CLAIMS

The invention is claimed as follows:

1. A system for monitoring a patient using a measurement associated with a pressure within a circulatory system of the patient while the circulatory system of the patient is connected to a pump, comprising:

a pressure sensor including a transducer disposed adjacent to or connected to a tube in fluid connection with the circulatory system and configured to generate an electronic signal associated with the pressure while the circulatory system of the patient is connected to the pump; and

an evaluation unit, including a computer processor communicatively connected to the pressure sensor to receive the electronic signal and a memory storing non-transitory computer-readable instructions that, when executed by the computer processor, cause the evaluation unit to:

obtain a time-domain pressure signal comprising values of an electronic signal associated with the pressure from the transducer based upon a physical phenomenon associated with the pressure of the patient over a sample period, wherein the sample period includes a plurality of time segments, including (i) one or more active time segments during which the pump is operating and (ii) one or more inactive time segments during which the pump is not operating;

identify a first plurality of the values of the time-domain pressure signal associated with the one or more inactive time segments and a second plurality of the values of the time-domain pressure signal associated with the one or more active time segments via forward and backward slope detection of the time-domain pressure signal;

delete the second plurality of values of the time-domain pressure signal;

generate a filtered time-domain pressure signal based upon the first plurality of the values and excluding the second plurality of the values;

apply a transformation to the filtered time-domain pressure signal to generate a frequency-domain pressure signal;

adjust the frequency-domain pressure signal, based on a ratio between a size of the second plurality of values of the time-domain pressure signal and a total sample window of values of the time-domain pressure signal; and

determine a patient status metric for the patient based upon the adjusted frequency-domain pressure signal via an equation that considers a plurality of harmonic frequencies.

2. The system of claim 1, wherein the pump is a peristaltic IV pump.

3. The system of claim 1, wherein the pump is configured to operate periodically, such that the one or more active time segments and the one or more inactive time segments periodically alternate.

4. The system of claim 1, wherein the tube is disposed between the patient and the pump such that a part of the pump is in fluid connection with the circulatory system of the patient via the tube.

5. The system of claim 4, wherein:

the transducer comprises a pressure sensor disposed in fluid connection with an interior of the tube; and

the physical phenomenon associated with the pressure is a pressure within the interior of the tube.

6. The system of claim 4, wherein the instructions further cause the evaluation unit to:

determine whether the patient status metric indicates a condition of the patient is abnormal; and

adjust operation of the pump when the patient status metric indicates the condition of the patient is abnormal by changing a rate of flow of a fluid from the pump into the circulatory system of the patient.

7. The system of claim 1, wherein the executable instructions further cause the evaluation unit to generate the filtered time-domain pressure signal by, for each of one or more pairs of the active time segments:

identifying one or more corresponding values within both of the active time segments of the pair; and

combining the active time segments of the pair by aligning the one or more corresponding values within both of the active time segments of the pair.

8. The system of claim 1, wherein the executable instructions that cause the evaluation unit to generate the filtered time-domain pressure signal include instructions that cause the evaluation unit to:

estimate a third plurality of values as substitute values for the one or more active time segments, wherein the third plurality of values are estimated based upon the first plurality of values without reference to the second plurality of values; and

generate the filtered time-domain pressure signal by combining the first plurality of values for the inactive time segments and the third plurality of values for the active time segments.

9. The system of claim 8, wherein the third plurality of values are estimated by performing at least one of regression analysis, forward-backward slope calculation, two-sided slope detection, and mirror matched filtering on at least the first plurality of values.

10. The system of claim 1, wherein the executable instructions that cause the evaluation unit to determine the patient status metric include instructions that cause the evaluation unit to:

identify a plurality of frequencies associated with local maxima of the frequency-domain pressure signal; and

determine the patient status metric based at least in part upon at least one of the plurality of frequencies associated with the local maxima.

11. The system of claim 1, wherein the patient status metric is a blood volume metric indicating one or more of the following: hypovolemia, hypervolemia, or euvolemia.

12. A device for monitoring a patient, comprising:

a pressure sensor, including a transducer configured to monitor a physical phenomenon associated with a pressure within a circulatory system of the patient while the circulatory system of the patient is connected to a pump; and

an evaluation unit, including a computer processor communicatively connected to the pressure sensor and a memory storing non-transitory executable instructions that, when executed by the computer processor, cause the evaluation unit to:

obtain a time-domain pressure signal comprising values of an electronic signal associated with the pressure received from the transducer of the pressure sensor over a sample period, wherein the sample period includes a plurality of time segments, including (i) one or more active time segments during which the pump is operating and (ii) one or more inactive time segments during which the pump is not operating;

identify a first plurality of the values of the time-domain pressure signal associated with the one or more inactive time segments and a second plurality of the values of the time-domain pressure signal associated with the one or more active time segments via forward and backward slope detection of the time-domain pressure signal;

delete the second plurality of values of the time-domain pressure signal;

generate a filtered time-domain pressure signal based upon the first plurality of the values and excluding the second plurality of the values;

apply a transformation to the filtered time-domain pressure signal to generate a frequency-domain pressure signal;

adjust the frequency-domain pressure signal, based on a ratio between a size of the second plurality of values of the time-domain pressure signal and a total sample window of values of the time-domain pressure signal; and

determine a patient status metric for the patient based upon the adjusted frequency-domain pressure signal via an equation that considers a plurality of harmonic frequencies.

13. The device of claim 12, wherein:

the time-domain pressure signal comprises a first time series of discrete values;

the filtered time-domain pressure signal comprises a second time series of discrete values; and

the second time series contains at least one segment of a sequential plurality of values within the second time series that are equivalent to a corresponding segment of a sequential plurality of corresponding values within the first time series.

14. The device of claim 12, wherein the executable instructions that cause the evaluation unit to generate the filtered time-domain pressure signal include instructions that cause the evaluation unit to:

estimate a third plurality of values as substitute values for the one or more active time segments, wherein the third plurality of values are estimated based upon the first plurality of values without reference to the second plurality of values; and

generate the filtered time-domain pressure signal by combining the first plurality of values for the inactive time segments and the third plurality of values for the active time segments.

15. The device of claim 12, wherein adjusting the frequency-domain pressure signal includes dividing magnitudes of the frequency-domain pressure signal by a quotient of the second plurality of values and the total sample window of values.