5. The system of any one of claims 1 to 4, wherein the analytics platform is further configured to analyze demographic data related to the patient in determining the occurrence of the symptom of the respiratory condition.~~

~~6. The system of claim 2, wherein the plurality of sensors further comprises an accelerometer.~~

~~7. The system of claim 6, wherein the plurality of sensors further comprises a pressure sensor.~~

~~8. The system of claim 7, wherein the symptom is shortness of breath.~~

~~9. The system of claim 8, wherein the analytics platform is configured to determine shortness of breath using a combination of:~~

~~breathing effort determined from the pressure sensor and the accelerometer, and~~

~~respiration rate determined from the respiratory sensor.~~

~~10. The system of any one of claims 1 to 9, wherein the plurality of sensors includes an audio sensor.~~

~~11. The system of claim 10, wherein the analytics platform is further configured to differentiate between a soft wheeze and other adventitious signals based on data from the audio sensor.~~

~~12. The system of any one of claims 1 to 11, wherein the analytics platform is executed on a remote server.~~

~~13. The system of any one of claims 1 to 12, wherein the analytics platform is configured to apply a model to the physiological data to determine the occurrence of a symptom of the respiratory condition.~~

~~14. The system of claim 13, wherein the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.~~

~~15. The system of any one of claims 1 to 14, wherein the analytics platform is configured to determine an occurrence of a symptom based on population health factors relevant to the patient.~~

~~16. The system of claim 15, wherein the population health factors comprise social determinants of health.~~

~~17. The system of claim 16, wherein the analytics platform is further configured to infer the social determinants of health based on a geographic location of a home of the patient.~~

~~18. The system of claim 15, wherein the population health factors comprise data gathered from another patient in a cohort of patients that is similar to the patient.~~

~~19. The system of any one of claims 1 to 18, wherein the analytics platform is further configured to analyze the physiological data to determine a risk evaluation of an event of the respiratory condition of the patient.~~

~~20. The system of claim 19, wherein the analytics platform is further configured to compare the risk evaluation with a threshold to predict the respiratory event.~~

~~21. The system of claim 20, wherein the analytics platform is further configured to initiate a corrective action in response to the predicted respiratory event.~~

~~22. The system of any one of claims 19 to 21, wherein the plurality of sensors includes an impedance plethysmography sensor.~~

~~23. The system of claim 22, wherein the analytics platform is configured to determine the risk evaluation by:~~

~~correlating impedance measurements from the impedance plethysmography sensor with lung volume;~~

~~constructing a flow-volume curve from the lung volume;~~

~~extracting one or more tidal volume parameters from the flow-volume curve;~~

~~deriving features from the tidal volume parameters; and~~

~~applying a model to the features to determine the risk evaluation.~~

~~24. The system of claim 23, wherein the plurality of sensors includes an ECG sensor.~~

~~25. The system of claim 24, wherein the analytics platform is further configured to reject noise generated by cardiac activity from the impedance measurements using the ECG sensor.~~

~~26. The system of any one of claims 23 to 25, wherein the plurality of sensors includes an accelerometer.~~

~~27. The system of claim 26, wherein the analytics platform is further configured to reject movement artefacts from the impedance measurements using the accelerometer.~~

~~28. The system of any one of claims 23 to 27, wherein the one or more tidal volume parameters are drawn from the group consisting of:~~

~~Time to Peak Expiratory Flow over Expiratory Time;~~

~~Volume at Peak Expiratory Flow over Expiratory Tidal Volume; and~~

~~Slope of post-peak Expiratory Flow Curve.~~

~~29. The system of any one of claims 23 to 28, wherein the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.~~

~~30~~1. A continuous monitoring device attachable to a patient, the monitoring device comprising:

an enclosure having a surface that may be adhered to the patient;

a plurality of sensors, each of the plurality of sensors configured to output physiological data relating to a respiratory condition, disorder or ailment of the patient;

a memory configured to store the physiological data; and

a transceiver operable to transmit the physiological data to an external device.

312. The monitoring device of claim 301, wherein the plurality of sensors includes a heart rate sensor and a respiratory sensor.

32. The monitoring device of claim 31, wherein the respiratory sensor is an impedance plethysmography sensor.

333. The monitoring device of claim 32, further comprising a pair of electrode pads configured to sense a voltage between the electrode pads.

34. The monitoring device of claim 33, wherein the heart rate sensor and the respiratory sensor areis coupled to the pair of electrode pads.

35. The monitoring device of any one of claims 33-34, wherein the impedance plethysmography sensor is coupled to the pair of electrode pads.

364. The monitoring device of claim 335, further comprising a second pair of electrode pads to which the respiratoryimpedance plethysmography sensor is coupled for injection of low-amplitude, high-frequency current.

537. The monitoring device of any one of claims 130 to 36, wherein the enclosure has a form factor that is one of the group consisting of: a patch, a wristband, a necklace, and a vest.

638. The monitoring device of any one of claims 130 to 37, wherein the plurality of sensors includes at least one of an audio sensor.

39. The monitoring device of any one of claims 30 to 38, wherein the plurality of sensors includes an accelerometer, and a gyroscope or.

40. The monitoring device of any one of claims 30 to 39, wherein the plurality of sensors further comprises a pressure sensor.

741. The monitoring device of claim 130, wherein the enclosure is fabricated from a flexible compliant material.

842. A system to monitor a respiratory condition of a patient, the system comprising:

a monitor attachable to the patient, the monitor including:

a plurality of sensors, each of the plurality of sensors configured to output physiological data relating to the respiratory condition of the patient; and

a first transceiver configured to transmit the physiological data;

an external device including a second transceiver configured to receive the physiological data from the first transceiver; and

an analytics platform, coupled to the second transceiver, configured to:

analyze the physiological data received from the second transceiver to determine the occurrence of a symptom of the respiratory condition.

~~43. The system of claim 42, wherein the plurality of sensors includes a heart rate sensor and a respiratory sensor.~~

~~44. The system of any one of claims 42 to 43, wherein the external device is a portable computing device.~~

9~~45~~. The system of ~~any one of~~ claim~~s~~ 8~~42 to 44~~, wherein the analytics platform is further configured to analyze environmental data related to the patient in determining the occurrence of the symptom of the respiratory condition.

10~~46~~. The system of ~~any one of~~ claim~~s~~ 8~~42 to 45~~, wherein the analytics platform is further configured to analyze demographic data related to the patient in determining the occurrence of the symptom of the respiratory condition.

11~~47~~. The system of claim 8~~43~~, wherein the symptom is shortness of breath, wherein the plurality of sensors includes~~further comprises~~ an accelerometer~~.~~

~~48. The system of claim 43, wherein the plurality of sensors further comprises~~ a pressure sensor, and a respiratory sensor~~.~~

~~49. The system of claim 48, wherein the symptom is shortness of breath.~~

~~50. The system of claim 49~~, and wherein the analytics platform is configured to determine shortness of breath using a combination of:

breathing effort determined from the pressure sensor and the accelerometer, and

respiration rate determined from the respiratory sensor.

12~~51~~. The system of ~~any one of~~ claim~~s~~ 8~~42 to 50~~, wherein the plurality of sensors includes an audio sensor~~.~~

~~52. The system of claim 51~~, and wherein the analytics platform is further configured to differentiate between a soft wheeze and other adventitious signals based on data from the audio sensor.

~~53. The system of any one of claims 42 to 52, wherein the analytics platform is executed on a remote server.~~

13~~54~~. The system of ~~any one of~~ claim~~s~~ 8~~42 to 53~~, wherein the analytics platform is configured to apply a model to the physiological data to determine the occurrence of a symptom of the respiratory condition.

14~~55~~. The system of claim 13~~54~~, wherein the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.

15~~56~~. The system of ~~any one of~~ claim~~s~~ 8~~42 to 55~~, wherein the analytics platform is further configured to analyze the physiological data to determine a risk evaluation for a respiratory event of the respiratory condition.

~~57. The system of claim 56, wherein the analytics platform is further configured to compare the risk evaluation with a threshold to predict the respiratory event.~~

~~58. The system of claim 57, wherein the analytics platform is further configured to initiate a corrective action in response to the predicted respiratory event.~~

16~~59~~. The system of ~~any one of~~ claim~~s~~ 15~~56 to 58~~, wherein the plurality of sensors includes an impedance plethysmography sensor~~.~~

~~60. The system of claim 59~~, and wherein the analytics platform is configured to determine the risk evaluation by:

correlating impedance measurements from the impedance plethysmography sensor with lung volume;

constructing a flow-volume curve from the lung volume;

extracting one or more tidal volume parameters from the flow-volume curve;

deriving features from the tidal volume parameters; and

applying a model to the features to determine the risk evaluation.

~~61. The system of claim 60, wherein the plurality of sensors includes an ECG sensor.~~

~~62. The system of claim 61, wherein the analytics platform is further configured to reject noise generated by cardiac activity from the impedance measurements using the ECG sensor.~~

~~63. The system of any one of claims 60 to 62, wherein the plurality of sensors includes an accelerometer.~~

~~64. The system of claim 63, wherein the analytics platform is further configured to reject movement artefacts from the impedance measurements using the accelerometer.~~

1765. The system of ~~any one of~~ claim~~s~~ 1661 ~~to 64~~, wherein the one or more tidal volume parameters are drawn from the group consisting of:

Time to Peak Expiratory Flow over Expiratory Time;

Volume at Peak Expiratory Flow over Expiratory Tidal Volume; and

Slope of post-peak Expiratory Flow Curve.

~~66. The system of any one of claims 61 to 65, wherein the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.~~

~~67. The system of any of claims 56 to 66, further comprising a medication rules engine configured to modify a therapy plan for the respiratory condition based on the determined risk evaluation.~~

~~68. The system of claim 67, wherein the medication rules engine is configured to adjust a dosage of a medication forming part of the therapy plan.~~

~~69. The system of claim 67, wherein the medication rules engine is configured to adjust a type of a medication forming part of the therapy plan.~~

1870. The system of ~~any one of~~ claim~~s~~ 1556 ~~to 69~~, wherein the analytics platform is further configured to issue an alert based on the risk evaluation.

1971. The system of claim 1870, further comprising an alert device configured to:

receive the alert issued by the analytics platform, and

alert a person on receipt of the alert.

20. A method to monitor a respiratory condition of a patient, the method comprising:

transmitting physiological data from a monitor attached to the patient, the monitor including:

a plurality of sensors, each of the plurality of sensors configured to output physiological data relating to the respiratory condition of the patient; and

a first transceiver configured to transmit the physiological data;

receiving the physiological data on a second transceiver of an external device configured to receive the physiological data from the first transceiver; and

analyzing the physiological data received from the second transceiver via an analytics platform coupled to the second transceiver to determine the occurrence of a symptom of the respiratory condition.

~~72. The system of claim 71, wherein the alert device is configured to arouse the person from sleep on receipt of the alert.~~

~~73. The system of any one of claims 71 to 72, wherein the alert device is a wearable alert device.~~

~~74. A method of predicting an event of a respiratory condition of a patient, the method comprising:~~

~~collecting physiological data relating to the respiratory condition of the patient from a plurality of sensors in a monitor attached to the patient; and~~

~~applying a model to predict an event of the respiratory condition based on the physiological data collected from the plurality of sensors.~~

~~75. The method of claim 74, wherein the plurality of sensors includes a heart rate sensor and a respiratory sensor.~~

~~76. The method of claim 75, wherein the plurality of sensors further comprises an accelerometer.~~

~~77. The method of claim 76, wherein the plurality of sensors further comprises a gyroscope.~~

~~78. The method of any one of claims 74 to 77, wherein the model takes into account environmental data related to the patient.~~

~~79. The method of any one of claims 74 to 78, wherein the model takes into account demographic data related to the patient.~~

~~80. The method of any one of claims 74 to 79, wherein the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.~~

~~81. The method of any one of claims 74 to 80, further comprising issuing an alert to an alert device upon prediction of the event, wherein the alert device is configured to alert a person.~~

~~82. The method of any one of claims 74 to 81, wherein the model includes inputs of population health factors relevant to the patient.~~

~~83. The method of claim 82, wherein the population health factors comprise social determinants of health.~~

~~84. The method of claim 83, further comprising inferring the social determinants of health based on a geographic location of a home of the patient.~~

~~85. The method of any one of claims 82 to 84, wherein the population health factors comprise data gathered from another patient in a cohort of patients that is similar to the patient.~~

~~86. The method of any one of claims 74 to 85, further comprising initiating a corrective action in response to the predicted respiratory event.~~

~~87. The method of any one of claims 74 to 86, wherein the plurality of sensors includes an impedance plethysmography sensor.~~

~~88. The method of claim 87, further comprising determining a risk evaluation by:~~

~~correlating impedance measurements from the impedance plethysmography sensor with lung volume;~~

~~constructing a flow-volume curve from the lung volume;~~

~~extracting one or more tidal volume parameters from the flow-volume curve;~~

~~deriving features from the tidal volume parameters; and~~

~~applying a model to the features to determine the risk evaluation.~~

~~89. The method of claim 88, wherein the plurality of sensors includes an ECG sensor.~~

~~90. The method of claim 89, further comprising rejecting noise generated by cardiac activity from the impedance measurements using the ECG sensor.~~

91. The method of any one of claims 88 to 90, wherein the plurality of sensors includes an accelerometer.

92. The method of claim 91, further comprising rejecting movement artefacts from the impedance measurements using the accelerometer.

93. The method of any one of claims 88 to 92, wherein the one or more tidal volume parameters are drawn from the group consisting of:

Time to Peak Expiratory Flow over Expiratory Time;

Volume at Peak Expiratory Flow over Expiratory Tidal Volume; and

Slope of post-peak Expiratory Flow Curve.

94. A system to monitor a respiratory condition of a patient, the system comprising:

a monitor attachable to the patient, the monitor including:

a plurality of sensors, each of the plurality of sensors configured to output physiological data relating to the respiratory condition of the patient; and

a first transceiver configured to transmit the physiological data;

an external device including a second transceiver configured to receive the physiological data from the first transceiver; and

an analytics platform, coupled to the second transceiver, configured to:

analyze the physiological data received from the second transceiver to predict an event of the respiratory condition.

95. The system of claim 94, wherein the plurality of sensors includes a heart rate sensor and a respiratory sensor.

96. The system of claim 95, wherein the plurality of sensors further comprises an accelerometer.

97. The system of claim 96, wherein the plurality of sensors further comprises a gyroscope.

98. The system of any one of claims 94 to 97, wherein the model takes into account environmental data related to the patient.

99. The system of any one of claims 94 to 98, wherein the model takes into account demographic data related to the patient.

100. The system of any one of claims 94 to 99, where the model is configured by machine learning based on collected physiological data and respiratory condition outcome data.

~~101. The system of any one of claims 94 to 100, the analytics platform is further configured to issue an alert to an alert device upon prediction of the event, wherein the alert device is configured to alert a person.~~

~~102. The system of any one of claims 94 to 101, wherein the model includes inputs of population health factors relevant to the patient.~~

~~103. The system of claim 102, wherein the population health factors comprise social determinants of health.~~

~~104. The system of claim 103, wherein the analytics platform is further configured for inferring the social determinants of health based on a geographic location of a home of the patient.~~

~~105. The system of any one of claims 102 to 104, wherein the population health factors comprise data gathered from another patient in a cohort of patients that is similar to the patient.~~

~~106. The system of any one of claims 94 to 105, wherein the analytics platform is further configured for initiating a corrective action in response to the predicted respiratory event.~~

~~107. The system of any one of claims 94 to 106, wherein the plurality of sensors includes an impedance plethysmography sensor.~~

~~108. The system of claim 107, wherein the analytics platform is configured to determine a risk evaluation by:~~

~~correlating impedance measurements from the impedance plethysmography sensor with lung volume;~~

~~constructing a flow-volume curve from the lung volume;~~

~~extracting one or more tidal volume parameters from the flow-volume curve;~~

~~deriving features from the tidal volume parameters; and~~

~~applying a model to the features to determine the risk evaluation.~~

~~109. The system of claim 108, wherein the plurality of sensors includes an ECG sensor.~~

~~110. The system of claim 109, wherein the analytics platform is further configured for rejecting noise generated by cardiac activity from the impedance measurements using the ECG sensor.~~

~~111. The system of any one of claims 108 to 110, wherein the plurality of sensors includes an accelerometer.~~

~~112. The system of claim 111, wherein the analytics platform is further configured for rejecting movement artefacts from the impedance measurements using the accelerometer.~~

~~113. The system of any one of claims 108 to 112, wherein the one or more tidal volume parameters are drawn from the group consisting of:~~

~~Time to Peak Expiratory Flow over Expiratory Time;~~

~~Volume at Peak Expiratory Flow over Expiratory Tidal Volume; and~~

~~Slope of post-peak Expiratory Flow Curve.~~

~~114. An apparatus for monitoring a respiratory condition of a patient, the apparatus comprising:~~

~~a plurality of means for generating physiological data relating to the respiratory condition of the patient;~~

~~means for transmitting the physiological data; and~~

~~means for analyzing the physiological data received from the means for transmitting to predict an event of the respiratory condition.~~